RECREATION STUDIED FROM ABOVE

AIRPHOTO INTERPRETATION
as input into
LAND EVALUATION FOR RECREATION

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Airphoto interpretation as input into land evaluation for recreation

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ABSTRACT

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327 pages, 16 tables, 90 figures, 344 references, one appendix; English and Dutch summaries (doctoral thesis Wageningen).

Recreation and tourism are of growing importance not only in the industrialized part of the world, but also in developing countries. Remote sensing and in particular airphoto interpretation can be used in several ways as input into land evaluation for recreation and tourism. An inventory of recreational facilities that can give a first indication of the spatial pattern of recreation, can be partly done by airphoto interpretation. For the analysis of the relation between recreational facilities and their resources, remote sensing can give the best overview of the landscape. The use of sequences of airphotos can reveal development processes. An extreme stage of recreational impact, recreational erosion, can be identified on airphotos. The gradual process underlying it can best be assessed from sequences of airphotos of different years. Airphotos are a useful tool too for the analysis of the spatial behaviour of recreationists, and sequences taken during one season or one day can provide the time dimension to that behaviour.
Airphotos are also ideal for analysis of the visual structure of the landscape, a first step to landscape evaluation.
Satellite images are not yet suitable for most applications, but in a number of studies reasonable results have been obtained with SPOT images, for example for change analysis and for the analysis of the visual structure of the landscape.
Application of remote sensing is especially appropriate in situations where conventional sources of data are scarce, completely lacking, obsolete or incomplete.

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Stellingen behorende bij het proefschrift getiteld:
Recreation studied from above.

1. De afstand van Amsterdam naar Groningen is groter dan die van Groningen naar Amsterdam. In deze stelling kan zonder bezwaar Groningen vervangen worden door Enschede, Maastricht of Vlissingen, en Amsterdam door Rotterdam, Den Haag of Utrecht.

2. Ook al heeft een land natuurlijke rijkdommen groot genoeg om het dubbele van de huidige bevolking te onderhouden, dan nog betekent dit niet dat men zonder beteugeling van de bevolkingsgroei gevrijwaard zal zijn van armoede.

3. Het overplaatsen van Instituten voor Internationaal Onderwijs, zoals bijvoorbeeld het ITC, naar ontwikkelingslanden is voor geen der betrokken partijen de beste oplossing.

4. Er is geen Derde Wereld.

5. Wanneer een bevolkingsbeleid zoals dat in China, waarin per echtpaar slechts één kind wordt toegestaan, daadwerkelijk volledig slaagt, zal dat naast gevolgen op vele andere terreinen ook gevolgen hebben voor de taal: woorden als broer, zus, oom, tante, neef en nicht zullen dan niet meer nodig zijn.

6. Op de Nederlandse Waddeneilanden zouden tram, electro-kar en/of paardentractie een oplossing van de vervoersproblemen kunnen zijn - vergelijk de toestand op enkele Oostfriese Waddeneilanden-, die beter bij de geadverteerde eilandsfeer past dan de huidige afhankelijkheid van de auto, ook op de zogenaamd autoloze eilanden.

7. In het kader van het behoud van de zeehond in de Waddenzee is het opvangen, verplegen en weer terugzetten van zeehonden door opvangcentra, hoe loffelijk ook als zodanig, slechts een doekje voor het bloeden.

8. Een korte cursus luchtfoto- en satellietbeeldinterpretatie zou standaard tot de opleiding van alle geografen moeten behoren.

9. Toerisme is geen wondermiddel waarmee alle economisch zwakke gebieden gezond gemaakt kunnen worden. (dit proefschrift).

10. Het ingeslopen gebruik om pixels uit te drukken in meters in het vierkant is niet correct en moet beschouwd worden als onzuiver taalgebruik.

11. Voor het interpreteren van remote sensing beelden is (specialistische) kennis van het te onderzoeken onderwerp meestal belangrijker dan gedetailleerde kennis van de remote sensing techniek. (dit proefschrift).

12. Bij de aanschafkeuze van een Geografisch Informatie Systeem (GIS) dient op meer gelet te worden dan alleen de eenmalige aanschafkosten van hardware en software.

13. Het koppelen van de begrippen recreatie en toerisme in termen als *toeristisch-recreatieve complexen* en toeristisch-recreatieve ontwikkelingsplannen (zie onder andere: Dietvorst, 1989, Complexen en netwerken: hun betekenis voor de toeristisch-recreatieve infrastructuur; Dietvorst en Jansen-Verbeke, 1986, Een geografische visie op de interrelatie vrije tijd, recreatie en toerisme; Jansen-Verbeke, 1987, Freizeit, Fremdenverkehr und Erholung) geeft aan dat de scheidslijn tussen recreatie en toerisme, zo die al zinvol is, veelal niet scherp te trekken is.

14.De laatste jaren is het aantal recreatiemogelijkheden uitgebreid door het beschikbaar komen van verschillende voertuigen, zoals All-Terrain-Bikes (ATB's), Off-the-road-vehicles, Ultra-Lichte-Vliegtuigen (ULV's), die geschikt heten te zijn voor alle terreinen. Helaas wordt bij het gebruik ervan wel eens over het hoofd gezien dat niet alle terreinen geschikt zijn voor dit soort voertuigen.

15.Er zijn meer toepassingsmogelijkheden van remote sensing voor recreatie-onderzoek dan alleen maar het tellen van boten, auto's of personen vanuit de lucht. (dit proefschrift).

16.Natuur is niet essentieel voor openluchtrecreatie. In veel gevallen is een illusie van natuur voldoende.

17.Natuurbouw is geen tovermiddel waarmee alle aan de bestaande natuur toegebrachte schade volledig kan worden gecompenseerd. (L.Meijer in: Waddenwijzer, jrg 12, no 2).

18.De uiterste precisie in plaatsbepaling en nauwkeurigheid van tellingen is lang niet in alle onderzoeken waarbij luchtfoto's worden gebruikt essentieel. Relatieve aantallen en ruimtelijke patronen kunnen vaak voldoende zijn om een bepaalde vraagstelling te beantwoorden. (dit proefschrift).

19.De verschillende stappen van de procedure van elke landwaardering dienen goed te worden omschreven en beargumenteerd en de gemaakte veronderstellingen en gebruikte criteria duidelijk te worden uiteengezet, want alleen door zo de procedure doorzichtig te maken is controle er op mogelijk en kan de methode algemeen als bruikbaar aanvaard worden, zelfs als geen precieze nauwkeurigheid kan worden gemeten. (dit proefschrift).

20.Het schrijven van een proefschrift over recreatie is geen recreatie, ook al kost het veel vrije tijd. (mijn vrouw en dit proefschrift).

Enschede, 13 april 1992
Dick van der Zee

CONTENTS

*****

List of tables

List of figures

... there will be always new horizons to discover, new coasts to sail, new mountains to climb, new challenges to meet ....

Foreword

This thesis is the result of a long process. My scientific interest in recreation and in the application of airphoto interpretation was aroused during the final phase of my study in human geography and planning at the university in Groningen. Even though my final project then was not really suited to integrate the two, enough applications were discovered where the combination could be more successful. At the graduation ceremony it was stated that the formula, that the degree of doctorandus *gives access to the promotion*, should not be considered as an idle one. A challenge which I was not able to meet at once.
First there was the military service to fulfil, after that a job to find. By chance, or was it destiny, I got a temporary assignment at the International Institute for Aerospace Survey and Earth Sciences (ITC), giving me the opportunity to expand my experience in airphoto interpretation and further explore the possibilities to apply it to the theme of recreation.
As part of my next job I had to look into landscape analysis approaches, some of which also apply airphoto analysis, and as member of a working group on recreation in the Wadden Sea area I could carry out my first real case study applying airphoto interpretation to a recreation study.
When I was invited to come back to ITC, I gladly accepted. There I could continue to pay attention to the possible applications of airphoto interpretation to recreation studies and had it listed as an official research theme. Though it never reached the status of a research project with a real budget, wherever possible case studies were carried out during standard course fieldworks and also by some MSc students the topic was adopted.
Every now and then there was the opportunity, the invitation, the urge, in short a challenge, to further analyze the results of these studies and raw data and to collect some additional material, in order to put something on paper. But it remained bits and pieces and I started to play with the idea to incorporate them into one overall framework and finally meet the original challenge offered to me at graduation.
The application of Geographic Information Systems and satellite images was added to the topic and the context widened from human geography to landscape ecology.
Because of the extraordinary combination of remote sensing and recreation it took some time to find a promotor to adequately guide me and help in restructuring the scope and setting the target for this particular study. It being finished now does not mean that there are no challenges left. Just as there will be always new horizons to discover, new coasts to sail, new mountains to climb, there will always be new challenges to meet.

This study could not have been carried out without the stimulating support of and contributions by ITC course participants and by colleagues both at ITC and other institutions. They have assisted me in collecting data in the several case studies, provided me with material for further study and/or served as a useful think-tank in discussions.
Of crucial importance have been professor I.S.Zonneveld, who gave me the final push to accept the challenge, and professor H.N.van Lier, who in critical but stimulating discussions helped me to restrict the scope of the study and to remain on the once selected track.
Last but not least I thank Ymkje, Sjouke, Wieger and Marten, who had to endure that for so many years I had to spend so much time in the study rather than in the living room, but still provided the stable home-base without which writing a thesis such as this one is impossible.

Enschede, February 1992
Dick van der Zee

Introduction

Increase of recreation and tourism.

Recreation and tourism have become an inseparable part of the modern lifestyle and are still growing in importance. The post-war development of international travel shows an almost constant growth under influence of the increase in vacation time, income and mobility (Theuns, 1985; 1989a; WTO, 1988). Between 1950 and 1988 the number of international travellers in the world increased from 25 to 390 million (WTO, 1988). Only some slight interruptions occurred, caused by, for example, the oil crisis in 1974, and a major one, that resulted from the economic recession in 1982 (Theuns, 1985; 1989a; WTO, 1988). See figure 0.1.

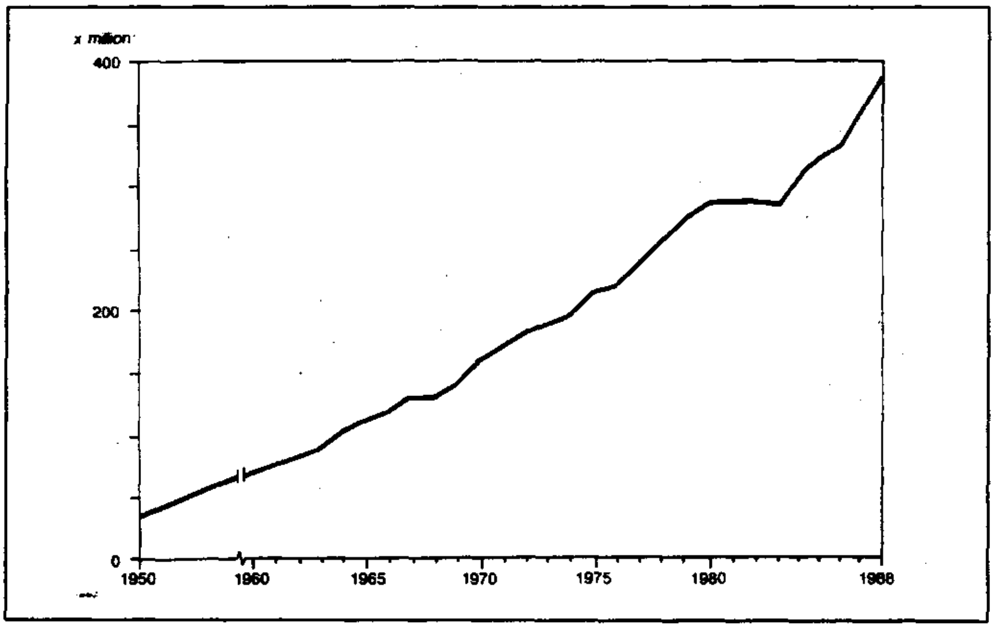

Figure 0.1. Arrivals of tourists from abroad all over the world in millions. (based on data from WTO, 1988).

But people appear to be resilient and determined to express their desire for recreation and travel in spite of fuel crises, recessions and inflation more than ever (Van Doren and Lollar, 1985). Therefore, as Gunn (1988) states, there is no sign of any slow-down in the growth of tourism as we look ahead to the twenty-first century.
Worldwide figures of the development of domestic tourism and recreation are hard to get, except for the statement that 90% of world tourism movements are due to domestic tourism (WTO, 1983b). In the Netherlands the vacation participation has increased rapidly, especially after 1960. Between 1954 and 1966 the number of vacations doubles from almost five to over ten million. The number of vacations in the own country increases with 90%, the number of vacations abroad triples. (Beckers, 1983). In the period 1977-1986 the number of overnight stays on Dutch camping grounds has increased with 23%, that in hotels with 6%; the capacity in hotels increased with 37% in the same period, that in camping enterprises increased with 11% (Bemelot Moens, 1990).
Also in many other countries increasing numbers of people take part in recreational activities, not only in the rich western part of the world, but also more and more in developing countries. Recreation and tourism have got a universal scope (WTO, 1983b).
The most explosive development of recreation, triggered by the automobile (Gunn, 1988), occurred during the 1960's, especially in Western Europe and North America (Van Doren and Lollar, 1985; Tarlet, 1990). In these 1960's recreation is considered as a mass phenomenon (Beckers, 1983), and in many Western European countries this resulted in a boom in the planning of outdoor recreation facilities in the public sector in the 1960's and 1970's (Van Lier, 1990b).

All this not only resulted in an increased political concern as well as a practical concern of planners in recreation and tourism, but also aroused an academic interest in that phenomenon (Dietvorst and De Pater, 1988).
The problems posed by recreation are far from new (Patmore, 1973), but in its mass form recreation is a rather recent phenomenon (Beckers, 1974), and therefore *what is unique to our own day is its scale and its scope.* A statement made by Wolfe already in 1966, but still valid today.
Its scale, particularly in the Western world and to a very large extent in communist countries too, where almost everybody can indulge in it to some degree (Wolfe, 1966). Although mass recreation in the communist countries is a comparatively recent phenomenon (Yanchev, 1988), and the growth in leisure time and personal mobility less marked (Coppock, 1982), it has assumed significant scope as a type of human lifestyle as well as a branch of economy in those countries too (Gerasimov et al., 1970; Rambousková, 1981). And after the most recent political developments further expansion of recreation and tourism can be expected. That recreation and tourism also in many developing countries becomes of ever increasing importance has been observed already by Robinson (1972). Leisure may still be *something of a luxury*, but more and more people have increasing time and increasing means to enjoy that luxury (Patmore, 1983).
Its scope, which embraces the whole surface of the earth, and increasingly the caves beneath that surface and the shallower beds of the sea itself. (Wolfe, 1966). There appears to be almost no place on earth that can completely escape from the influence of recreation. Nearly every location on the world has become accessible to visitors (Gunn, 1988), there are already even cruises to Antarctica. There has been a tremendous geographical spread of recreation and tourism (Theuns, 1989a).

The importance of recreation and tourism.

Recreation as a source of economic development.

Recreation and tourism, the recreation industry, can play an important role in the economic development of an area. The providing of goods, services and entertainment to visitors who come to an area for recreational activities can be of considerable economic importance for that area and provide a source of income that in many countries can hardly be missed any more (Ashworth, 1985; Bergstrom et al., 1989; Gunn, 1988; Krapf, 1962; MacConnel and Stoll, 1969; Pearson, 1961; Peppelenbosch and Tempelman, 1973a, 1973b; Theuns, 1989a; WTO, 1983b; Van der Zee, 1983, 1986). Worldwide, tourism is looked upon as a *smokeless industry* (Gunn, 1988), *the goose that lays the golden egg* (Jansen-Verbeke and Dietvorst, 1987), and on a world scale tourism is in dollar volume the second most important economic activity after the oil industry (Barkhof, 1988). The WTO (1988) estimated that the worldwide revenue from tourism amounted to about 200 billion dollars in 1988. See figure 0.2.
This figures of growth of tourism receipts are exaggerated when compared to those of tourism arrivals (see figure 0.3.) because they have not been corrected for inflation.

When the visitors the tourist industry is catering for come from abroad, tourism can be an important source, a valuable earner of badly needed foreign exchange (Culpan, 1987; Krapf, 1962; Robinson, 1972), be *invisible export* (Krapf, 1952; Theuns, 1989a; WTO, 1983b), and by a positive influence on the exchange balance influence the international trade (Krapf, 1962).
Tourism accounts for a considerable portion of Gross National Product (GNP) of such major tourist receiving countries such as Spain, Greece, Mexico, Kenya, Tunisia and Morocco. (Culpan, 1987). And also for Switzerland tourism represents one of the major sectors of the economy. In 1988 the total income from tourism amounted to SFr 16.9 billion, or 6% of the Swiss gross national product. Making tourism for years the third largest *export sector*. (Jacsman et al., 1990). In the Netherlands the revenues from incoming tourism were 6,407 million gulden in 1989 (Janssen, 1990). But the total amount of money spent in the Netherlands by both Dutch and foreign tourists is estimated to be 30 billion gulden, about 12% of the total consumptive spending. For comparison, the turnover of the motorcar branch in 1988 is estimated to be 18 billion gulden. (Dietvorst, 1989d; 1989e).

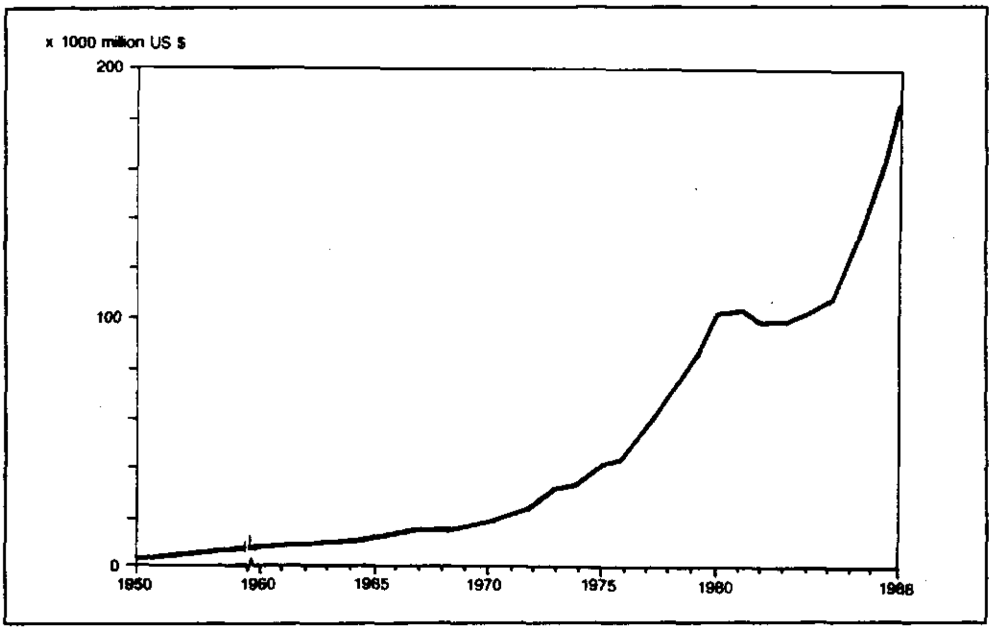

Figure 0.2. Receipts from international tourism all over the world in 1000 million US $. (based on data from WTO, 1988).

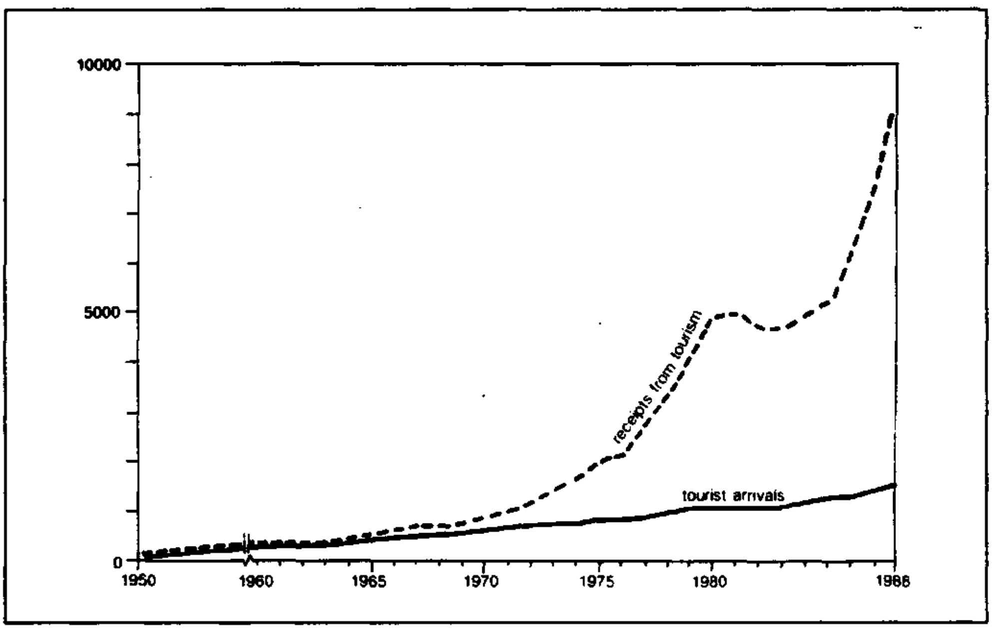

Figure 0.3. Worldwide tourism arrivals and receipts from tourism indexed for 1950 = 100. (based on data from WTO, 1988).

In addition tourism is a major source of employment, both directly and indirectly (Clout, 1976; Culpan, 1987; Dietvorst, 1989a; Peppelenbosch and Tempelman, 1973b; Patmore, 1983; Theuns, 1989a). It has been estimated that about 1.5 million people in Britain owe their livelihood directly or indirectly to tourism (Patmore, 1983), and estimates for the Netherlands vary from 230000 or 11% of the employed population (Venema, 1990), to 240000 or 6% of the Dutch working population (Beckers, 1988a;
Dietvorst, 1989d, 1989e; Van Lier, 1991), or even 250000 in 1984 (Bergsma, 1985). It has been compared to the agricultural sector, that with 260000 employees produces for

11500 million $, whereas recreation and tourism have a *production* of 15000 million $ (Van Lier, 1991). With about 220000 employees in 1988, or about 7.4% of the working population, tourism is one of Switzerland's major employers (Jacsman et al., 1990).
In addition to the direct employment in recreation and tourism the indirect employment should not be neglected. A study in Morocco revealed that each new hotel-bed created direct employment for 0.4 person, but additional indirect employment for 1.4 persons (Peppelenbosch and Tempelman, 1973b), and of the employment generated by tourism in the province of Drenthe, the Netherlands, one out of four man-days was found to concern indirect employment. (Kloosterman et al., 1985). The increased employment is not only of economic importance but is also in social aspects a great improvement. A side-effect is that education is stimulated, and not only in the specific tourism oriented branches. (Tempelman, 1973).
One of the big problems in measuring the effects of touristical spending and especially of the effects on employment is, that the touristical sector consists of a large number of sub-sectors that often do not get their full 100% income from tourism alone: for example, hotels/restaurants, retail trade. Other sectors are much more clearly touristical: camping-sites, bungalow-parks, the watersports sector. The business and congress visits complicate matters again for the hotel sector. (Kloosterman et al., 1985).
In addition, many benefits arising from (outdoor) recreation cannot be measured in ordinary economic terms. Values created by many recreation projects traditionally have been accepted as *free goods* (Palmer, 1967).

Special role of recreation in economically weak regions.
It has been stated that tourism is drawn towards the periphery (Christaller, 1955; 1964; Krapf, 1962; Bergsma, 1985), but on the other hand there is also a growing awareness of the importance of urban areas for recreation (Coppock, 1982; Ashworth, 1985; Jansen-Verbeke and Dietvorst, 1987; Dietvorst, 1987, 1989f; Dietvorst and De Pater, 1988; Gunn, 1988). These are the areas with a weak economy and therefore the income from tourism is a very welcome support. Tourism may create economic activities in areas that are not industrialized and are located far from the major markets (Krapf, 1962), and in this way regions economically benefit from factors which cannot be utilized otherwise: high mountain chains, barren rocky landscapes, heather, unproductive dunes (Christaller, 1955; 1964). Many countries have found tourism to be especially useful in correcting regional imbalance within their own frontiers. (Cosgrove and Jackson, 1972). Thus, recreation and tourism are seen as an economic draught-horse (Venema, 1990). Some consider tourism development as a universally applicable panacea for the problem of regional economic imbalance, others consider it as one more example of the neo-colonial exploitation of the economic periphery by the centre. (Ashworth and Goodall, 1985). Defert (1952) depicts tourism as a flood that spreads over a village or town and leaves a fertilizing sediment for the local economy, thus giving new life to an area. In the wake of tourism a lot of additional supporting enterprises find a place: restaurants, cafes, (souvenir)shops, art-shops, shops in sports equipment, barbershops, post-offices, tourist-offices, garages and car repair shops. Sometimes the old traditional crafts start flourishing again, woodcarving, weaving, etc. The transportation network becomes improved, special touristic roads constructed. (Christaller, 1955). Tourism gives the economically underdeveloped regions a chance to develop themselves, and more new regions for tourism are opened (Christaller, 1964). Recreation and tourism could be important in stimulating employment initiatives in regions with severe unemployment (Dietvorst and De Pater, 1988). Thus, the general feeling is that tourism can be a positive element with respect to development (Peppelenbosch and Tempelman, 1973a), and for many poorer countries or regions is becoming an increasingly attractive source of income as well as a means of financing other development (Cosgrove and Jackson, 1972). In addition, it is generally compatible with existing rural enterprises such as forestry and agriculture and helps to enhance the overall quality of life by providing recreational opportunities to local residents (Bergstrom et al., 1989).
On the Dutch Wadden Sea islands, for example, the introduction of recreation and its increasing importance, especially in the period after the second World War, created a possibility for the islands' populations to earn a living in other activities than agriculture or maritime professions. Starting as an additional source of income the recreation industry

nowadays is the most important economic activity on almost all Wadden Sea islands. Because of this the islands' populations could remain more or less stable in numbers. (Van der Zee, 1983). Tourism thus can have the result that the resource level is raised and by that the threshold of overpopulation (Defert, 1952).
Also in the otherwise economically weakly developed Alpine region, tourism has become the primary engine for the economic development since thirty years. The area has got a monopoly in the European wintersport business. (Danz, 1984). As such, tourism fulfils an important regional function in a country such as Switzerland, because most of the jobs in tourism are in mountainous areas where otherwise only agricultural and forestry jobs in limited scope would be available. Although tourism alone cannot solve economic problems in mountainous areas, without it there is no alternative. (Jacsman et al., 1990).

The importance of recreation in developing countries.
What is stated for the economically weak regions in general, certainly applies for developing countries in particular, in many of which tourism is an economic activity of importance (Theuns, 1985; 1989a). Despite the tremendous absolute increase of tourist arrivals in developing countries, their share in the world total remains modest (Peppelenbosch and Tempelman, 1973a; Theuns, 1989a). In the gross receipts from international travel in 1980 the developed countries of Europe took 63.2% of the total, the less developed countries of Europe 0,9%; North America got 13.4%, Latin America and Caribbean 8.4%, the developed countries in Africa 0,5%, the less developed countries in Africa 1.6%; the developed countries in Asia and the Pacific 1.7%, the less developed countries 6.7%; the developed countries in the Middle East 0.9% and the less developed countries 2.6% (Theuns, 1985). This is summarized in figure 0.4.

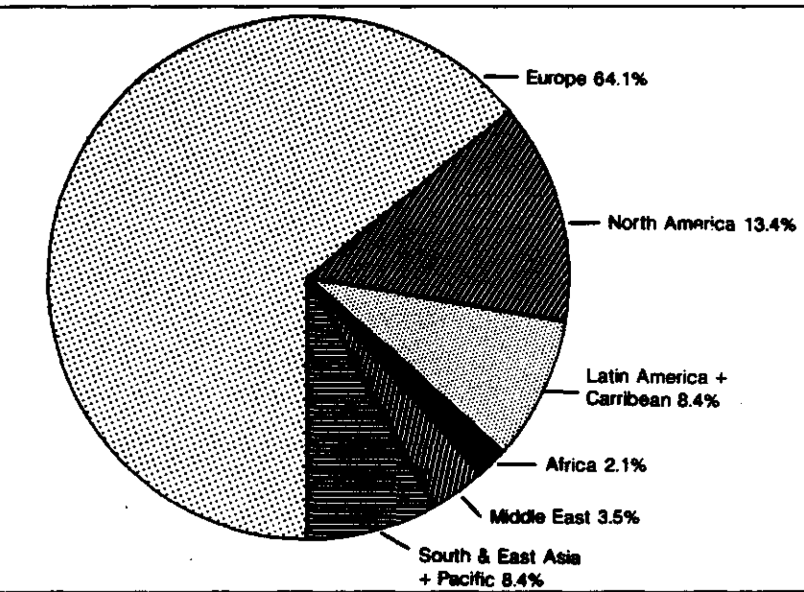

Figure 0.4. The share in receipts from international tourism by different parts of the world. (based on figures from Theuns, 1985)

In total the developed countries received 79.8% and the third world 20.2% (Theuns, 1985; 1989a). The share of the third world countries has increased gradually though: 15.3% in 1966, 16.3% in 1968, 15.8% in 1970, 16.7% in 1972, 19.3% in 1974, 17.9% in 1976, 18.5% in 1978, and 20.2% in 1980. The receipts from the export of touristical services in the third world in fifteen year have increased ten times, and it is not to be expected that in the near future tourism to the third world in general will collapse, although on a regional level increases and decreases may occur side by side (Theuns, 1985).
The airplane is the important means of transport for tourism to developing countries, and especially the introduction of charter flights has boosted mass tourism. This applies even stronger to the *long-haul* destinations in the third world. (Theuns, 1985; 1989a). Important

advantages of developing countries for tourism are: often a good climate, fascinating landscape, cultural-historical monuments, other customs and habits (the *exotic way of life*) and not to be forgotten the low prices. (Peppelenbosch and Tempelman, 1973b).
In most countries tourism provides only a small proportion of total foreign exchange receipts on current account and is more a modest source of income, and only of a very few countries the economy depends substantially on tourism (Peppelenbosch and Tempelman, 1973a).
The relative contribution of international tourism to the total receipts from export is a function of the *rate of development* of tourism on one hand and the *rate of general autarchy* or export orientation on the other. A high share of tourism in the export sector therefore often will occur in small countries, see table 0.1. An indication of the dependency on this source of income can be obtained to relate the income from tourism to the per capita income, see table 0.1. (Theuns, 1985; 1989a).

Table 0.1. Receipts from international tourism in 1980 for selected countries.

Country	as % of total export	as % of GNP per capita
Bahamas	51,5	50,9
Barbados	44,1	30,6
Grenada	36,5	39,1
Haiti	24,9	18,0
Jamaica	16,9	5,3
Mexico	21,0	9,1
Uruguay	18,7	2,8
Kenya	11,1	2,9
Morocco	13,8	2,5
Seychelles	57,7	40,5
Tunisia	22,5	7,8
Cyprus	18,5	9,7
Jordan	30,6	17,9
Malta	28,0	28,9
Yemen	20,4	2,2
Nepal	23,3	2,9
Thailand	10,6	2,6
Fiji	22,9	11,0

(based on data from Theuns, 1985).

In Sri Lanka tourism earnings in 1979 are 2.4% of the GNP, in Nepal 2.0%, in India and Pakistan 0.4%. In Sri Lanka in 1979 tourism earns 6.6% of the total foreign exchange, in Nepal 15.3%, in India 5.3% and in Pakistan 3.9%. In Sri Lanka it was on the 5th rank as foreign exchange earner. (WTO, 1983b). However, the number of tourist arrivals dropped from 338000 in 1983 to 183000 in 1987 (WTO, 1988), because of the political instability in the country.
In Botswana, tourism ranks fourth as a foreign exchange earner after diamonds, beef and copper-nickel (KCS, 1985). And in Thailand it is the largest of all the export sectors (TAT, 1987a).
International tourism has tended to concentrate on only a few countries of the developing world (Peppelenbosch and Tempelman, 1973a). Within the group of developing countries, European countries in 1980 had a share of 4.4%, Latin America and Caribbean 41.5% (of which Mexico 21.5%), Africa 7.7%, Asia and the Pacific 33.3% and the Middle East 13.0% (Theuns, 1985; 1989a). The rapid increase in Asian countries is influenced by the development of Japan as a tourist generating country (Theuns, 1989a).
The relevance of tourism for developing countries is often mainly seen in the context of foreign tourism (Robinson, 1972). Tourism to these countries is considered to belong to the consumptive acquisitions of the present welfare society. As a consequence the developing countries are overflown by the *golden hordes* of tourist from western countries and incorporated in the *pleasure periphery* (Theuns, 1985).
Tourists need not be exclusively foreigners, however, and the recreational needs and wants of the local population should not be overlooked (Robinson, 1972; WTO, 1983b).
In the developing countries domestic tourism can enjoy considerable growth (WTO, 1983a), and its importance as an endogenous economic activity must be underlined (WTO, 1983b).

Already Robinson (1972) observed that their rates of participation in recreation were rapidly increasing (Van der Zee, 1986). And even when a developing country's own people may not yet be ready to take advantage of its pleasant climate or lovely scenery, any more than they can use its bauxite or oil or wolframite, the very amelioration of poverty that tourism from abroad helps to bring may make it possible for them to begin to enjoy the amenities of their own country (Wolfe, 1966). Free time for recreation at present may be limited, and thus reducing the range of possible activities. If once the time and the means to embark on full-scale vacations are available to a wide section of the urban population, an explosion can be expected not only of traditional forms of recreational activity, but also of forms new to the region. (Robinson, 1972).

Not only because of the importance of both domestic and foreign tourism for the economy of region and nation, it may be rewarding to analyze the rural landscapes for their recreational potential, that is, to identify and evaluate their recreational resources. It should also be considered as a necessity to reserve some recreational capacity for when the participation of the local population in recreation will increase in the future.

The economic effects of tourism are in general positively appreciated. Of the social, cultural and social-psychological effects it is normally implied that for developed countries they are positive or at least not negative. This implication is not necessarily true for developing countries however, and these effects need therefore to be incorporated in the evaluation. (Theuns, 1989a).

Pressure on resources.

As population, mobility and participation in recreational activities increase, so does the demand that recreation makes on the land. This escalating demand for (outdoor) recreation leads to pressure on finite resources of land and water almost everywhere in the world. The observation that *congested roads and crowded beaches seem the inevitable concomitant of the summer weekend and the lover of rural solitude seeks often in vain for the peace and isolation he values so highly* (Patmore, 1972) has become more and more true. Wolfe already in 1966 warned the we should think about what would happen by 2000 AD : *We will have more of everything except space* (Wolfe, 1966). The year 2000 is much nearer now, and a lot of what Wolfe foresaw became reality. Recreation and tourism entered more and more into competition, and sometimes even conflicts with other land uses (Dietvorst, 1982; WTO, 1983b; Gunn, 1988). This growing pressure presents *an urgent and varied challenge, a challenge bedevilled by the inherent paradox of the need not only to conserve the scarce resources of land and amenity, but also to provide for their fuller use and enjoyment* (Patmore, 1972).

Like every human activity recreation brings about changes not only in the socio-economic sphere, but also in the sphere of environmental management (Rambousková, 1981). The great variety of recreational activities have become a landscape forming factor of importance (Dodt and Van der Zee, 1984). Tourism has created landscapes, but it has also destroyed others (Tarlet, 1990). In this respect recreation has been depicted as a wave breaking across the landscape. *Three great waves have broken across the face of Britain since 1800. First the sudden growth of dark industrial towns. Second, the thrusting movement along far-flung railways. Third, the sprawl of car-based suburbs. Now we see, under the guise of a modest word, the surge of a fourth wave, which could be more powerful than all the others. The modest word is leisure.* (Dower, 1965, quoted in Patmore, 1983).

Recreation also has been accused to be the greatest swallower of space. (*Le loisir est le plus grand devoureur d'espaces*, Duminy, 1967), as well as tourism of being a *landscape-glutton* (*Landschaftsfresser*, Danz, 1984), that both seem to gradually destroy the natural resources of their existence.

Therefore tourism and recreation policy should be influenced by the growing concern for the environment among the population, and recreational behaviour should no longer lead to consumption of rare nature values. This does not mean that all recreationists have to disappear from nature areas. It does mean that education and information have to create understanding for the fact that certain areas are not accessible or only accessible under restrictions. (Kromhout, 1986). It also means that careful planning and management of nature and recreation areas are needed, because only planning can avert negative impacts (Gunn, 1988). In comparison to apparent issues like the pollution of air, water and soil, rationalization of agricultural land use and increasing occupation by urban zones and transport networks, problems like impacts of outdoor recreation are often treated as *luxury problems*. Nonetheless such problems have become more and more relevant, especially in small countries that cannot do without trying to compromise conflicting land use forms. (Van der Ploeg, 1990).

Not only nature may suffer under increasing recreational pressure, also recreation itself may loose in quality with increasing quantity. All tourism resources -natural or man-made- are fragile, finite and depletable. Damage to the appearance of the landscape and places of interest results in a loss of the quality which originally attracts the tourism. The Manila Declaration on World Tourism of 10-10-1980 states: *The satisfaction of tourism requirements must not be prejudicial to the social and economic interests of the population in tourist areas, to the environment or, above all, to natural resources, which are the fundamental attraction of tourism, and historical and cultural sites. All tourism resources are part of the heritage of mankind.* (WTO, 1983b).
Moreover, if a quantitative value could be assigned to pleasure, the overall pleasure would surely be found not to increase at anything like the rate of recreational activities. The time must come when an increase in aggregate recreational activities will result in a decrease in aggregate pleasure. *Two motorboats on a lake may be heaven, whereas twenty will be hell.* The law of diminishing returns applies here with equal force. (Wolfe, 1966).
Another aspect is that by the time people from developing countries are ready to take part in using their own recreational resources, they may find that their country is no longer theirs to enjoy. The benefits of tourism are obvious and immediate, but the costs, dimly seen today, may prove to be a heavy burden on future generations. The tourist spends money, but he also uses commodities, and in time the one commodity he uses most of, space, may become too precious to be exchanged for even the hardest of currencies. (Wolfe, 1966). It is not only that the masses threaten to disturb the ideals of recreation in the free nature and threaten the conservation of nature (Beckers, 1983), but also the living conditions of the local communities can be affected (Dietvorst and De Pater, 1988). In addition to the environmental effects, there are the social and cultural effects of tourism (Gunn, 1988). The balance between positive and negative impacts should be made up, and the sustainable use of touristic or recreational (environment) resources should be ensured by environmentally sound strategies (WTO, 1983b).

Need for planning.

All this brings new problems for planning both in the recreational areas near the cities as well as in the more remote holiday regions, where proper management of the resources is dearly needed (Dodt and Van der Zee, 1984).
A proper planning for recreation cannot be attempted without an understanding of the capacity of recreational facilities and resources to absorb the demands that fall upon them, without damage or deterioration in the quality of the recreational experience. (Rodgers et al., 1973). Thus, knowledge is needed of both the demand and the supply. Having a better understanding of people's motivations, perceptions and satisfactions with respect to recreation does not lessen the importance of a clear understanding of the resulting patterns of activity and the complex demands on land and water resources that they generate. For such understanding and for proper planning and management good information is indispensable and the complex relation between recreation and landscape may be conveniently presented in a land evaluation procedure. Therefore, in addition to land evaluation for all kinds of agricultural, grazing, forestry or other landuses, land evaluation for recreational landuses is becoming more and more relevant, also in developing countries. The landscape as a whole and specific elements or components of the landscape in particular can be highly valuated as a resource for recreation.
But usually the sufficiently comprehensive and reliable database, that is essential for a land evaluation procedure, is lacking, because the various recreational development processes cannot be covered any more with the labour intensive and thus expensive, or time consuming and thus unpractical conventional methods of inventories by comprehensive mapping, counts

or enquiries in the field. And planning that has to be based on results of representative sample surveys or even pure estimates, may often not be satisfactory. (Dodt and Van der Zee, 1984).

Use of airphoto interpretation.

Therefore, in the inventory and analysis phase of such a procedure of landevaluation for recreation, remote sensing techniques -so far mainly airphoto interpretation has been used- are very important.

It has been stated that airphoto interpretation is a relatively fast, reliable and economic method to cover the existing need for data. Although this may not apply to all data that are needed or wanted it can be maintained that airphoto interpretation is an excellent tool to analyze the suitability of an area for recreation, with a minimum of effort and still very detailed. (Dodt and Van der Zee, 1984).

Analysis of the present situation with the aid of airphoto interpretation can be very useful in the first stage of establishing what type of recreational activities can be considered as relevant land utilization types and what requirements they have, that is, what are their recreational resources. If it is possible to compare the present situation with situations in the past, the process of developments can be analyzed and may give an indication of what to expect in the future.

The analysis of such sequences of photographs and of the impact of recreation on the landscape can already give an indication of the spatial behaviour of recreationists. This spatial behaviour can also be analyzed by taking several sequences of vertical or oblique airphotos during a single day. Analysis of the spatial behaviour in this way can give a more detailed understanding of what use is made of which specific (parts of) recreational resources.

Inventories and analyses of this kind thus can provide the necessary information for a landevaluation: what are the relevant recreational land utilization types and what are their requirements with respect to recreational resources. These requirements can not and should not exclusively be expressed in terms of physical suitability. Accessibility and location with respect to the major population concentrations (=sources of recreationists or tourists) is very important too. Also the general attractiveness of the area, that is the aesthetic qualities of the environment (the landscape, the scenery), in which the recreational activities take place, is of utmost importance.

Outline of the study.

The purpose of the study is to fully explore the possibilities and limitations of remote sensing as an input for land evaluation for recreation and tourism related land uses.

It is thought necessary to first clarify some concepts. Therefore in chapter 1 the concepts of *recreation, tourism, recreational resources, land evaluation* as well as *airphoto interpretation* and *remote sensing* will be discussed. As a result of this discussion the objectives of the study will be defined and the approaches and methods indicated. Chapter 2 then will concentrate on the potential of remote sensing for the inventory of recreational facilities and resources. Chapter 3 will discuss the possibilities to analyze development processes by studying sequences of images or airphotos. Chapter 4 will focus on the possibilities to analyze the spatial behaviour of recreationists. In chapter 5 then all the information that could be obtained in the previous phases and is of relevance for the land evaluation procedure is combined to assess the potential of remote sensing for the inventory, analysis and evaluation of recreational resources.

1. SOME CONCEPTS.

1.1. CONCEPTS OF RECREATION AND TOURISM.

Recreation.

The term recreation is frequently used in common language and may be therefore in many studies and plans it has not been thought necessary to define it. But even if it is defined, there is a large variety of definitions of touristical and recreational concepts, because more and more disciplines have shown an increasing scientific interest in this phenomenon (NRIT, 1975). The field of *recreation science* is a complex one and needs a multidisciplinary approach (Dietvorst, 1989a). But also the recreationists are more and more classified into specific groups, the definitions of which are determined by the point of view from which the classifications are made (Dietvorst, 1990a; NRIT, 1975; see also Hendriks and Zom, 1976a). In addition, overlaps occur with definitions of the related concepts *leisure* and *tourism*, and various definitions are not clear with respect to what is included and what is excluded (NRIT, 1975).
The concept of recreation needs to be defined and clarified, because otherwise the implicit use of different definitions, typologies and classification-systems may make it difficult to compare research results (NRIT, 1975). But it has to be realized that a social phenomenon that is as complex as recreation can be impossibly comprised in one *closed* system of definitions. There will always remain phenomena that cannot be completely covered by one certain definition. (WTR, 1973). Scientifically justified definitions nor simple attempts to explain how recreation is determined by personal or social factors seem to succeed to produce a clear *behaviour* that can be called *recreation* (Kelly, 1978, quoted by Wezenaar, 1982).

The basic principle of recreation.
Beckers (1983) distinguishes five meanings in the development of the concept, but refreshment of body or mind is, according to Pearson (1961), how the definitions of recreation given in most dictionaries can be best simplified. *Physical and mental relaxation* is a corresponding term found in many definitions. (RMNO, 1988; NRIT, 1975). The definition by Gerasimov et al. (1970), *recreation is a means of restoring strength and calming the nervous system and of preserving man's muscular and cardiovascular system at a proper level*, is more elaborate but may be less comprehensive, emphasising a health approach, that can also be found with Kiemstedt et al. (1975), as well as in one of the meanings given by Beckers (1983), in which health means not only the absence of illness and weakness, but the complete physical, mental and social well-being.

Recreation as activity....
MacConnel and Stoll (1969) see recreation as a *renewing experience* for those who participate. Clawson and Knetsch (1966) agree, that in a deeper psychological sense, recreation indeed refers to the human emotional and inspirational experience arising out of the recreation act, but then state that commonly the latter is used to stand for the whole. They conclude that *recreation* therefore means *activity*, and many others implicitly or explicitly do the same (for example, Beckers, 1974; Beckers and Slettenaar, 1986; Dietvorst, 1982; Jansen-Verbeke, 1982; Bemelot Moens, 1985; RMNO, 1988; Gunn, 1988; Van der Ploeg, 1990). Recreation also has been defined as *behaviour* (NRIT, 1975), because often it is not one single activity but as a rule includes an entire complex or system of both physical and mental activities (Gerasimov et al., 1970; Roomer, 1974). Mere idleness is not recreation. Only when the inactivity is consciously decided upon, planned, it can be considered as recreation. (Clawson and Knetsch, 1966).
But, recreation is activity of a special kind, *undertaken because one wants to do it* (Clawson and Knetsch, 1966). Recreation involves activities that people engage in from choice (Palmer, 1967), voluntarily (NRIT, 1975). Therefore, in defining recreation the motives behind the activities get strong emphasis. (NRIT, 1975; Hendriks and Zom, 1976a).

...of a special kind.

As an activity recreation contrasts with work and also with the mechanics of life, such as eating, sleeping, housekeeping, personal care and study (Clawson and Knetsch, 1966; Bernelot Moens, 1985, Zwaan et al., 1990). It comprises all forms of activities not compulsory determined by external and periodical physical obligations (Roomer, 1974), and are motivated by the pleasure with which they are carried out (Zwaan et al., 1990). Some state that all outdoor activities of man that are not related with his profession have to be considered as recreation (Van der Werf, 1972; Van der Ploeg, 1990), that there is a gap between work and non-work (Maas, 1971). But there is no sharp line between recreation and all other activities. The same activity may be work at some times and recreation at others, or it may be work for one person and recreation for the other. The distinguishing characteristic of recreation is not the activity itself, but the attitude with which it is undertaken (see also NRIT, 1975; Dietvorst, 1982; Beckers and Slettenaar, 1986). It takes place under specific *conditions*. When there is little or no feeling of compulsion or *ought to*, an activity can be considered to be almost purely recreation. However, elements of social compulsion are present even for recreation. (Clawson and Knetsch, 1966). That recreation, *in any socially accepted sense, involves constructive activities for the individual and the community* (Palmer, 1967), is a limitation that is not really essential in the conceptual sense.

As a result of the previous considerations the concepts mentioned have been integrated into the following definition:
Recreation: refreshment of body or mind by activities (or a planned inactivity) undertaken because one wants to do it, without any moral, economical, social or other pressure. (Van der Zee, 1971; 1986; 1987; 1990).

In this way it may be difficult to determine what is recreation and what not for individual cases. Certain activity patterns that in outward appearance are identical may be based on individually different factors. For one person going on holiday may mean the satisfaction of the want for rest, change of environment, contact with other people, etc., whereas for another person it may just be the meeting of certain wishes that exist within the family, not necessarily being exactly his personal first choice. (NRIT, 1975; Hendriks and Zom, 1976a). But when studying society as a whole, fortunately there is some aggregation into activities that most people agree to consider as recreational. And, disregarding possibly deviating individual motivations, all those activities are comprised in recreation of which it can be assumed that they are undertaken because people want to do them out of their own free will without any pressure. (See also NRIT, 1975).

Recreation and time.

Many times recreation is defined as activities taking place in specific time: *leisure, leisure time* or *free time*. For example: *..recreation is that which one does when at leisure* (Cosgrove and Jackson, 1972; Gunn, 1988), and thus is seen as synonymous to leisure activities (Beckers, 1974, 1983, 1988b; Bernelot Moens, 1985; Patmore, 1972; Usher, 1973; WTR, 1973; Zwaan et al., 1990). But activities are not recreation because they take place in a specific *time*, but because they take place under specific *conditions*. Even though these conditions may include a time dimension. (Roomer, 1974).

Leisure and recreation are highly correlated but they are not the same. Leisure time is far from synonymous with the time devoted to recreation (Patmore, 1972), nor is recreation restricted to the time free of work (Van der Voet, 1989; Van der Voet and Haak, 1989). Leisure is *time* of a special kind; *recreation* is *activity* (or inactivity) of special kinds. Recreation takes place during leisure; but not all leisure is given over to recreation. (Clawson and Knetsch, 1966). In French *loisir* depending on the context may be interpreted as *leisure* or as *recreation*, for example, in *Le loisir est le plus grand devoureur d'espaces* (Duminy, 1967) (= recreation is the greatest swallower of space).

However important the concept of leisure may be in relation to recreation, there is no real need to incorporate it in the definition of recreation.

Recreation and space.
Sometimes recreation is defined as activities in a specific spatial setting (Gerasimov et al., 1970; Roomer, 1974). It is very common to restrict recreation to *outdoor recreation* (Bemelot Moens, 1985; Dietvorst, 1986; Koetsier, 1982), specifically to activities in the countryside (Jansen-Verbeke, 1982; Van der Voet, 1989) at some distance of the own residence (Van der Ploeg, 1990). Even more restrictive is the definition of recreation as all forms and/or facilities for recreation in the outdoors that occupy a certain amount of space (Sas, 1988). This may be justified in the context of a particular study for pragmatic reasons. But, from a conceptual point of view the element of space is not really necessary in the definition of recreation.

Thus there appears to be no real need to revise the definition given by using time and/or space aspects as delimiting factors. It therefore remains rather wide and comprises a large variety of activities from watching television to mountain climbing. (Van der Zee, 1986; 1987).
In the context of specific studies it may be useful to add certain restrictions to the definition to make it operational. Such restrictions should however be clearly stated in order to enable comparison of results of different studies of the same subject. And because it often is not clear at the start how a certain aspect will fit in the larger whole, the restrictions should not be made too narrow in the beginning, they can always be further tailored afterwards.

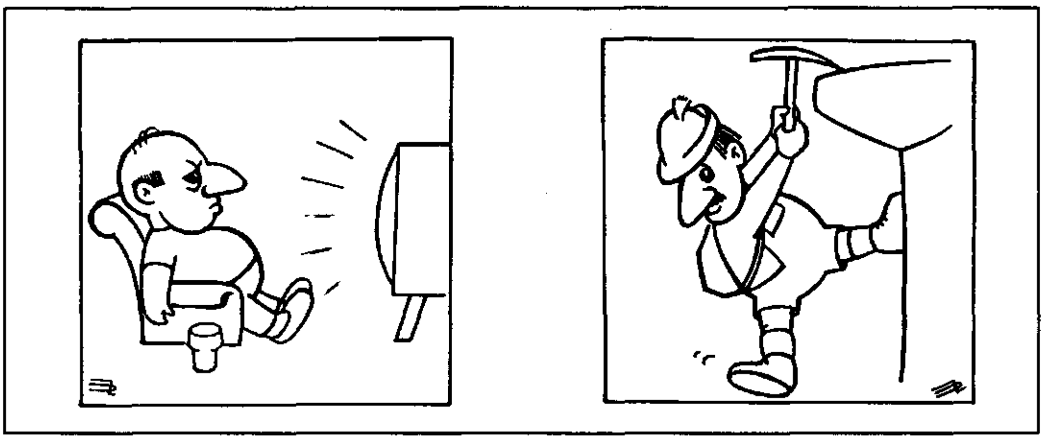

Figure 1.1 ***...from watching television to mountain climbing.***

Tourism.

Recreation and tourism.
A term recreation is frequently related to is *tourism*. In the everyday language the terms tourism and recreation are not clearly defined (NRIT, 1975), and the variety in definitions of tourism is perhaps even larger than for recreation. However, tourism and recreation are no synonyms, although they are often used as such (Klöpper, 1972). But they are no separate phenomena either (Beckers, 1974), their concepts are inseparable and overlapping (Ashworth and Goodall, 1985), and when their terms are used in quite distinct different meanings, they are still closely related. Some state that tourism can be considered as recreation, but that not all recreation is tourism. Others state that tourism coincides partly with recreation, but that not all tourism is recreation (Bemelot Moens, 1985), or that one concept does not comprise the other as one of its parts (Klöpper, 1972). The distinction between recreation and tourism thus is rather vague and often

depends on the spatial level of analysis (Oosterhaven and Verhek, 1985), or the particular point of view.

In trying to define tourism it is useful to distinguish between the *concept* and the *technical definitions*. The concept provides a theoretical framework, which identifies the essential characteristics, and which distinguishes tourism from similar, often related, but different phenomena. Technical definitions provide instruments for particular statistical, legislative, and industrial purposes, but often are restricted to only that part of tourism in which a company or organisation is interested (Leiper, 1979; Heeley, 1980).

Some holistic definitions attempt to embrace *the whole* essence of the subject, such as the definition by Hunziker and Krapf that has been adopted by the Association Internationale d'Experts Scientifiques du Tourisme (AIEST): *the sum of the phenomena and relationships arising from the travel and stay of non-residents, in so far as they do not lead to permanent residence and are not connected to any earning activity* (Leiper, 1979; Kosters, 1976; NRIT, 1975). But as such, the definition is too vague (Leiper, 1979). Gunn (1988) suggests that perhaps the best definition is that by Mathieson and Wall: *Tourism is the temporary movement of people to destinations outside their normal places of work and residence, the activities undertaken during their stay in those destinations, and the facilities created to cater to their needs*. Also rather holistic and not less vague.

Büchli (1962) gives a review of definitions of tourism, or rather of *Fremdenverkehr*, the German equivalent of tourism, and finds that four main aspects are or may be involved: a change of place away from home (= travel); a *stay* away from home, but temporary, not meant to be permanent; the use of special services; and the condition that the travel and stay should not be related to business or professional activities (Van der Zee, 1987).

Also Van Doorn (1980) reviews a number of definitions and meets the same elements : travel (movement), stay (destination outside) and no work or vocational training (motive). The emphasis is on the dynamic (travel) and the static (stay) aspect (see also Leiper, 1979), with a silent assumption that tourism occurs in leisure time. Other authors state that being somewhere else (Bergsma, 1985), in another environment (NRIT, 1975), are essential characteristics.

Tourism as (international) travel.

Tourism, according to the dictionary, is *the theory and practice of touring, travelling for pleasure* (Leiper, 1979). And in many definitions of the concept tourism the element of *travel* is essential (Büchli, 1962; Pearson, 1961; Van Doorn, 1980; Beckers, 1974; NRIT, 1975; Leiper, 1979; Heeley, 1980; Bernelot Moens, 1985; Gunn, 1988; Theuns, 1989a). Pearson (1961) even suggests that, since the root word *tour* implies travel, the terms: *tourist* and *tourism*, be applied only to those activities in which the movement occupies a large part of the time and where travel, with sight-seeing, is the factor which brings refreshment of body or mind.

A similar point of view can be found with Leiper (1979) and also Van Doorn (1980). The *travel* itself is seen as an important recreational activity: *travelling for pleasure* (NRIT, 1975; Hendriks and Zom, 1976b). The journey can be an aim in itself.

In some definitions tourism implies the travelling across international boundaries (Peppelenbosch and Tempelman, 1973a; Theuns, 1973a; Leiper, 1979). But the dividing line between international and domestic travel is somewhat arbitrary. What to the British is a holiday abroad in terms of distance and cost is to the North American a weekend excursion to a cottage or campsite. (Cosgrove and Jackson, 1972). It has already been mentioned that domestic travel comprises the largest part of all travel.

Still, often the criterion is maintained because data can be collected at the international boundaries via *entry-* and *exit-cards*, which is usually not possible at provincial boundaries. However, it is a technical criterion and not a conceptual one.

It can be concluded that tourism is a special type of recreation involving travelling away from home, in which the crossing of international boundaries is not essential. Tourism is recreational *travel* and a tourist is somebody who *travels* for pleasure. But, although the definition of a tourist as a special, travelling type of recreationist is certainly interesting from a conceptual point of view, in a survey it will be very difficult, if not impossible, to distinguish this specific type amongst the many visitors passing (Van der Zee, 1986).
Taking the distance away from home as a criterion (Hendriks and Zom, 1976b), gives an artificial distinction that certainly is not realistic from the point of view of the actor personally (Dietvorst, 1987a; Jansen-Verbeke and Dietvorst, 1987). Also for the purpose of land evaluation this seems to be less relevant, because it is the type of activities that determines the character of the land utilisation type, not the place of residence of the persons engaged in these activities (Van der Zee, 1986).

Tourism as stay of a certain duration.
The second main aspect in definitions of tourism is the *stay* away from home, in *another environment* (NRIT, 1975). Although to some tourism implies an absence of at least a few days (Tarlet, 1990), in most technical definitions at the national level the 24 hours stay, or one overnight stay appears to be the uniform criterion especially for domestic tourism, and irrespective of the motive of the travel (Defert, 1952; Robinson, 1953; Büchli, 1962; Cosgrove and Jackson, 1972; Theuns, 1973a, 1989a; Leiper, 1979; Heeley, 1980; Ashworth and Goodall, 1985; Gunn, 1988). *In many areas however a large part of the recreation activity is made up of persons who leave home during the daylight hours and return during the evening* (Pearson, 1961). If such persons do a lot of travelling, touring or sightseeing in that period they should be considered as tourists even if they do not spend a night away from home. Also Büchli (1962) agrees with the aspect of stay under condition that not specifically a stay overnight is meant, and that touring around in an area without staying long time on any particular place also is tourism. In terms of use of resources it matters little whether the visitor to coast and countryside is out for the day from home or on holiday. On a day-to-day basis, holidaymakers' patterns of activities within the holiday area differ but little from those of day visitors. (Patmore, 1983; Heeley, 1980).
On the other hand tourism has also been distinguished from stays of long duration such as summer holidays, and is characterised as an activity, in which the total journey is of rather long duration but the stay in each place short. (Christaller, 1955; Van Doorn, 1980). This aspect enhances tourism as a typically travelling type of activity.
An additional criterion often is that the destinations should be outside the places where people normally live, therefore, in tourism *the stay in another environment is of primary importance* (NRIT, 1975; Hendriks and Zom, 1976b).
But, as already discussed with respect to the aspect travel, another environment needs not imply another country (Hendriks and Zom, 1976a). And, when observing their actual activities, people cannot be directly classified into recreationists or tourists without having further information on *the own habitat* of the people engaged in them (Hendriks and Zom, 1976b). It is therefore not a very practical criterion.

It can be concluded that a stay away from home is essential in the concept of tourism, but that this stay should be not too long on one place. Taking a stay overnight as the criterion is an unnecessary restriction. Also the stay not necessarily needs to be in another country. And, since the element of travel already implies a stay away from home it is not even necessary to additionally include the aspect of stay in the definition of tourism.

Tourism as use of services.
Although the element of stay may not be essential to define the concept of tourism, still often the stay overnight is used as *counting unit* (Defert, 1952). This tendency to use the overnight stay as criterion often coincides with the emphasis that many definitions place on the use of special

services and facilities by tourists. Of course many tourists will use special facilities meant for them, but some types of tourists do manage without (Büchli, 1962). Therefore also this aspect is not essential in defining the concept of tourism as such. Unless tourism is not what tourists do, but something completely different.

Where Pearson (1961) gives his definition of tourist he adds the one on tourism: *In the past it has been common practice to refer to all persons who travel away from their place of residence for pleasure as 'tourists' and to the various activities that provide them with entertainment, food and lodging as 'tourism'*. In these definitions it is clear that tourism is *not* what tourists do, and many other authors use tourism in the same way (Van der Zee, 1987). *They either see tourism as an industry* (Cosgrove and Jackson, 1972; Gunn, 1988; Mittmann, 1990), or as *belonging to the tertiary sector*, and as *invisible export* (Krapf, 1952; Theuns, 1989a), being a sector of economic importance. Christaller (1955) translates *Fremdenverkehr* into *tourist trade*. These definitions stem from an economic approach of tourism in which emphasis is placed on the tourist being a consumer, spending money he does not earn while on tour (Leiper, 1979; Van Doorn, 1980), and are clearly formulated from the point of view of the *industry*, the *supply* side, that provides travellers (= tourists) with food, lodging, transport and entertainment (Beckers, 1974; Theuns, 1989a). Thus, indeed often this industry itself is defined as *tourism* (NRIT, 1975; Leiper 1979; Van der Ploeg, 1990).

When tourism is seen merely as an economic activity it is understandable that the elements of stay and of the use of facilities are used as criterion. Tourists that do not stay long enough nor make use of facilities simply are not interesting for the economy.

The conclusion is that tourism may be defined in two different ways:

1. Tourism is the phenomenon of recreational travel as a special type of recreation: *tourism is what tourists do.*
2. Tourism is an economic activity providing goods and services to tourists: *tourism is what is done for tourists.*

Which meaning is used by different authors is often not clearly stated and has to be deduced from the context (Van der Zee, 1987).

In the Netherlands, although on the level of national policy still a distinction is made between tourism and (outdoor) recreation, at the regional and local level the concepts are used in a more integrated approach, especially in the Tourism Recreation Overall Plans (TROP's) (Jansen-Verbeke and Dietvorst, 1987; Dietvorst, 1990b; Weerstra, 1990). This tendency to take tourism out of the strict economic context and consider it as part of recreation can also be observed in other European countries (Dietvorst and Jansen-Verbeke, 1986).

Tourism as recreation.

When for the managers of tourist facilities the motives of their visitors for making the trip are not relevant, for the definition of tourism as a type of recreation they certainly are (NRIT, 1975; Hendriks and Zorn, 1976a). Tourism is *travelling for pleasure* (Leiper, 1979), as relaxation, especially with the aim to visit different points of interest or well-known places (Theuns, 1989a; Gunn, 1988). The pleasure and recreation motive are important in many definitions (Pearson 1961; Heeley, 1980; Ashworth and Goodall, 1985; Zwaan et al., 1990), business trips are not considered as tourism (Heeley, 1980; Kosters, 1976). Touristic activities are not aimed at earning money (Van Doorn, 1980; Leiper, 1979). Difference should be made between business travel and touristic travel. Routes and means of transport serve both, but the motive for travelling is different. Therefore there are special touristic routes. (Defert, 1952). This view is shared by Christaller (1955).

When for pragmatic reasons congress visits and business travel often are included in the definition of tourism (Cosgrove and Jackson, 1972; NRIT, 1975; Kosters, 1976) this is not conceptually justified and mainly supported by the economic point of view. The same applies to subdivisions into *tourism* in a wider sense that comprises all travelling, and *a more strictly defined recreational tourism* as only a specific part of it. (Geigant, 1962, *Erholungsfremdenverkehr* against *Fremdenverkehr*).

Tourism in land evaluation.

In the context of land evaluation for recreation it seems logic to restrict the definition of tourism to a *special travelling type of recreation*. Still, in general practice, if planning is meant to satisfy the recreational needs and wants of the own population, often the terms recreation and recreationists will be used. But, if the aim is to attract recreationists from elsewhere it is most likely that the terms tourism and tourists will be used (Van der Zee, 1986; see also Weerstra, 1990). This is reflected in the distinction of two different approaches in land evaluation: the *recreation approach* and the *tourism approach*, that will be discussed in chapter 5.

In an increasing degree, however, developments serve both categories, and then the term *touristic-recreational complexes* (Dietvorst and Jansen-Verbeke, 1986; Dietvorst, 1989a) may be most appropriate. The distinction between tourism and recreation then is not really relevant. In the context of this study *recreation* will be used when it concerns activities leading to refreshment of body or mind, even if authors referred to have used the term tourism. *Tourism* will be used, if at all, referring to the economic activity or industry. The *travelling type* will be dealt with as a special type of recreation.

Recreational resources.

The wide definition of recreation implies that it includes a large number of activities that take place in or near home: watching television, playing games, gardening, etc. for which no specific resources are necessary. Another part of the leisure time will be spent in the home settlement or its near environment, some of them may be dependent on the availability or presence of certain resources others may be not. But there are also types of recreation for which people leave their home base and travel some distance.

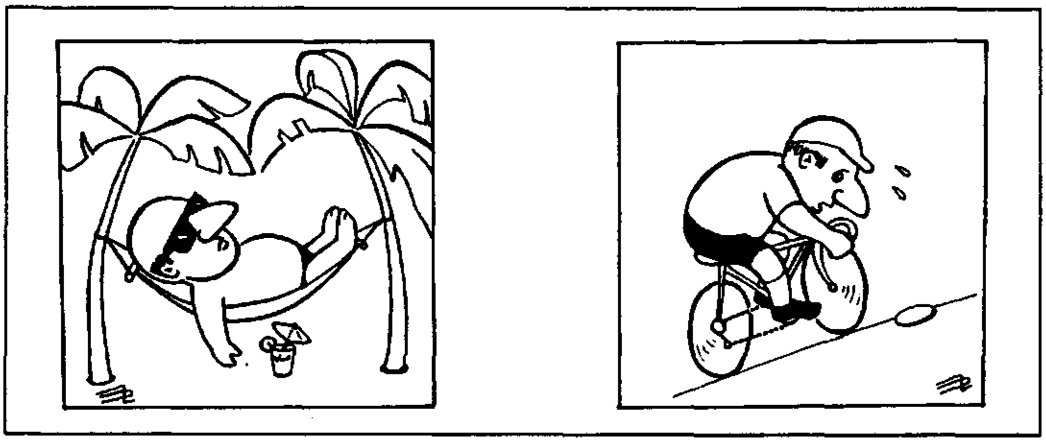

Figure 1.2 *recreation .... tourism ?*

Why do people want to go that far away from home for their recreation? Because they want a type of recreation that cannot be provided for in their own settlement. For some it is the mere change of surroundings, so any place away from home will do, others add to that a general preference for a change of climate and still others put even more specific requirements to their recreation. They want sunny and sandy beaches to lie on, mountains to climb, lakes to sail on, snow to ski on, wildlife to hunt or just watch or photograph, etc. (Van der Zee, 1987, 1990). These are the recreational resources, those landuses or elements in a landscape which play a positive role in satisfying the demand for recreation (Palmer, 1967).

Recreational resources often are associated with the natural environment, with the rural landscape. (See for example Van Oort and Jeekel, 1982; WTO, 1983b). But they are not identical with that, because not all natural areas or rural landscapes are in the same degree suitable or attractive for recreation (Van der Zee, 1986).

The word *resource* does not refer to a thing or a substance, but to a function which a thing or a substance may perform or to an operation in which it may take part. It is an abstraction reflecting human appraisal and relating to a function or operation (Zimmerman quoted by Mulder, 1982). Resources are a subjective concept, a cultural appraisal dependent upon people's wants or needs. That appraisal transforms nature and artifacts into resources, and is dependent on increased knowledge and expanding technology, as well as on changing individual and societal objectives. It is a matter of perception, since the resources exist only in the minds of those who use them. (Goodall, 1985).

Thus, resources are only resources when man identifies and appreciates them and is able to use them as such (Van der Zee, 1990). This also applies to recreational resources. *There is nothing in the physical landscape or features of any particular piece of land or body of water that makes it a recreation resource; it is the combination of the natural qualities and the ability and desire of man to use it, that makes a resource out of what otherwise may be a more or less meaningless combination of rocks, soil, and trees* (Clawson and Knetsch, 1966).

Recreational resources are resources just as Fenland soils or North Sea gas are resources, and, like all else, their exploitation has to be regulated. (Cosgrove and Jackson, 1972). Ferrario (1979) even considered recreation as a landscape industry, that, as in other industrial processes, requires the transformation of raw material (the available natural/cultural resources) into a finished product. The fact that such resources often are intangible and difficult to define does not detract from their real productive value.

But unlike many resources, tourist attractions can be sold to many people at one time and resold to later consumers. Multiple use at one time and over time, however, does not mean that the resources are infinite. Each sale modifies the resource which thus changes continually. (Cosgrove and Jackson, 1972). Therefore, as in many other industries, recreation faces an increasing resource problem (Ferrario, 1979), and constant monitoring and proper planning and management are necessary (Van der Zee, 1987).

Original recreational resources.

The necessary interaction between the characteristics of the landscape and the requirements of the demand as a decisive factor in determining which landscapes or landscape elements will be or are recreational resources and which not, can also be found with Geigant (1962) (Van der Zee, 1971, 1987).

Cristallisation of recreation and creation of recreation places can occur everywhere where the characteristics of the area correspond to the needs of the travelling public. All *material and immaterial goods or services that are capable to satisfy the need for a change of place and correspond to the expectation connected with that need* he calls *touristic supply* (*Fremdenverkehrsangebot*). This supply he again subdivides into *original supply* and *derived supply*. A division that goes back on Mariotti: *attrative spontanee* and *attrative derivate* (Geigant, 1962). Therefore another translation could be *original attractions* and *derived attractions*, or *original resources* and *derived resources.*

The difference between the two categories of supply may not be always very clear, but still is important because these categories in principle have a different attraction, a different influence on size and direction of flows of recreationists, on the *cristallisation* of recreation and on the creation of recreation places. The original attraction factors in their nature have no relation to recreation. They are originally existing or *non-purpose-built* (Theuns, 1989a; see also Oosterhaven and Verhek, 1985), and become recreational resources only when man is attracted by them and when people regularly travel to them for their recreation. The derived supply in its objectives is clearly directed to tourism and recreation. It comprises all facilities that serve tourists and recreationists.

The original supply can be characterised as the *cause*, the *origin* of the cristallisation of recreation at a certain place (Gelgant, 1962). It is the *pulling power* (Ferrario, 1979). The derived supply appears in a double role, cause and consequence at the same time of such local or regional concentrations of recreationists. (Gelgant, 1962). If the *supply* in Gelgants economist approach in a somewhat wider context may be translated into *resources*, then the difference between his original supply and derived supply, in line with his explanation, may be enhanced by translating it as *original resources* and *derived facilities*.

This corresponds with the ideas of several other authors, although they use quite a range of different terms, for example:

intrinsic resources	-	extrinsic resources	(Rodgers et al., 1973)
environmental resources	-	man-made facilities	(Rodgers et al., 1973)
attractions	-	infrastructure/facilities	(Ferrario, 1979)
free inherent and natural resources	-	tourist business	(Leiper, 1979)
carrier	-	formula	(Mulder, 1982)
natural resource	-	supplementary facilities	(Bergsma, 1985)
primary condition	-	secondary condition	(Theuns, 1989a)
primary elements	-	secondary elements	(Dietvorst, 1990b)

Although all these terms tend to express more or less the same, it is felt that *original resources* and *derived facilities* still express it best.
It is predominantly the goods of the original resources -immaterial factors mainly- that determine direction and shape of recreation flows. They have a magnetic function (Dietvorst, 1990b), are conditional (Van der Voet and Haak, 1989). A visitor does not come to a place because he wants to stay a night over, but he has to stay a night over, because he wants to achieve something at that place. (Walther, quoted by Gelgant, 1962). The derived facilities also exercise attraction on recreationists, but do not attract them to a specific location. They rather serve the functioning of recreation on a location (Dietvorst, 1990b). The derived facilities are more *location filling* than *location founding* (Gelgant, 1962). Or, in geographical terms, the original resources determine the *situation*, the derived facilities the *site* of recreation (Van der Zee, 1971).

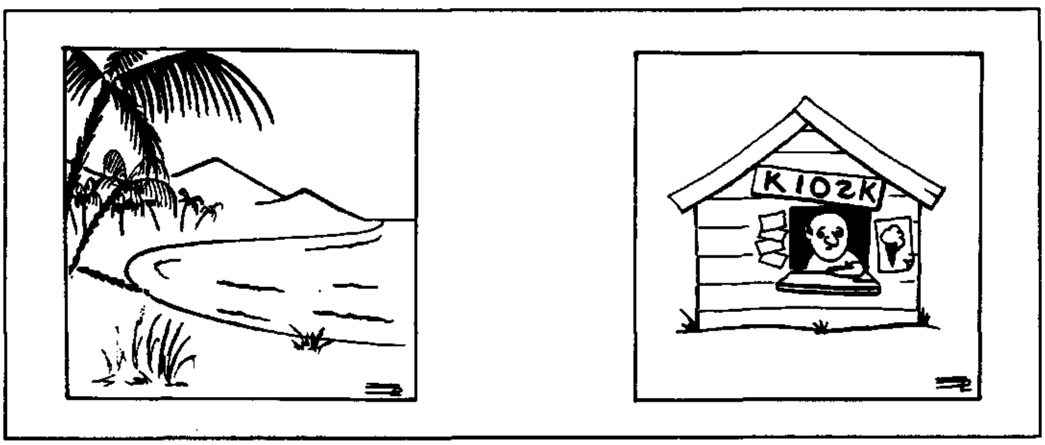

Figure 1.3 *original resource .... derived facility*

The differences between original resources and derived facilities is not always coinciding with that between natural and man-made factors. Also man-made attributes may be found among the original resources. (Goodall, 1985; Oosterhaven and Verhek, 1985; Van der Zee, 1990). Gelgant (1962) mentions in this respect: local cultural manifestations and events, but these are resources of a special, very temporal type. As more permanent man-made recreational resources can be mentioned, for example, monuments, reservoirs, picturesque towns or villages (Christaller, 1955; Ashworth, 1985; Van der Zee, 1990). The basic aim of the preservation of monuments and historic

buildings or sites may be in the first place to preserve a heritage rather than provide facilities for recreation, but many of the monuments are the object, or an incidental part, of a day's outing (Patmore, 1972). Thus, *original recreational resources* comprise natural and man-made recreational resources together. Although they may attract recreationists, they have not been and are not created and managed for recreational purposes in the first place (Van der Zee, 1986; 1987).
In addition there are attractions that are specially created for recreation, so-called *purpose built* (Theuns, 1989a). They may comprise derived facilities but are not derived facilities themselves. The term *created recreational resources* is suggested for this category.

Resource-based : user-oriented.
The spatial distribution of the original resources is not always most suitably corresponding to the spatial distribution of the users. *There is a locational imbalance between the areas of greatest demand and those of readiest supply* (Patmore, 1972). The recreation areas, that are considered to be the result of the interaction between the demand for recreation and the supply of resources in their different spatial patterns, therefore have been classified into three main types: *user-oriented, resource-based and intermediate* by Clawson and Knetsch (1966). This classification, also referred to by Clout (1976) and followed by Patmore (1983) still seems useful to explain patterns of recreation in their relation with the landscape and its resources.
At one extreme then are the user-oriented areas for which the accessibility is more important than the inherent quality of the resource. At the other extreme are the resource-based areas, that because of their outstanding physical resources still will attract recreationists despite large distance and relative inaccessibility. A range of intermediate areas lies between these extremes. (Clawson and Knetsch, 1966; Patmore, 1972, 1983; Van der Zee, 1990). These different types of area may correspond to different recreational activity patterns. The use of user-oriented areas is closely correlated with the free time available each day. Because a visit to a resource-based recreation area often involves considerable travel, such visits are typically vacations. Intermediate areas can be considered as typically within an hours' driving time and almost certainly within two hours time. They therefore are suitable for trips of a full day or for weekend recreation. (Clawson and Knetsch, 1966).
It may be concluded that in the resource-based recreation areas it are the original recreational resources that dominate the spatial pattern of recreation. In the user-oriented recreation areas high quality original recreational resources need not be absent, but if they are, that may be compensated by the amount and type of facilities. In some cases recreational resources may be specially created: for example, man-made lakes and parks. (Van der Zee, 1987). Increasing pressure and especially increasing mobility and accessibility have tended to blur the distinction between resource-based and user-oriented areas, or at least shift the distance ranges. Mittmann (1990) suggests that the opportunities for recreation can be arranged along a spectrum or continuum: the *Recreation Opportunity Spectrum*, which is divided into six classes, ranging from primitive to urban. It may be considered as a further elaboration of the concept *resource-based: user-oriented*, of which still, as Patmore (1983) states, the simplicity remains its strength. Where the resource is the focus, its character and conservation are the dominant issues; where the user is the focus, the creation of adequate opportunity predominates (Patmore, 1983). This is especially true when discussing the recreational facilities.

For the recreational activities in the home settlement or its near environment some simple facilities may be needed, for example, paths for walking or cycling, or more complex and expensive facilities, for example, a theatre, a stadium, a city park. Many of this second category of facilities can only exist if there are enough people to use them and to pay for them. Therefore such facilities will only occur in or near concentrations of users, they are typically *user-oriented*. (See also Tarlet, 1990). Such concentrations of users normally are the larger (urban) settlements and only a limited amount of user oriented facilities may be found in rural areas. For these user-oriented

facilities the location usually is more important than the quality of the original resource, if there is a relation with such a resource at all.
When large numbers of recreationists are attracted by original recreational resources in rural landscapes all kinds of facilities may become necessary. If the rural landscapes are far away from the recreationist's home settlement he may need lodging accommodation (hotel, camping ground) and restaurants to provide food and drinks. Certain facilities may become necessary to make the original resource accessible: roads, paths, parking places, ski lifts, marinas. Because this type of facilities only occurs where original recreational resources are available they are typically *resource-oriented*. They are truly *derived* from the resources. (Van der Zee, 1990).

Recreational facilities, can be considered as the expression of the provision of goods and services to recreationists, and thus belong to the sphere of tertiary activities. Often, tertiary activities in their spatial pattern reflect the population distribution, that is, they follow the settlement pattern. In the case of the recreational facilities this is valid only for the user-oriented facilities, the resource-oriented facilities by their nature are extremely resource-based and in their distribution therefore may deviate from the typical pattern of tertiary activities. Still, also many resource-oriented facilities are located in settlements (see also Ashworth, 1985), but these are settlements that are located near the original resources. In addition many resource-oriented facilities may occur outside the settlements, distributed around or over the resource area itself.

The recreation in the major part of the rural landscape, that is, beyond the direct sphere of influence of the large population agglomerations, will be resource-based, and *it is in the resource-based land that the most serious conflicts arise between those who seek to enjoy the resource and those concerned, with varying motives, for its preservation* (Patmore, 1972; Van der Zee, 1990). For the thorough understanding of the relations between the various recreation types and the various landscape types that is needed in order to achieve an optimal combination of both recreation and the preservation of nature and landscape, a number of (interrelated) approaches can be used. Land evaluation can play a central part in that. (Van der Zee, 1990).

1.2. LAND EVALUATION FOR RECREATION.

Land evaluation.

Proper landuse planning and environmental management in general, thus also with respect to recreational and touristical resources in particular, should guide decisions on land use in such a way that the resources of the environment are put to the most beneficial use to man, whilst at the same time conserving those resources for the future (FAO, 1977), thus aiming at *sustained optimal use of the earth* (I.Zonneveld, 1987). Such planning and management therefore must be based on an understanding both of the natural environment and of the kinds of landuse envisaged (FAO, 1977), on a knowledge of what land resources are available and what they are suitable for (Purnell, 1986). It is a function of *land evaluation* to bring about such understanding and to present planners with comparisons of the most promising kinds of landuse (FAO, 1977). But it should be realized that land evaluation is only part of the process of landuse planning.

Land evaluation is determining the usefulness (=value) of the natural environment in certain areas to human society (I.Zonneveld, 1979). Evaluation in the strict sense means translation into values. Values are determined by human appreciation (I.Zonneveld, 1979), and the way we see and value land or landscape is in large part a function of what we do in them. Values are clearly tied to the individual's personal experiences and purposes. Because different persons may have different needs and desires the same landscape or landscape element can be valued by three different persons for three different purposes. (Zube, 1987). Therefore land evaluation needs to find

means of resolving the competing demands on land of activities such as farming, forestry, recreation, and wildlife conservation (Young, 1973).
Land evaluation thus is concerned with the assessment of land performance when used for specified purposes (FAO, 1977; Beek, 1978), and *should be based on objective observations of the natural features (physical and biological) and man-made features of the region concerned, and moreover, it should take into account the cultural and socio-economic situation of the area and its relation to other parts of the world* (I.Zonneveld, 1979). By its very nature land evaluation is a multi-disciplinary activity (Riezebos, 1988).
Sometimes land evaluation is referred to simply as suitability study. A study that aims at getting insight in which parts of an area are in what degree suitable for which functions or activities as a special means for allocation of the demand within an area (Van Lier, 1988), or, to determine the rate in which within an area an optimal functioning can be approached and to also analyze the limitations (Sas, 1988).

Land evaluation may be concerned with present land performance. Frequently, however, it involves change and its effects in change in the use of land and in some cases in the land itself. Land evaluation then is preceded by the recognition of the need for some change in the use to which land is put; this may be the development of new productive uses, such as agricultural development schemes or forestry plantations, or the provision of services, such as the designation of a national park or recreational area. Recognition of the need for some change is followed by identification of the aims of the proposed change and formulation of general and specific proposals. The evaluation process itself includes the description of a range of promising kinds of use, and the assessment and comparison of these with respect to each type of land identified in the area. This leads to recommendations, with alternatives, involving one or a small number of preferred kinds of use, together with their consequences. These recommendations then can be used in making decisions on the preferred kinds of landuse for each distinct part of the area. (FAO, 1977, 1983). In principle, land evaluation is a value neutral exercise, but in practice value judgements are often included (Van de Putte, 1989).

Basic principles of land evaluation.
International discussions led to agreement on most of the principles of a proposed framework for land evaluation and in 1976 the FAO Framework for Land Evaluation was launched (Beek, 1978; FAO, 1983; Riezebos, 1988). This Framework for Land Evaluation (FAO, 1977) was developed in order to provide a systematic way of looking at various options and predicting the results of alternative courses of action. (Purnell, 1986). It nowadays is widely accepted and has led to the development of different land evaluation methodologies for various land utilisation types. (Riezebos, 1988). The FAO Framework and Guidelines for land evaluation propose a procedure to select relevant land-use types and to indicate not only their physical suitability, but also their economic viability on the land in question. They are intended to be flexible and for users to select those methods which meet their needs and to adapt them as required. (Purnell, 1986). However, the FAO Framework is mainly concerned with physical land evaluation (Beek, 1978; Van de Putte, 1989).

According to the framework, land evaluation is based on certain basic principles (FAO, 1977):
1. Land suitability is assessed and classified with respect to specified kinds of use. There is not one overall suitability of land. Different kinds of landuse have different requirements. The qualities of each type of land are compared with the requirements of each use.
2. Evaluation requires a comparison of the benefits obtained and the inputs needed on different types of land.
3. A multidisciplinary approach is needed. Landevaluation by a one-person-team is impossible.
4. Evaluation is made in terms relevant to the physical, economic and social context of the area concerned. Such factors as the regional climate, levels of living of the population, etcetera,

form the context within which evaluation takes place.
The assumptions underlying evaluation will differ from one country to another and, to some extent, between different areas of the same country. It may be self-evident, that such assumptions should be made explicit, and that there is not one single world-wide solution.

5. Suitability refers to use on a sustained base. The aspect of environmental degradation has to be taken into account when assessing suitability. This principle by no means requires that the environment should be preserved in a completely unaltered state. But it does mean that use remains possible in the long term. Sustainability of use is often a case of respecting the *ecological margins* (Van der Ploeg, 1990).
6. Evaluation involves comparison of more than a single kind of use. Often it will include comparing existing uses with possible changes. If only one use is considered there is the danger that, whilst the land may indeed be suitable for that use, some other and more beneficial use may be ignored. It is nearly always desirable to classify for at least one alternative form of use (FAO, 1983).

The FAO Framework (1977) also distinguishes three levels of intensity in land evaluation: reconnaissance, semi-detailed and detailed. These are normally reflected in the scales of the resulting maps, and therefore can also be considered as three levels of generalisation. Reconnaissance surveys are useful for a resource inventory, identification of promising areas and for providing a basis for more detailed study. Semi-detailed surveys are employed for project feasibility studies. Detailed surveys are used for project planning and implementation. (FAO, 1983).

Land Utilisation Types.
Because land evaluation can only be done against the background of a certain envisaged specified kind of use, or better, a set of alternative types of use (I.Zonneveld, 1987), or *Land Utilization Types*, this is a crucial concept in landevaluation (I.Zonneveld, 1979; Beek, 1978).
A *major kind of landuse* is a major subdivision of rural landuse, such as rainfed agriculture, irrigated agriculture, grazing, forestry, or recreation. A *Land Utilisation Type* (=*LUT*) is a kind of landuse described or defined in a degree of detail greater than that of a major kind of landuse. It consists of a set of technical specifications in a given physical, economic and social setting (FAO, 1977, 1983; Beek, 1978). It is a complex of specific functions (I.Zonneveld, 1979).

In the selection of land utilization types, those that are not relevant for considering in the area concerned should be eliminated. Not relevant does not mean that the land is not suitable for the given use, but only that it has not been assessed for it. (FAO, 1983). As soon as land utilization types have been selected, they should be well-defined and their requirements expressed (I.Zonneveld, 1979). *Requirements* of a Land Utilisation Type refer to the set of land qualities that determine the production and management conditions of that specific LUT (FAO, 1977).
In the determination of requirements two basic concepts can be distinguished: 1. Every LUT has its own site requirements in relation to natural features in the landscape; 2. LUT's brought into proximity to one another are likely to show different degrees of compatibility (Edington and Edington, 1977).
Limitations are land qualities, or their expression by means of diagnostic criteria, which adversely affect a kind of landuse. The set of requirements and limitations indicates the types of data which are required for evaluation, and thus condition the nature of the surveys needed. (FAO, 1977, p 42).

Land Units.
A detailed discussion on the land unit as a fundamental concept is given by I.Zonneveld (1989). In the context of land evaluation, a *Land (mapping) Unit* is a mapped area of land with specified characteristics. The degree of homogeneity or of internal variation of such a unit varies with the scale and intensity of the study. (FAO, 1977, 1983). The *characteristic properties* (I.Zonneveld, 1979)

or *land characteristics* are attributes of land that can be measured or estimated, and are characteristic of certain units and for the hierarchical arrangement (if any) of the land units (FAO, 1977, 1983).
The first step of evaluation is to translate these characteristic properties into qualities. A *land quality* is a complex attribute of land which acts in a distinct manner in its influence on the suitability of land for a specific kind of use (FAO, 1977, 1983). This means that the specific purpose must be known before land evaluation can start (I.Zonneveld, 1979). Land qualities may be expressed in a positive or negative way. A land quality is not necessarily restricted in its influence to one kind of use. Only qualities relevant to the landuse alternatives under consideration need to be determined. (FAO, 1977).
Critical values in these qualities or *diagnostic criteria* are used to arrange the resources into classes of usefulness (suitability) (I.Zonneveld, 1979; FAO, 1977).
Several sets of factors are determining the suitability (Van Lier, 1988):
- physical factors (for example soil, water-regime),
- location (position with respect to other elements),
- other factors (social, management).

Land suitability classification.
The focal point in the land evaluation procedure is that at which the various data are brought together and compared, the comparison leading to the suitability classification. Thus, the relevant land utilisation types and their requirements and limitations are compared with the land units and their land qualities (FAO, 1977; I.Zonneveld, 1979), and out of this *matching* land suitability classes can be deduced and presented on a map (I.Zonneveld, 1979). This has to be done in the context of the economic and social conditions (FAO, 1977), because the land evaluation is not complete without an economic and social study and an environmental impact analysis (Purnell, 1986).
The economic study is necessary to assess whether the benefits of an envisaged land utilisation type justify the costs of investments. The social study is necessary to ensure that any recommendations meet the needs and have the approval of the local community, without which they are doomed to failure.
And the environmental impact study is partly to ensure that on-site degradation has been thoroughly covered, but more particularly to investigate the off-site or downstream effects. (Purnell, 1986). Land use effects that are felt outside the land unit where they originate are sometimes not foreseen when land use recommendations are made, but they are most important (Beek, 1978). The impact may be favourable as well as unfavourable (Purnell, 1986). Environmental consequences of at first view profitable land use types may influence the suitability in a negative way (I.Zonneveld, 1979; FAO, 1977).
The economic approach to conservation, however, judging its merit solely on costs and benefits, is not really adequate. Economic analysis is useful and necessary for investment but it should not be the only criterion. (Purnell, 1986).
The results of the matching process thus are combined with those of the assessment of inputs and benefits, environmental impact, and economic and social analysis to produce a classification, that indicates the suitability of each land mapping unit for each relevant kind of landuse (FAO, 1977).

Land is assessed as suitable when sustained use of the kind under consideration is expected to yield benefits which justify the inputs, without unacceptable risk of damage to land resources. If land is assessed as suitable the degree of suitability can be classified as highly, moderately and marginally suitable.
A classification of *current suitability* or *actual suitability* refers to the suitability for a defined use of land in its present condition, without major improvements. A classification of *potential suitability* refers to the suitability for a defined use, of land units in their condition at some future date, after

specified major improvements have been completed where necessary. (FAO, 1977; Van Lier, 1988; Sas, 1988).
The degree in which one has to interfere in an actual situation in order to approach an optimal functioning could be a measure for suitability. *No interference necessary* is the most favourable situation and being suitable then means that the values of the area studied, the actual situation, meet the requirements. (Sas, 1988).

Suitability classifications can be qualitative or quantitative.
A *qualitative classification* is one in which relative suitability is expressed in qualitative terms only, without precise calculation of costs and returns, and often is used as a first rapid approximation. Determination of value is essentially a subjective process. It can be made more objective already by clearly specifying the parameters that have been used. The next step to make this approximation as objective as possible is by applying a *quantitative classification*, that is, one in which the distinctions between classes are defined in common numerical terms, which permits objective comparison between classes relating to the different kinds of land use (FAO, 1977). However, the more comprehensive the land evaluation, the more difficult it will be to present purely quantitative results. And it is therefore questionable if land evaluation is well served by a strict distinction between qualitative and quantitative. (Beek, 1978). Also, it is better not to comprise all suitability factors into *one* single formula, because then the influence of each individual factor on the suitability is not clear. Also the different factors can not be determined with the same degree of objectivity. (Sas, 1988).
Because of the importance of cost-benefit analysis in land evaluation the numerical terms used for the objective quantification preferably should be expressed in terms of money. A special problem in this respect will be the transformation of natural potentials into economic categories of matters that scientific thought had regarded as *value-free* in content (Neef, 1984). Non-material values can never be expressed in absolute figures. Any effort to try and express in figures *natural beauty* or *fresh air* or *natural accent in a cultivated area having still flowers, birds and other animals in road verges, semi-cultivated parts and little rest-wilderness spots* have failed and are to be principally failing, because they are of a different character, a different dimension. Immaterial values can only be approached via the function that they have for man. (I.Zonneveld, 1979).

Main activities in land evaluation.
The main activities in a land evaluation thus are (FAO, 1977):
- Identification and formulation of the objectives of the evaluation, and the data and assumptions on which it is to be based.
- Description of the kinds of landuse to be considered, and establishment of their requirements.
- Description of land mapping units, and derivation of land qualities.
- Comparison of kinds of landuse with the types of land present.
- Economical and social analyses.
- Land suitability classification (qualitative or quantitative).
- Presentation of the results of the evaluation.

It can be summarized that land evaluation is a method or procedure in which specific land uses or *Land Utilisation Types* (LUT's) with their requirements are confronted with *Land (Mapping) Units* (LU's) with their characteristics and qualities in order to establish which land units are in what degree suitable for which land utilisation types (Van der Zee, 1986).

Applying land evaluation to recreation.
Recreation can be considered as a *major kind of landuse*, in the same way as *forestry* or *irrigated agriculture*. But in the FAO Framework the land evaluation for this landuse is not further elaborated because the provision of recreational or tourist facilities is considered as belonging to the

Intangible benefits in the same way as the creation of employment, nature conservation and aesthetic considerations. The evaluation of intangible benefits presents special problems. Land used for recreation or protected as a nature reserve does not necessarily produce directly measurable benefits, and in particular it is difficult to translate such benefits into economic terms. Instead of a purely commercial approach, a political decision may be needed to set aside areas of land for aesthetic, educational, conservational or other needs. This calls for methods of rating land in terms of land qualities which have a positive or negative effect on its use for recreation or conservation. For example, sustained carrying capacity expressed as man-days per year per unit area could be one measure of land suitability for recreation. Scarcity of land of a given type and distance from centres of population is frequently relevant.
Land evaluation of recreation as a major kind of landuse is usually done in studies of a qualitative or reconnaissance nature. Only sometimes *benefits* can be assessed in physical terms, for example, estimated numbers of recreationists, that then, so far as practicable, can be translated into economic terms, on the basis of stated assumptions about prices, etcetera. (FAO, 1977).
But, carrying out a land evaluation for (outdoor) recreation at large is far from ideal. It has to be realized that recreation can appear in many different forms (Van Lier, 1988), that may have quite different demands on land.

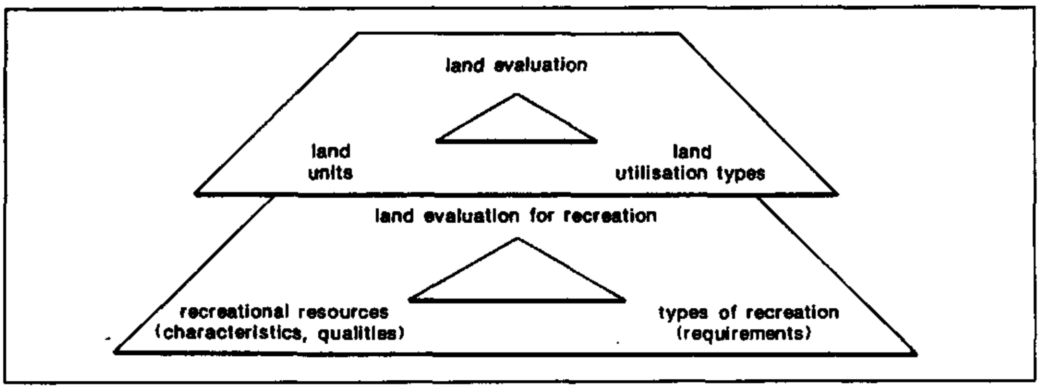

Figure 1.4. *Land evaluation for recreation. (Van der Zee, 1986, 1990).*

Therefore, because a *land utilisation type* is a kind of land use described or defined in a greater degree of detail it can be applied to different *types of recreation* (boating, swimming, hiking, riding, etcetera). Each of them will have its own requirements with respect to land qualities that have to be specified, after which the land units can be interpreted for their *recreational resources*. The first thing to do will be to identify what are relevant recreation types (LUT's) and what are their requirements with respect to the characteristics of their resources (LU's). (Van der Zee, 1986; 1988c). Then the landscape and its elements or units can be analyzed for its characteristics and qualities and these can be matched with the requirements in order to assess the suitability for a given activity.

Recreational Land Utilisation Types and their requirements.
Identifying the relevant land utilisation types.
It may be self-evident that of the whole range of activities comprised in the definition of recreation only those that take place outside the direct home environment are of interest for land evaluation. And what particular types of recreation then have to be considered as a relevant land utilization type will depend on the type of recreationists one can expect, considering the available amount of leisure time, money and the distance at which the landscapes under study are located from the larger population agglomerations (Van der Zee, 1982).

The activities usually thought of when considering outdoor recreation are: swimming, hiking, camping, picnicking, hunting, fishing, and playing games (Clawson and Knetsch, 1966), and in certain cases of land evaluation for recreation these are taken as land utilisation types, just without further discussion. Such a selection is often based on common knowledge and experience and/or some observations of actual recreational behaviour. After all, there obviously exists at a national or regional level some agreement on what is the most pleasing way to spend disposable time and money. But at the same time differences in taste and attitude exist between individuals, within societies and from one age group to another. (Cosgrove and Jackson, 1972).
Such lists of activities thus may not necessarily applicable to other regions and other periods than they have been made for. Recreational activity patterns are changing rapidly (Van Lier, 1987, 1990b). Social processes such as individualisation, differentitation in life-styles and changing time-space behaviour are expressed in an increasingly colourful variety of recreation activities and recreation styles (Dietvorst, 1989a; Van Doren, 1985; Funke, 1977). In addition to this larger diversity of recreational activities, a trend is observed towards more active forms of recreation, towards more individual activities or activities in small groups, and towards a more diffuse spread of activities in time and space (Van Lier, 1987, 1990b).
Many people are not content anymore with *sunbathing stupidity* on a beach. *Passive holidays* have given away to *active holidays*. (Tarlet, 1990).

In a less casual approach the relevancy of recreation types can be determined by looking at membership of associations or clubs (examples in Cosgrove and Jackson 1972, and Patmore 1972, 1983) but there are two objections. First, membership registration does not necessarily give a realistic indication of the rate of active participation. Second, it covers only the realm of formal recreation activities and excludes the large field of recreation in the informal sphere. Moreover, such data hardly reveal anything about the land quality requirements.
A variant to this approach is to look at the sales of specific recreation equipment to assess the importance of a certain activity. So it was observed that since the introduction in the Netherlands in 1972 the number of windsurf boards had increased to 400000 or 450000 and then stabilized. And also that the number of canoes increased from 30000 in 1980 to over 100000 in 1990. (Droogers, 1990). But also this does not necessarily reflect active participation.

Establishing preference for and actual participation in various recreation types by interviewing people requires a representative sample of sufficient size, a standardized and tested questionnaire and numerous skilled interviewers. This approach therefore will be difficult to organize and expensive. The development of a good questionnaire is far from easy, especially when trying to find out about people's preferences and motivations for the selection of activities and sites or their degree of satisfaction over their choice. It is already difficult enough to get some reliable answers on these matters from people of the same culture and language, as was experienced in the study of Van der Zee (1971) in the Netherlands. But it becomes almost impossible to get a good impression when working in a different cultural setting and having to rely on interpretors for the interviewing.
Of course, when other studies already made an inventory of recreational activities, this can be taken as a starting point. Thus, Kiemstedt et al. (1975) classified the leisure time activities that can be done in the landscape: walking, bathing/swimming, driving for pleasure, visiting sport events, playing outdoors, hiking, cycling, visiting objects/places of interest, camping, angling/fishing, active sports, visiting open air concerts and theatres, nature observation, mountain climbing, rowing and canoeing, sailing, motorboating, skiing, skating, tennis, golf, horse riding and hunting. The activities on this list then were assessed for their therapeutical recreational value with respect to the target group of population considered, according to the amount of expenses involved and above all to the relative participation. Walking (53.4%), bathing/ swimming (42.1%) and playing outdoors (28.5%) show the highest participation rates whereas the expenses involded are lowest. (Kiemstedt et al., 1975).

But such inventories should be constantly verified for being up-to-date. Specific recreation activities, such as hiking, camping, skiing and boating, have increased greatly in popularity in recent decades (Cole, 1989), and in addition to regular shifts sudden rapid changes, *mutants*, occur. Such mutants are *snowmobiling* in the USA and windsurfing in the Netherlands. (Van Lier, 1987). Other examples are motor-crossing, hang-gliding, making hot-air-balloon trips (Van Lier, 1987), and the use of all-terrain bicycles (Sideway, 1987b; Gunn, 1988).

If however no information on relevant recreation types is available from other studies and it is not considered acceptable to take some recreational land utilisation types for granted and their requirements as selfevident, then a simple and objective method to identify what are relevant recreation types would be most welcome. The *method of the potentialities* suggested by Defert (1954) may be a solution and will be further discussed in chapter 2.1.

Defining recreational land utilisation types.
In order to answer the question what are the relevant land utilisation types and what are their requirements it first has to be clear how land utilisation types can be defined and described.
It has already been stated that the suitability of an area can never be established for recreation *in general.* Recreation in itself is a multiple use form (Van der Ploeg, 1990). In this respect the only example of a recreational land utilisation type given in the FAO framework: *a national park for recreation and tourism* (FAO, 1977), is not a good one.
Still, many studies, such as Kiemstedt's first apporach in 1967, include recreation in this more general sense and not only on reconnaissance level. For example, agriculture, forestry, recreation, game conservation and nature conservation were the activities for which the evaluation was carried out in the North York Moors conservation project. (Statham, 1972). Even a further subdivision into main classes such as field sports, game conservation, informal and sightseeing activities, pursuits on foot and horse, watersports, camping activities and motor sports, was made. But, no further specification is given, and therefore it is not a real elaboration into land utilisation types. However, it is better than some studies that do not bother at all about naming land utilisation types. In the landevaluation for outdoor recreation in the North Eastern USA, as described by Dill (1962), the start was not a set of land utilisation types, but just the basic statement of the importance of water for recreation. After that five basic types of site were defined. For one site type swimming, fishing and boating were mentioned as the recreational activities for which the site would be evaluated. For another site type only was mentioned that swimming and boating are not possible. For the rest of the site types no mention of recreational activity for which the site should be suitable was made at all.
In many studies the recreation types are defined on a semi-detailed level.
For example, the evaluation of the resource base of Snowdonia National Park was done for a range of ten activities: rambling, rock climbing, sailing, canoeing, swimming, fishing, field studies, camping, caravanning and picnicking. (J.W.Gittins in: Rodgers et al., 1973).
In a study by Olson et al. (1969) for Michigan, three outdoor recreation activities were considered: boating, swimming and camping. In an approach of Duffield and Owen, discussed by Patmore (1983), the categories of land-based recreation considered were: a. camping, caravanning and picnicking; b. pony-trekking; c. walking and hiking; d. game-shooting; e. rock-climbing;
f. skiing. Patmore considers the choice of these activities as obviously arbitrary, but it appears to be no exception. More examples of such lists can be given.
The predominant types of recreation activities outside the town in the Netherlands were stated to be: making trips by motorcar or boat, fishing, swimming, playing or sporting in the open, walking, cycling, skating, picnicking and camping. For the Dutch Waddensea islands the activities were specified as bathing, sunning, being lazy, walking, cycling, horse riding, nature research, going on safari to a seagull colony, camping and angling along the beach, whereas on the Waddensea activities are angling, sailing, boating and *wadlopen.* (Maas, 1971).

In the basic recreation plan for North and Central Drenthe, the Netherlands, the types of recreation distinguished are: *Nature recreation*, cycling, horse riding, driving for pleasure, swimming and sunbathing, watersport, angling and *stay recreation*. (Boonstra and Herfkens, 1985).
Except for the fact that in some cases these are mere lists of activities without further description, in these examples the recreation types are not all of the same level. Rock climbing and canoeing are much more specific than camping and watersports, leave alone *informal and sightseeing activities*. With less specific definitions the determination of the requirements will become more difficult. Therefore the less specific recreation types should be either better specified or divided in sub-types that are more specific. Thus, in the basic recreation plan for North and Central Drenthe, *Nature recreation* is defined as comprising walking, picnicking, day-camping, etcetera, in a more or less natural environment (Boonstra and Herfkens, 1985), and *stay recreation* would have needed some further definition in the same way.
The activity *visit of waterfall sites* in the case study on the Mae Sa valley in northern Thailand comprised a complex of sub-activities such as resting, picnicking, bathing, swimming and enjoying the scenery (Van der Zee, 1988a).
In some German studies on land evaluation for recreation the defined land utilisation types are groups of activities rather than single activities. For example (Funke, 1977): *Nature-Sport-Amusement*, comprising activities that are related to partly enclosed spaces or special infrastructure; provisions for such activities assume a certain concentration of users: they are user-oriented; *Nature-Landscape experience* comprising all quiet activities that are not restricted to enclosed spaces or special infrastructure; these are more reource-based; *Recreational residence*, more an indication of a facility than of activity; *Winter sports*, comprising all activities in winter.
Already a bit more activity specific are Kiemstedt et al. (1975): *summer recreation along the waterside* comprising all activities restricted to the shorelines: bathing/swimming, sitting and playing along the shore, camping, and angling; *summer recreation on the water* comprising all the activities that occur on the surface of lakes: rowing/canoeing, sailing, making a boat trip; *summer recreation in the landscape* comprising those activities done in summer that are not directly water oriented: walkinh, playing/sitting, visiting objects of interest; *recreation in winter* comprising the most important winter sport activities in the winter landscape. The individual (sets of) activities in each group have been further defined where necessary. For example, in *sitting and playing along the shore*, sitting includes: picnicking, sun bathing and resting, whereas playing involves more physical activities, for example ball play, children's play. *Camping* is described as a special type of recreation close to nature. *Walking* includes hiking. Pleasure in the physical exercise, experiencing the landscape and nature observation make up its importance. *Playing/sitting* are more *sedentary* activities. *Visiting objects of interest* means the purposeful visiting of objects of interest (landscape or architecture) or the visiting of excursion restaurants. *Cross country skiing* combines experiencing the landscape and nature observation with physical exercise.
In the Netherlands Segers (1970) comes to a useful classification, based on an approach from two different points of view. A main division is made into land recreation, water (including shore and beach) recreation, and air recreation (gliding, parachuting). Air recreation is then further left out of consideration, but the other two are grouped into three categories: terrain related forms of outdoor recreation; area related forms of outdoor recreation; route related forms of outdoor recreation. In this sub-classification *terrain* means a piece of land of smaller size than is the case with *area*, and often with a more specific function. *Route* may be a road or a water way.
The grouping of activities according two these two approaches can be expressed in the form of a scheme, see figure 1.5.

Each of the activities has also been further specified (Segers, 1970).
Picnicking: using a meal that has been brought along, outdoors and usually in company; under normal circumstances it should be possible to sit on the ground.
Sailing: sailing on a lake or interconnected group of lakes, returning every day to the same base.

Free playing: playing, for example on a playing lawn, kicking field, dune slope or in or around a splash pond.

Swimming and sunbathing: visiting the sandy beach along the sea coast or along fresh inland waters. Swimming and sunbathing are considered together as one combined activity.

Driving for pleasure: touring with the car along an attractive route during an afternoon or a whole day.

Walking: walking for pleasure in forest or free nature.

Camping with tent or caravan: staying one or more weeks on the same camping ground, for example, during vacation.

Regular stay: staying overnight in caravan or bungalow-tent, that is located on the same place during the whole season, and where outside the vacation also the weekends are spent.

Cycling: cycling for pleasure in an attractive surrounding or along an attractive route during an afternoon or whole day.

	Land recreation	Water recreation
terrain related	ball games, playing, gardening, field sports	swimming and sunbathing, rowing and canoeing, skating
area related	camping, picnicking, enjoying a view	sailing, motor-boating
route related	cycling, driving for pleasure, horse riding, tour-camping.	tour-sailing and tour-skating.

Figure 1.5. *A classification of recreational land utilisation types, according to Segers (1970).*

In Botswana three main types of wildlife oriented tourists have been distinguished: big game hunters that are after trophies (safari-hunters); big game hunters using a camera only or just viewing wildlife; game hunters that are after meat (non-safari-hunters) (Campbell, 1971; Von Richter and Butynski, 1973; Mpaphadzi, 1984), each corresponding to a particular activity pattern. These then are the three main recreational or touristical LUT's for which an evaluation of the recreational resources of that country should be made.

Thus, preferably the recreational land utilisation types should be described according to the activities carried out, these activities need to be carefully defined and sometimes even may have to be divided into sub-activities that each have their own requirements with respect to the resources (see also Goodall, 1985). Some activities are strongly interrelated and should be always considered in combination. Other activities have to be considered separately. For example, *jogging* has branched off from recreational walking as a separate activity. *Watersports* need to be subdivided according to the type of boat that will influence the requirements with respect to depth and width of water, but will also influence the activity pattern. There are not only striking differences between sailing-boats and motor-boats, but also between cabin yachts and open sailing-boats, and between motor cruisers and open motor boats. These different boat types have different patterns with respect to the activities *sailing* and *lying along the shore*. The characteristics of the shoreline may be as important as the qualities of the water for this type of recreation.

The conclusion is, that for a good landevaluation the recreational land utilisation types should be properly defined, in order to be able to determine their requirements in a realistic way. But often only when trying to define the requirements it becomes clear in what way the definition of the land utilisation type is still deficient. Take for example the three land utilisation types of the Michigan case study by Olson et al. (1969).

They state that for boating the primary factor is the size of unobstructed water surface. Bridges, snags protruding above water, shoals or any obstacle restricting the free use of power boats were considered disqualifying. Apparently *boating* implies *power boating* and sailing-boats are not considered. The same criteria may be valid for sailing-boats as well, though certain bridges that are passable for motor-boats may be an obstacle for sailing-boats and wind-catching trees or hills along the shore may influence the suitability for sailing more than for power boating.

Emphasis on the availability of beaches implies that *swimming* in the context of their definition apparently is more than just the activity in the water. It is a complex of activities including lying or sitting along the waterside, taking a sunbath, playing along the waterside, etc. For swimming as such the quality and especially the quantity of the beach is less relevant. The description of the requirements for camping makes clear that it, at least in Michigan, implies an association with water based activities. This, however, needs not be the case for camping in other regions or countries. Camping on the one hand has been revolutionized and popularized by technological innovations in recreational vehicles that enable people to carry alongthe amenities of modern urban development (Gunn, 1988), on the other hand also experiences a trend towards sober, light-weight, back-pack style close-to-nature camping. In the study of Olson et al., picnicking was not considered as a separate activity because the resource requirements for picnicking and camping were considered to be essentially the same. Such a conclusion, however, should be well argumented and based on a good comparative analysis of both recreation types that should be well defined.

And since, as stated already, the deficiencies of such definitions come to light best when trying to define the requirements, the attention will now be focussed on them.

Specifying the requirements.

Whether or not a certain recreation activity can be carried out will depend on the fact whether or not certain relevant conditions are met, that is, in what degree the requirements are fulfilled by the available resources.

In order to answer this question the requirements of each relevant recreation type have to be specified. For some types they seem rather obvious. For boating and swimming water is essential. Yet a map merely of waterbodies and watercourses not necessarily gives a good picture of the potential for watersports. For many recreational activities a forest setting is attractive, but a map of forest areas is far from identical with a map of recreational resources.

Not all waterbodies, not all forest types are in the same way suitable or attractive for a specific type of recreation.

Three main aspects have to be considered.

1. In the first place there are the specific *physical requirements*: for example, for boating water of a certain minimum extent and depth is a basic requirement, swimming requires certain water and shoreline qualities and campers prefer specific soil and vegetation cover conditions. These requirements should be described, qualified and as far as possible quantified. For example, for canoeing the minimum width of the water should be four meter, the minimum depth half a meter, bridges should not be lower than one meter, and at obstacles simple facilities to lift the canoe out of the water and carry it across should be present (Droogers, 1990).

The requirements related to each recreation type are in some cases self-evident, but often a closer analysis of the recreational activity concerned may be needed. Analysis of the actual recreational use of the land, and especially of the different elements of the landscape, may reveal some of these requirements. (Van der Zee, 1982). The requirements may not only refer to the natural qualities of the landscape, the original resources, but may also comprise the availability of certain facilities.

In this respect, following Kiemstedt et al. (1975), the criteria could be classified in different steps of importance. *Necessary* or *minimum value required* indicate a condition without which an activity is not possible at all. For example, footpaths for walking, water for swimming. The

formulation of such a minimum requirement can first be done verbally based on every-day experiences and results of research, but after that has to be made operational, be translated into measurable criteria and threshold values. For example, a minimum number of kilometers of foot path for walking, a minimum area of water for sailing and the availability of a boat rental station.
Improving is a condition that is not strictly necessary for an activity but enhances the suitability for it. For example, benches for resting and small restaurants as such are not necessary for walking, but make a walking route more attractive for many people. A minimum amount of water is a basic necessity for swimming, when there is more this may increase the suitability level. The availability of improving conditions can be translated into a quality rating.
Restrictive are conditions that put considerable limits to a recreational activity if not making it impossible completely. For example, water pollution with respect to swimming or angling. A negative quality rating may be used to express this.

2. In the second place comes the general attractivity of the landscape. That is the aesthetic or scenic quality -visual quality (Patmore, 1972), or *visual amenity* (Coppock, 1966)- of the environment (the landscape) in which the recreational activities take place. The sensory - especially visual- impression of the landscape and the *irrational experience of nature* are important factors determining the recreational value of the landscape (Kiemstedt, 1967). The *scenic quality* can make one site more attractive than the other, even though the physical suitability is exactly the same. A swimmingpool in a cityblock for many people is less attractive than the same pool in a forest setting. When for picnicking in the countryside of southwestern Spain a preference for sites near water is observed (Van der Zee, 1982), this can be attributed to the contribution of that water to the scenic quality, although the possibility should not be excluded that the presence of water is a physical requirement because *picnicking* may imply a close association with bathing/swimming.
Although in the general opinion and in the planning practice recreation still often is considered in relation to the *free landscape* and *nature* (Kiemstedt, 1967), also cultural elements can be attraction factors for recreation.

3. Not the least important is the *accessibility*. A site can be physically the most suitable and have the nicest scenic setting, but if people cannot reach it they will go to less suitable, less attractive but more accessible sites. Accessibility can be defined as the general proximity in terms of time of all points in a region to a given kind of activity or facility, reflecting the degree to which a resource can be approached (Grinde and Kopf, 1986).
A distinction has to be made between *access*, legal rights of entry, and *accessibility*, how these rights are exercised, depending on the awareness of opportunities, personal mobility and resources, and beliefs and preferences. Accessibility is very much a social construction. (Sidaway, 1987a).
Four aspects can be distinguished with respect to recreational accessibility:
- a physical spatial aspect (it is possible or not);
- a juridical aspect (it is allowed or not);
- a social-psychological aspect (one likes to go or not; this is determined by attraction, hindrance, barriers);
- an information aspect (one knows the possibilities or one does not).

(Van der Voet and Haak, 1989; Jansen-Verbeke and De Klein, 1990).
Another distinction with respect to accessibility, already suggested by Defert (1966), is that between the *external accessibility* or *long distance accessibility* and the *internal accessibility*.
An area for recreational use has to be accessible (reachable) from the place of primary or secondary residence. That means, that the external accessibility is determined by the distance of the (potential) recreational resource to the large population concentrations or holiday resorts and the existence of good roads connecting the area to that outside world. But, an area for recreational use also has to be internally accessible. That means, that there have to be roads and

paths, that allow moving around in the area, as well as spaces where people can stay for a while and carry out activities. (Smith-Romeijn, 1969, 1970; Maier, 1972; WTO, 1983b; Jurgens, 1989; Van der Voet, 1989; Van der Voet and Haak, 1989).
For certain recreation types the external accessibility or distance factor may be less critical then it can be for many other land utilisation types, because the journey may be an integral part of the recreation experience. This has to be included in the definition of that recreational land utilisation type then. Also it will be necessary to include a time aspect in the definition in order to assess the potential distance range for the activity considered. The means of transportation is also of importance.
The internal accessibility is determined by the existence of roads and paths, or waterways, that give access into the recreation area itself, and by the means of transport that are allowed in the area. Parking areas can be an important component of this accessibility. See also figure 1.6.
It could be argued that the internal accessibility actually is part of the physical requirements, but it is equally justifiable to leave it under the concept of accessibility. Since the aspect has to be incorporated in the evaluation procedure any way, it is not really relevant under which heading it appears. With respect to the internal accessibility also minimum requirements and improving conditions can be distinguished.

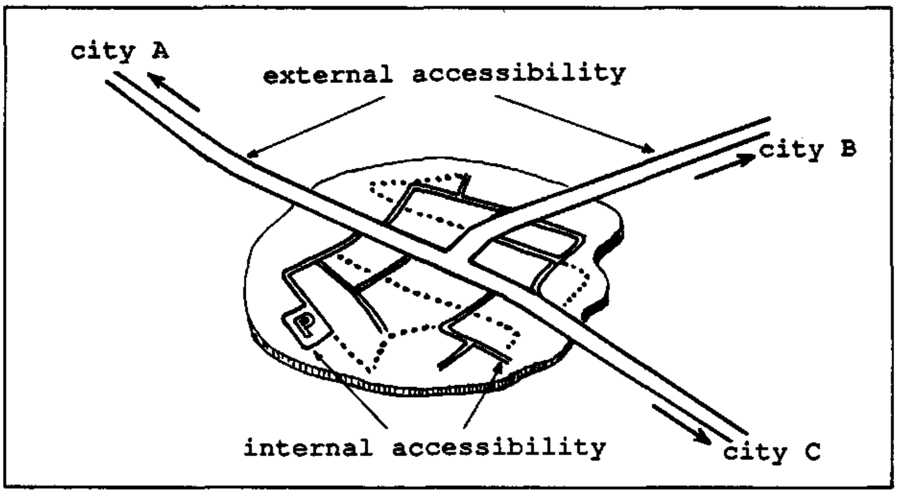

Figure 1.6. *External and internal accessibility.*

In addition to the more physical aspects of accessibility come economic and social aspects: are the resources available for public use and if so, under what conditions? Access may be restricted to non-motorized means of transport, or to members only, or in specific periods only. Entrance fees or parking fees may create a threshold that some are not able or willing to pass. Certain types of areas that are located in between the residential areas and the recreational areas because of their character may be perceived as barriers: busy roads, industrial complexes. (Van der Voet and Haak, 1989).

The incorporation of the accessibility aspect in addition to the physical suitability and scenic quality makes the landevaluation complete in its widest sense. Which of the aspects is most important in determining the actual use pattern and potential suitability will vary from one situation to the other, and depend on the type of recreation and the type of landscape.
The aspect of scenic quality has the largest degree of subjectivity of the three and often is not included in landevaluation for non-recreational land utilisation types. For landevaluation for recreation it cannot be neglected however.

For certain types of recreation certain physical requirements are so essential that accessibility and scenic quality are very much subordinate. Other types of recreation are especially attracted to areas of high scenic quality and less specific about physical requirements. The point of gravity in the triangle of land evaluation (figure 1.7) of the aspects will differ from one recreation type to the other. Some examples will be given in the discussion of categories of land utilization types in the next section.

Van Lier (1988) also distinguishes three factors of suitability. The physical factors correspond with the physical requirements. His spatial factors comprise both scenic quality and accessibility. In addition come then social- economic factors. These, however, may be partly related to the demand rather than the requirements, whereas management aspects of terrain or area could be also considered as part of the physical requirements.
Klemstedt (1967, 1972) adds to the aspects of physical suitability and scenic quality the aspect of climate. It is an aspect that only becomes relevant when carrying out a land evaluation for a large area in which differences in climate are significant, or for land utilisation types for which certain aspects of climate are critical, such as the snow conditions for winter sports. Although the aspect should not be overlooked, it is of a different order than the three types of requirement in the triangle. Thus, there appears no clear need to expand the triangle to a quadrangle.

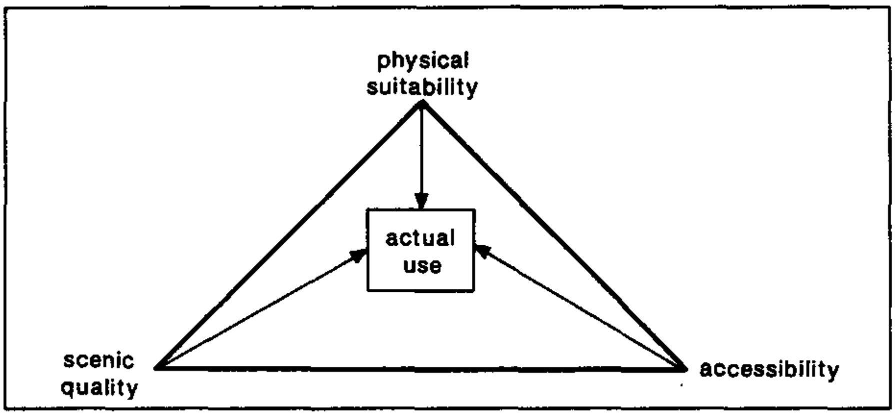

Figure 1.7. *The suitability 'triangle' (Van der Zee, 1990).*

From the attempt to assess the relative importance of each of the aspects of the suitability triangle for a number of waterfall sites in northern Thailand, it became clear that it is very difficult to quantify the aspects and really calculate their proportional influence. But some general conclusions could be arrived at. High use intensities did correspond with high rates of accessibility, except when the site quality (determined by physical characteristics as well as scenic quality) is low. Higher accessibility can compensate a somewhat lower site quality but cannot bring high use to the lowest quality sites. (Van der Zee, 1988a, 1988b).

In a good land evaluation also the compatibility of the envisaged land utilisation types with each other and with other activities or land uses in the area has to be considered. Not only because of off-site effects, but especially because recreational use often is but a secondary or additional use (Van der Voet, 1984).
Thus, in the first place the required minimum widths and depths of water and access problems of the different kinds of water resources may limit the range of boating activities they can support. But in addition, important non-recreational functions of the water bodies, including commercial navigation, drainage, water supply and waste disposal, often play a critical role in determining the extent to which recreational use is allowed or possible. For example, water skiing and power

boating is seldom permitted on reservoirs because of pollution risk and has been excluded from most rivers and canals by the imposition of speed limits designed to prevent bank erosion and conflicts with other users of the water. (J.W.Gittins in: Rodgers et al., 1973). Sometimes, the other uses put restrictions to recreation in another manner. For example, for angling, that needs little in the way of permanent facilities and may be developed wherever conditions are capable of supporting fish life, the main limiting factor is pollution rather than lack of access to water (J.W.Gittins in: Rodgers et al., 1973). In multiple use situations, often recreation is attributed a subordinate position (Van der Voet, 1984), but this is not a necessity.
However, recreation not only has to be reconciled with other uses, or other uses with recreation, but also different recreation types have to be compatible with each other. Different groups of visitors have different objectives, motives, expectations and experiences, and this may lead to conflicts between users. For example, conflicts may occur between walkers and cyclists and horsemen (Boonstra and Herfkens, 1985), or between walkers/ cyclists and motorcar drivers, or between anglers and surfers. This can be to such an extent, that one of the groups does not consider visiting the area any more. (Van der Voet and Haak, 1989).

Categories of land utilisation types.
Although the range of recreational activities is so wide as almost to defy classification, in the context of land evaluation, especially on semi-detailed level, it may be useful to group them into categories that have (almost) the same requirements. For a detailed evaluation the individual activities then have to be considered separately again.
Several classifications of recreational activities have been made from different points of view, but not all of them are useful for land evaluation.
For example, in the classification by Edington and Edington (1977) into *physical pursuits*, typically involving tests of skill and endurance (for example, climbing, caving, skiing), *sight-seeing activities*, based principally on an aesthetic appreciation of the countryside and *activities which have a specific involvement with wildlife*, such as natural history, hunting, shooting and fishing, each category comprises activities with a large variety in requirements.
Of the three types of categories of recreation pursuits that can be distinguished according to Burton (1967, in: Usher, 1973), the first one, *cultural*, attendances at theatres, museums and art galleries, and participation in amateur plays, concerts and exhibitions, is not relevant for land evaluation. The second type, *sports and physical*, comprises participation in such traditional games as football, cricket and hockey and, also, in the (relatively) newer pursuits such as golf and waterskiing. The third type, *informal*, includes walking, driving for pleasure, camping, taking picnicks and informal nature studies. Both types also cover a large range of requirements.

Coppock (1966) divided the recreational uses in Great Britain broadly into five types, on the basis of their demands on land and other resources. Patmore (1972) distinguishes the same five groups of activity. The accompanying indications in the suitability triangle are but tentative.
1. The *passive enjoyment of rural beauty* (Coppock, 1966) or, the *passive contemplation of the rural scene*, the *visual appreciation of the harmony of nature and of man* (Patmore, 1972). This contemplation may require no actual contact (Patmore, 1972), or little direct access to land (Coppock, 1966). Scenic quality is the major requirement. Of course one should get close enough to the landscape to see it. An activity related to this visual enjoyment therefore could be *driving for pleasure*. It is the most popular recreation activity in both the USA and Great Britain (Palmer, 1967), as well as in many other countries. This activity naturally requires access to the landscape, but access along paved roads only and therefore of a different order, it is no direct access to the land itself. Therefore physical requirements of the land are rather irrelevant. See figure 1.8.
Sometimes the term *countryside visiting* is used, encompassing a tremendous variety of activities that can be enjoyed in rural surroundings. Not only are the activities themselves numerous, but they make use of the countryside in a variety of ways. Probably, for most townspeople visiting the country, it is the countryside experience which is the main consideration, the particular activities

they engage in depending very much on chance opportunities and impulses in the course of an outing with no clearly pre-defined objective (Patmore, 1983). For most visitors, countryside recreation is an informal, passive activity, with the emphasis on sitting in or near the car, or walking a short distance, but for other people the activity itself can be the primary attraction and the countryside location incidental (Patmore, 1983) and, although the scenic quality of the landscape will enhance the attractivity, now other requirements become more important.

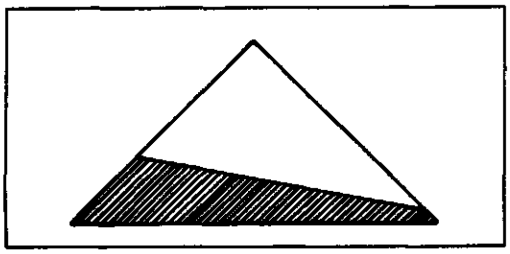

Figure 1.8. Suitability triangle for driving for pleasure

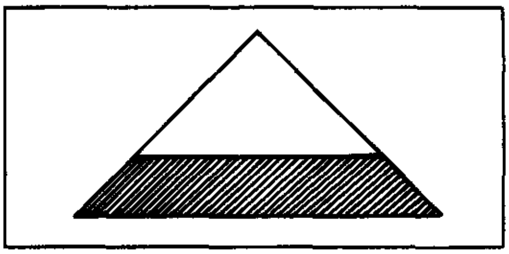

Figure 1.9. Suitability triangle for "informal pursuits".

2. *Informal activities* such as walking (Coppock, 1966), are an extension of roadside contemplation, with penetration on foot or on horseback into the countryside (Patmore, 1972). Walking, letting out the dog, being outdoors, enjoying nature, watching wildlife are amongst the activities people mention (Goderle, 1986), for which a pleasant setting close to home ranks high in perceived priorities (Patmore, 1983). This group of activities is not only concerned with the preservation of visual amenity (as was the first activity) but also with the establishment and maintenance of adequate access (Coppock, 1966; Patmore, 1972). Thus, both scenic quality and accessibility are required, physical qualities of the land still being less relevant. See figure 1.9. It is a *linear* demand, with satisfaction from movement and vista (Patmore, 1972).

3. *Sports*, such as cricket or motor-racing, for which a pitch or other specially constructed facilities are required (Coppock, 1966), *form a group of activities with needs that are satisfied at particular* sites, a *nodal* rather than a linear demand (Patmore, 1972). The areas may be restricted in extent by nature, for example, caving and climbing are restricted to suitable limestone areas and rocky outcrops. Another sport where the requirements are related to the season as much as the nature of the site is skiing. (Patmore, 1972). Physical requirements of land now are the dominant aspect. See figure 1.10.

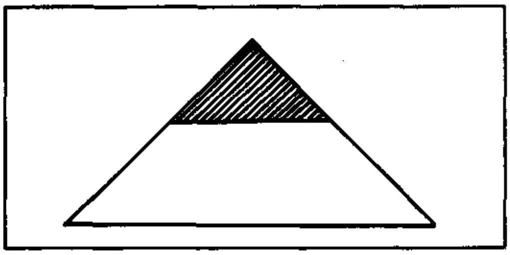

Figure 1.10. Suitability triangle for sports with emphasis on physical requirements.

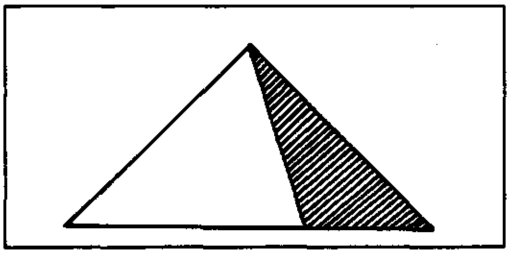

Figure 1.11. Suitability triangle for sports with emphasis on accessibility.

But there are also sports of a more organized nature, where interest focuses on particular sites and for which the requirement is more often land as such, rather than an inherently rural setting. Race courses, motor and motorcycle tracks, airfields for gliding and private flying come into this category. (Patmore, 1972). Physical requirements still rank very high, but accessibility is even more important. Scenic quality is subordinate. See figure 1.11.

4. *Traditional rural sports* (Coppock, 1966), or *fieldsports* in the sense of hunting and shooting, are a group of activities of which the needs are not restricted to a routes network nor to specific sites, but range uninterrupted over a considerable area (Patmore, 1972). The demand is *areal* in this case. These activities rarely demand the exclusive use of land however, and by and large they are compatible with agriculture and other uses. Hunting with hounds on fox, stag, otter and hare involves no direct reservation or management of land, but many forms of shooting -the most widespread is the shooting of game birds- demand active management of land or livestock. However, neither hunting nor shooting exact much exclusive demand on land. (Patmore, 1972). For this wildlife-based activity the physical requirements are strongly related, if not identical, to the habitat requirements of the wildlife concerned. Accessibility and scenic quality are but subordinate. See figure 1.12. The activity needs to be considerd in relation to conservation. (Edington and Edington, 1977).

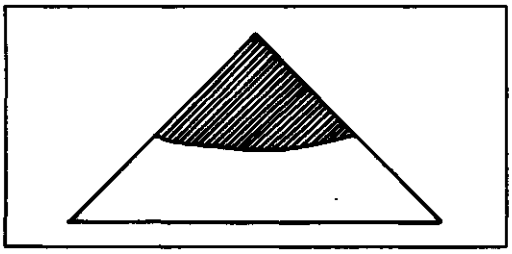

Figure 1.12. *Suitability triangle for hunting and shooting.*

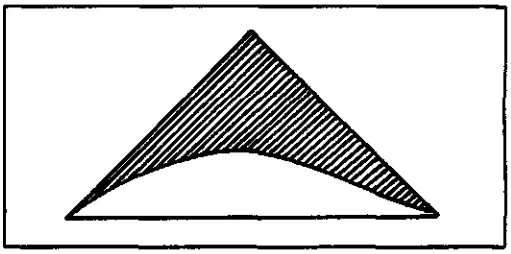

Figure 1.13. *Suitability triangle for water sports.*

5. *Water-based activities* (Patmore, 1972), or *aquatic sports*, which are practised in both coastal and inland waters, make only limited (though very localised) demands on land (Coppock, 1966). For sheer numbers of participants, swimming and angling are by far the most important. (Patmore, 1972). Physical requirements are dominant, but accessibility and scenic quality are not to be neglected. See figure 1.13.

Although this classification is very interesting, still some observations need to be made. As indicated already, the visual enjoyment of the land mainly has to be considered in combination with other activities. The range from linear via nodal to areal use of the land corresponds with Segers' classification into route related, terrain related and area related. But in this range the category water-use does not logically fit as a separate spatial use mode. It much more refers to a specific characteristic or quality of the land, and with respect to that another subdivision can be made. Segers matched his spatial use modes with a division into land recreation and water recreation (see figure 1.5). Kiemstedt et al. (1975) grouped their complexes of recreational activities into: recreation along the waterside, recreation on the water and recreation in the landscape. If the landscape then is further distinguished into specific sub-types relevant to recreation, this approach can be expanded into five categories of recreational land utilisation types: those concentrated in mountain areas, forest areas, water areas, coastal areas or just rural or countryside areas. Urban areas may be included to make this series complete, but in the context of this study that has not been done.

The two approaches, type of space use and character of the land used, may be combined to classify the recreational land utilisation types in more detail, as presented in figure 1.14.

Type of Space Use	Character of the land used				
	Mountains	Forest	Coast	Water	Rural
Linear	walking	walking	walking		walking
Nodal	camping climbing	camping	camping	swimming angling	camping sports
Areal		hunting			hunting

Figure 1.14. *Classification of recreational land utilisation types.*

In this matrix, which is not necessarily limited to the activities indicated, a particular activity may occur on more than one place. For example, walking falls under the category Linear, but within this may occur as well in mountain areas as in forest areas or in rural areas and even along the coast. Camping as a more nodal activity may be practised in mountain areas, forest areas, rural areas, but also in coastal areas.
It also has been suggested to include the aspect of season. Kiemstedt et al. (1975) distinguished summer and winter recreation. In the matrix this aspect could be included by adding the specific season to each activity. For example, S = summer, W = winter, A (or nothing) = all year round. Another solution can be to make a separate matrix for each season. But since for most activities the optimal season seems to be selfevident this aspect will not be further elaborated here. It also seems not to be relevant to include in such a matrix whether the activity is mainly carried out in vacations, in weekends or on free afternoons, because this is less related to the type of activity and more to the accessibility, that is, to the location of the recreation areas with respect to the major population centres.

But, a third dimension can be added by a subdivision according to the approach of popularity. In terms of total recreation experience of an individual over his whole lifespan, three clear groups can be distinguished (Patmore, 1972). The first group of activities, followed by 30% or more of the population, are all cheap to undertake, needing only simple skills taught at childhood or at school and require facilities, such as sports pitches and swimming baths, that are readily available in most communities. Activities are: team-games, swimming, cycling, tennis, athletics, camping and hiking. Camping ranks surprisingly high in terms of recent participation, but the term itself is broad and covers both the simple, cheap and arduous form most practised by the young and single, and family camping of later years often associated with car ownership. The next group of activities are still fairly common: skating, fishing, sailing, bowls, golf, riding, hill-walking, natural history and youth-hostelling. After these come true minority pursuits such as motorsports, sub-aqua sports, wintersports, archery, skiing, ponytrekking, gliding, waterskiing. Golf remains a minority sport, albeit with vocal, and powerful, adherents. Access is often restricted, especially the economic and social access.
Kiemstedt et al. (1975) could rank the recreational activities in their study according to relative participation: walking 53.4%, bathing/swimming 42.1%, lying/playing outdoors 28.5%, hiking 15.6%, cycling 13.9%, visiting places of interest 11.2%, camping 8.9%, angling/fishing 7.0%, active sports 6.0%, nature observation 5.8%, mountain/rock climbing 5.8%, rowing/canoeing 5.1%, sailing 5.1%, making a boat trip 4.2%, cross-country skiing 4.0%, (bob)sledging 4.0%, downhill skiing 4.0%, skating 4.0%. From this ranking a similar grouping can be made as Patmore did.
In this way groups of activities can be classified as *majority*, *common*, and *minority* recreational activities.

The matrix of figure 1.14 can be repeated in three layers to visualize this third dimension, and if the activities mentioned by Patmore in his subdivision are filled in in the three layered matrix, the pattern presented in figure 1.15 may occur.

An alternative that may be applied too, is a distinction into activities mainly or exclusively practised by (foreign) tourists and activities predominantly practised by the own population. It may not be relevant in all situations though, and has not been further elaborated.

MAJORITY RECREATION ACTIVITIES

Type of Space Use	Character of the Land Used				
	Mountains	Forest	Coast	Water	Rural
Linear	hiking walking	hiking cycling walking	walking		hiking cycling walking
Nodal	camping	camping	camping	swimming	camping tennis teamsport athletics
Areal					

COMMON RECREATION ACTIVITIES

Type of Space Use	Character of the Land Used				
	Mountains	Forest	Coast	Water	Rural
Linear	hill-walk			skating sailing	riding hill-walk
Nodal	youth-hostelling	youth-hostelling	fishing	fishing skating	youth-hostelling golf
Areal	natural history	natural history	natural history	natural history fishing sailing	natural history

MINORITY RECREATION ACTIVITIES

Type of Space Use	Character of the Land Used				
	Mountains	Forest	Coast	Water	Rural
Linear	winter sport				pony-trekking
Nodal	climbing				archery gliding
Areal	skiing	hunting		water-skiing sub-aqua	hunting

Figure 1.15. *Majority, common, and minority recreation activities.*

When in a proper land evaluation also the effects of the planned land utilisation types have to be taken into account, a rough approach is to list those activities that are considered to be compatible with other land uses.
Thus, for example, the forms of public recreation favoured by the management of Meyendel, a nearly 2000 ha part of the coastal dune belt along the Dutch Northsea coast, are: walking, nature watching and cycling, because they can be successfully combined with nature conservation and with water catchment in the same area. (Van der Meulen et al., 1985).
In general, however, there are few types of actual recreational behaviour of which can be stated that they are always detrimental for the natural environment. Mostly the amount of damage depends on the intensity of the behaviour and the sensitivity of the natural environment at that

place. (RMNO, 1983a). To include this dimension also in the matrix would make it confusingly complex. A separate matrix to indicate the potential impact is preferred. This is not the most suitable place to further elaborate on that, however.

Land units and their qualities as recreational resources.

With respect to recreation the usual subdivision of landscape characteristics into soil, terrain configuration, water, climate, vegetation and animal world seems to be less relevant. The (natural) elements of the landscape need to be distinguished according to their qualitative and quantitative effects on recreation. (Kiemstedt, 1967). But, there is no single quality of the landscape. Landscape quality can only be defined with respect to a certain use. (Van Oort and Jeekel, 1982). Therefore only after the relevant recreational land utilisation types have been identified and their requirements specified, the landscape can be analyzed for its recreational resources and the relevant characteristics and qualities of the land units determined. The question arises how these qualities can be assessed, measured and ranked and how representative, reliable and accurate the conclusions from such an exercise are.

Any land area can be developed for some kind of outdoor recreation. Nevertheless, some resource complexes are more suitable than others for specific activities. (Olson et al., 1969). Some physical features or characteristics are better adapted to outdoor recreation than are others, and will be preferred when choice is possible. Resource quality for recreation is largely a subjective matter. Yet most people would agree that some areas are inherently more attractive and outstanding than others. (Clawson and Knetsch, 1966). Still, taste...is the variable about which least is known at present. Therefore we should beware of such statements as: *The single most desirable characteristic of recreational land is the presence of water* (Cosgrove and Jackson, 1972). Nevertheless, the landevaluation for outdoor recreation in the North Eastern USA (Dill, 1962) starts with such a statement. In that study the desirability of natural shade, suitable terrain and good highway access are stated to be additional essential items for consideration in site selection, without specifying the recreational land utilisation types for which sites have to be selected.
Evaluation of natural elements alone is not sufficient, accessibility and man-made attractions and facilities have to be taken into account as well (Smith-Romeijn, 1969, 1970; Kiemstedt, 1972; Patmore, 1973; Goodall, 1985). Thus, it is logical to analyze the land units for the same three aspects for which the requirements of the land utilisation types have been formulated: physical suitability, scenic quality and accessibility. Yet, an example where this has been consequently applied in practice is hard to find.
The approach of Duffield and Owen (discussed by Patmore, 1983) used four separate assessments of land capability for outdoor recreation: suitability for land-based recreation, suitability for water-based recreation, scenic quality and ecological significance.
How the scenic quality is assessed or what exactly is meant with ecological significance is not mentioned. The aspect accessibility apparently is included in the suitability, together with the physical qualities. For example, for camping, caravanning and picnicking the suitability criteria were: all countryside within 400 m of a metalled road, for pony-trekking: all upland areas above 300 m with rights of way, or established footpaths and bridleways and for walking and hiking: all upland areas above 450 m with rights of way, or established footpaths or bridle ways. For rock-climbing all cliff faces over 30 m in height and for skiing an available relief over 280 m with an average snow holding period of more than three months were considered suitable. But, as Patmore stated, the choice of both activities and criteria for activities is obviously arbitrary. The description of the physical characteristics is rather limited, the factor accessibility only touched upon and the aspect scenic quality totally absent.
Other land evaluations for recreation have hardly been more specific with respect to land characteristics and qualities. For example, for the evaluation of the Snowdonia National Park seven elements were considered. 1. scenic resources = relief and landform landscapes;

2. ecological resources; 3. land-use landscapes; 4. natural resources for recreation; 5. man-made resources for recreation, including facilities; 6. roads for recreation; and 7. water for recreation. (J.W.Gittins in: Rodgers et al., 1973). In this case the aspect scenic quality is present, but the way of assessing only hinted at. The accessibility aspect may be comprised in *roads for recreation*. The physical qualities may be comprised in the other elements without being specified. Kiemstedt et al. (1975) include both the assessment of physical suitability and scenic quality, but are less specific about accessibility.

The physical characteristics, the accessibility as well as the scenic quality have to be made explicit and, if possible, quantified.
In the absence of absolute standards for evaluating recreational land resources, however, planners often have turned to relative measures (Cosgrove and Jackson, 1972), to qualitative descriptive evaluations (Maier, 1972). And this is no wonder, because although some characteristics of nature, such as the occurrence of sandy beaches and the temperature of the water, *are easily measured, quantifiable, and probably subject to general agreement among all* or most users (Clawson and Knetsch, 1966), many others are far more difficult to define. And even when it is possible to clearly define the characteristics, still some problems may occur. For example, the factors for a successful coastal resort were once stated to be the presence of flat, sandy shores, a location distant from a river mouth, and cliffs to add to the scenic interest. But others pointed out that most resorts do not have one physical feature in common other than being on the coast. (Cosgrove and Jackson, 1972).

But, however difficult it may be, for a good land evaluation it remains essential to clearly specify the criteria and if possible quantify them.

Physical suitability.
The more specific the requirements of a land utilisation type have been defined, the more exact the physical characteristics to match them can be expressed in parameters. The land units then can be screened in order to see whether in the first place the *minimum requirements* for the activity concerned are met, and if so, whether some *improving* conditions are available in addition. At the same time also the *restrictive* conditions should be looked at. When a certain land characteristic does not have any influence on the specific type of recreation concerned it is called *indifferent* (Kiemstedt et al., 1975; Goodall, 1985).
It also should be indicated whether deficiencies in the minimum conditions or the presence of restrictions are absolute or can be overcome by certain investments, such as creating simple facilities, improving accessibility or purifying water.
For certain recreation activities, for example, downhill skiing, the conditions can be specified within a very narrow range of tolerance (Goodall, 1985). But, in many cases the specification of the requirements of the land utilisation types are pretty vague and the description of the corresponding land qualities rather wide. So it has been stated, for example, that for coastal bath-resorts type and area of beach are of importance, furthermore the characteristics of the sea: temperature of the water, currents, tidal regime, and that in addition the back country plays a role as a bad weather provision (Defert, 1954). But no quantifiable parameters were given.
The land utilisation types have been grouped in those concentrated in mountain, forest, water, coastal and rural areas. Thus, a first division of the landscape into these major types of area can be a start. However, as already stated before, not all waterbodies, not all forest types are in the same way suitable or attractive for a specific type of recreation. And the same applies to the other types of area.
When the *spatial pattern of recreational facilities can be related to the characteristics of the* resources from which they apparently are derived, and these are compared with other elements of the landscape in the same area and similar elements in other areas, this may give insight in the factors that determine whether a landscape element becomes a recreational resource or not.

For such comparisons the physical characteristics of the resource should as much as possible be described by quantitative or qualitative parameters.
For agricultural land utilisation types such parameters are mainly described in terms of soil and terrain qualities that often are easily quantifiable, are similar for different land utilisation types and have given rise to standardized procedures (See for example: Beek, 1978). For recreational land utilisation types such kinds of parameters can seldom be used exclusively, sometimes not at all. There are examples where soil conditions have been specified in relation to recreational activities (for example by Segeren, 1971, and Sas, 1988), but then it usually concerns activities that are localized on areas of restricted size. It is more land evaluation for specific recreational facilities, such as sport field, camping ground, playing lawn. For most recreational land utilisation types specific parameters have to be developed, that in some cases are applicable to that type only. An example of that are the parameters developed to analyze waterfall sites in Northern Thailand (Van der Zee 1988a, 1988b, 1990), after a reconnaissance inventory had revealed that such sites were highly favoured for recreation (Van der Zee, 1988c). See figure 1.16.

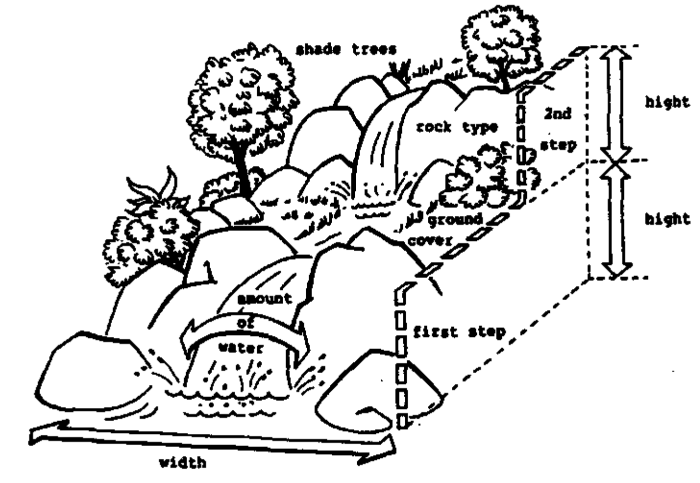

Figure 1.16. *Parameters for physical suitability of waterfall sites. (Van der Zee, 1988a, 1989, 1990).*

In many cases however, only a relative value can be attached to these parameters and not an absolute one. In addition, there is an element of subjectivity in selecting the particular variable for measuring a factor. For example, with respect to slopes, should the gradient be measured or the slope changes per unit of distance? The next element of subjectivity concerns the weights given to the factors, even where based on preferences of recreationists. (Goodall, 1985).

The suitability of an area for recreation is also strongly influenced by the other uses that are made of the area (Klemstedt, 1967). Because, a fair amount of recreation takes place on land that is not set aside for that purpose (Sideway, 1987a). Only certain types of recreation require specially equipped areas (Van Oort and Jeekel, 1982), but often recreation occurs in *multiple use*. In conditions of multiple use, four general types of interaction between uses can be distinguished. *Indifferent*, when two use forms do not utilize the same properties of the resource, or if they do only very modestly so. *Cooperation*, when two use forms utilize the same properties of the resource in the same way without consuming them in terms of extraction. *Competition*, when two use forms claim to utilize the same properties of the resource in such a way that one or both are forced to less use than in the case of absence of one of them. Competition depends on the size of the area and on the intensity of the use forms. *Exclusion*, when two use forms can not utilize the same property together at all. (Van der Ploeg, 1990).

Although for most types of recreation climatic conditions do not belong to the minimum requirements, but more to the additional improving conditions, still, since vacation is as much a change of environment as a change of climate, stability and variety of climate are important factors.
One could establish an optimal *recreation climate* and map its occurrence. More important is the distinction of various degrees of suitability for recreation in this respect (Defert, 1952). In addition, it has to be realized that the factor climate is different for different parts of the world. Where in Western and Northern Europe and Northern America there is a longing for the sun and the warmth, in tropical countries search for the cooler places.

But, as already stated when discussing the requirements, climate is mainly relevant only when considering the national or international level. On regional level climate can be considered as a constant factor, with a few exceptions. For example, summer-resorts in the mountains are determined by the climatological factors: altitude, insolation, temperature and precipitation. For wintersport-resorts the snow condition and the insolation are the major factors. (Defert, 1954).

Scenic quality.
The way in which landscapes are seen and valued for their scenic quality is different from one person to another, thus highly subjective (Clawson and Knetsch, 1966; Zube, 1987). How then, to determine parameters with which the scenic quality of the land units can be assessed?
Because most people will agree that some areas are inherently more attractive and outstanding than others (Clawson and Knetsch, 1966) it is possible to compile such opinions by enquiry surveys, sometimes referring to landscape elements depicted on a map or to photographs of specific landscape scenes (Baumgarnter, 1981; Zube, 1987) and cluster subjective judgements into reasonably objective results. But the approach is rather laborious, still not free of suggestive and subjective tendencies and difficult to translate into simple parameters. It is also possible to analyze the actual spatial behaviour of recreationists. That appears to be closely related to the spatial structure of the landscape and reveals preferences for certain landscapes and landscape elements. These landscape elements are reproducible by photography and sketches and accessible in cartographic form as well (Neef, 1984), and therefore can be described according to objective characteristics to which their apparent attractiveness can be related. For comparative purposes these characteristics should be quantified. One approach to include quantification in the analysis and assessment of the scenic quality or *landscape evaluation* for recreation is that developed by Kiemstedt (1967, 1972 and Kiemstedt et al., 1975), who made use of the principles for analyzing the spatial structure of the landscape used by Van der Ham and Iding (1971). More details on this and other methods of landscape evaluation will be given in chapter 5.4.

Accessibility.
Though physical suitability as well as scenic quality are important, they are not always decisive. Other reasons may explain the development of recreational use. Conditions of location and access may be critical (Goodall, 1985). Location is a factor of importance that makes that standards of physical suitability and scenic quality are meaningful only with respect to the type of recreation area concerned. Therefore the kinds of standards that have been established and their degree of explicitness differ considerably between user-oriented, intermediate, and resource-based areas. (Clawson and Knetsch, 1966). The travel ranges for weekend and vacation travel vary (Gunn, 1988) and in relation to that the requirements for day trips and weekend trips in general are less high with respect to the quality of the resources than the requirements for vacations (Geigant, 1962).

When a certain quality is available in abundance, sites without good accessibility will not be considered. Thus, in the study by Olson et al. (1969) for Michigan, USA, because of the general availability of lakes and streams no site was considered significant which did not provide access to water across dry ground. If however only few sites of adequate quality are available it may be rewarding to invest in an improvement of the accessibility. This applies to both external and internal accessibility.

Therefore, distance to the main sources of recreational demand, the major population centres, is the first aspect of accessibility that has to be determined. This external accessibility will determine whether (potential) recreation sites can be of regional significance or of local importance only. And this again often determines what should be the minimum size of suitable land in order to satisfy the demand on that level. Of course this distance should be related to the available transportation lines and means. Although motorcar and plane tend to dominate most recreational and tourist travel, other modes of transportation, such as boat, train, horseback, cable lift and hiking, frequently are critical links of the transportation system (Gunn, 1988). For motorized transport accessibility becomes less of a problem because of the larger radius of action. For non-motorized recreationists lack of external and internal accessibility is more rapidly of decisive importance. (Van der Voet and Haak, 1989).

Also, distances should be expressed in time travelled, for example by isochrones, lines indicating zones with identical travel time (Kiemstedt, 1972), rather than in mere distances measured *as-the-crow-flies*.

With respect to the internal accessibility of a recreation area, it is also best to express accessibility in terms of time needed to get somewhere as a function of type and quality of road, slope steepness, etcetera.

The accessibility will be most important with respect to day trip recreation (Kiemstedt, 1972). People travel very short journey-distances in the proximity of their urban settlement (Sideway, 1987a), although for day recreation a distance of maximal one hour travel is no objection (Sas, 1988).

With respect to the influence of distance both Geigant (1962) and Maier (1972) refer to the *distance sensitivity law* of Lill (*Gesetz der Distanzempfindlichkeit*) dating back to 1891, but still found to be applicable. According to this law the number of journeys decreases with increasing distance. This distance can be expressed in terms of time-effort-cost. Especially in the sphere of day and weekend recreation this factor is important. The longer the stay, the less heavy the travel costs weigh on the total budget (Theuns, 1989a).

Thus, the range within which people travel for recreation is determined by the time that they have available. The wide definition of recreation implies that most of it is done in or near home or its direct environment. If only a part of the day is available for recreation, the range is determined by the distance that can be covered in that short period for going to and from and still having time for recreation itself. This range can be called the zone of *nearby recreation*. Beyond that lies the zone of *day recreation*, of which the range is determined by the possibility to travel to and from and in addition have time for recreation. (Van der Zee, 1971). In the Netherlands it has been found that of the total number of day trips (in 1982) 40% takes less than two hours, and that in 53% the total distance is maximally 7.5 kilometre (Heijens-Lijnse and Bernelot-Moens, 1988). Outside the zone of day recreation at least one overnight stay will have to be made: the zone of *weekend recreation* is entered. Beyond that lies only the zone of *vacation recreation*. This zonation can be seen as a kind of Von Thünen-like belts for recreation. Such a set of belts can be conceived with the individual as centre, but becomes more interesting when the individual patterns are aggregated to that of a population agglomeration. The zones of nearby recreation and day recreation will include the home settlement. The zones of weekend and vacation recreation will start outside that settlement. The different zones will show considerable overlaps.

A schematic impression of such a recreation belt system is presented in figure 1.17.

Thus, from each population agglomeration the range of is recreation area can be determined. The *metropolitan area* of Geigant (1962) is the area that receives the recreationists of a certain *metropolis*. Another term that could be used is that of *recreational hinterland.*

The size of such an area is related to the size and density of the population, the economic and social situation, etcetera. But also to the developments in the transportation sector. As a result of faster cars and better roads the *critical distance*, that is the maximum distance that can be covered within reasonable time and effort with a certain means of transportation, for car travel has increased. As a consequence the recreation zones have expanded outward. (Theuns, 1989a).

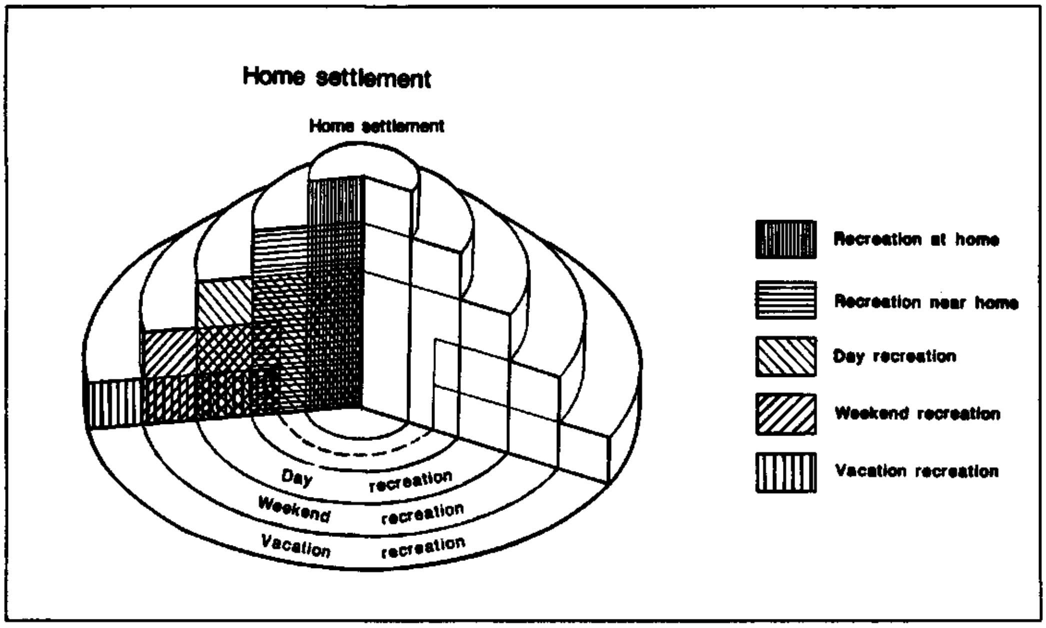

Figure 1.17. *Distance related recreation belts.*

Of course the real pattern is not nicely concentric, but irregular, determined by transportation infrastructure, and available resources and facilities. The zones need not even be contiguous. Especially the zone of vacation recreation can be completely detached from its metropolis in this era of airplanes. In addition, the patterns of various agglomerations may also interfere with each other and thus create a complex mosaic.
The complexity can become even greater if not only the access in a physical sense is considered, but also the legal, social and psychological aspects are included. Areas have to be classified according to their accessibility status in these respects too.

Ecological aspects.
Although ecological aspects are not included in the suitability triangle of the requirements at the demand side, at the supply side they certainly need to be considered. Because, the statement made for land evaluation in general, that the suitability assessment should also be based on the risks involved in applying the land utilization type concerned certainly also applies to recreational land utilisation types. *Landscape forms a valuable but vulnerable resource*, and various forms of *development* result in formidable landscape changes. How to decide on which developments to permit and which not on the grounds of landscape *erosion*? (Clout, 1976). Thus, the *environmental impact* should be studied. Fortunately, recent trends in tourism and recreation policy also point to the environmental consequences of recreational and tourism development

(Jansen-Verbeke and Dietvorst, 1987). The awareness grows that it is wrong to slaughter the goose-that-lays-the-golden-egg.

Not all ecosystems or landscapes are subject to recreational influences. Most at risk are those areas of the highest scenic quality whose attraction is national rather than regional or local. Their appeal may be largely visual or may lie also in a sense of remoteness and wildness instilled by their sheer extent. (Patmore, 1972).

Not all nature areas are as such sensitive for recreational impact. Of course it is clear that some types of landscape, plant or animal species are more sensitive than others. (RMNO, 1983a). For example, dunes are easily damaged because of their loose sandy soils and thin vegetation cover. (Van der Meulen et al., 1985).

Also, the effects of recreation on the natural environment are very varied (RMNO, 1985a), and it therefore is not useful to speak of *the* influence of *the* recreation on *the* natural environment. The relationships have to be studied for each landscape type and each type of recreation separately. More information is needed about the components and processes that are potentially sensitive for recreation. (RMNO, 1983a). One specific activity can lead to qualitatively and/or quantitatively different effects in different types of landscape. Therefore it should be established which components of the natural environment are influenced (birds, vegetation, soil, surface water) and at what level of integration the effect is considered. A distinction can be made into four levels: organism (individuals), population (species), association (groups of interrelated species) and ecosystem. (RMNO, 1985a).

Because most forms of recreational behaviour can be regulated, that is, measures can be taken to change the number of recreationists that display one specific behaviour (RMNO, 1983a), to the assessment of the (potential) impact should be added an indication whether or not certain measures can alleviate or even completely prevent a certain impact.

The impact of recreation will be discussed in more detail in chapter 4.2.

Suitability rating and data format.

As in land evaluation in general, also for land evaluation for recreation a suitability assessment results from a confrontation of land utilisation types, of which requirements have been defined, with land units, of which the characteristics or qualities have been described. To make this matching successful both requirements and qualities have to be described in the same format, that means by the same parameters, preferably in quantitative measurable units at the same level of accuracy, and as objectively as possible. In addition, for the method to be really applicable, the evaluation criteria selected should make it possible to inventory with simple statistical means and concentrate on some dominant factors (Kiemstedt, 1967).

Two types of figures should be clearly distinguished (Kiemstedt et al., 1975): 1. measured values, for example: 3 km of forest border, 4 ha of water, 2 restaurants, etcetera; 2. qualitative values, that means, results of an evaluation into quality classes.

The measured values can again be subdivided into really objective ones, and the ones which still have a touch of subjectivity. For example, some requirements and qualities are really fixed: a boat of 1.5 metre high can not pass under a bridge of 1.3 metre. And so also measures of width and depth can be considered as fixed. But how strict are standards with respect to the minimum amount of surface water per boat? How have these standards been established? It makes sense to allow a certain level of tolerance in the matching in this respect.

With qualitative values it is even more critical to know how they have been assessed, and what a ranking really means. The problem is that the many independent variables can hardly be objectively valued and subjective values can only be applied for the group and the region for which they have been established (Maier, 1972).

Thus, in the evaluation of the quality of the recreational resource base over and above the presence of minimum user requirements, an element of subjectivity is involved. The key problem

is the comparison and weighting of the wide range of factors. Subjectivity could be additive or multiplicative. (Goodall, 1985).
Sometimes the catalogue of parameters is restricted because for some criteria the data can not be obtained. (Klemstedt et al., 1975).

And when the problem of defining the individual parameters can be solved to satisfaction, the next problem arises, that of integration or synthesis of several different parameters into one evaluation value. Whether computer mapping techniques in geographical information systems or the cartographic *sieving* device with transparent overlays is used, the problem of inequality in class intervals and value judgements has to be solved. (Clout, 1976). To incorporate all indicators in one overall numerical scale is impossible, when the importance of the individual indicators for their recreational relevancy is not known (Funke, 1977). Moreover, it is not a question of simple addition of the different parameters for the three main aspects. It should not be merely aggregation but integration. (Dietvorst, 1989a).
It is best to maintain the principle that the numerous individual criteria are grouped together step by step into statements that are more and more complex, and that these steps remain recognisable as such (Klemstedt et al., 1975). This should be done especially when the quality of individual recreational facilities is also determined by the way in which they are integrated into a larger whole, a recreational complex. Characteristic for such a complex is, that the elements are not haphazardly distributed in space. They are interrelated, need each others vicinity and as a whole are more attractive then each on its own. (Dietvorst, 1989a).

Of importance is also at what level of spatial aggregation the suitability assessment is done. The geographical level of aggregation that is used is often the wrong one. Delimitation of recreation areas using administrative (municipal and provincial) boundaries, for example, only in accidental cases is relevant for certain categories of recreationists. (Weerstra, 1990).
In many studies in land evaluation for recreation the suitability assessment has been made on the basis of grid squares, often of 1 km^2 (Klemstedt, 1967; Funke, 1977; Bellemakers and Thijs, 1983), sometimes larger (Klemstedt et al., 1975 : 2 x 2 km). But, apart from some advantages, the use of a grid has also many disadvantages. Therefore the approach in general land evaluation to take land units as the basic unit for assessment seems to be very useful too in the case of land evaluation for recreation.
The evaluation should be conducted on a regional scale to assure that all opportunities are considered. The inventory of data by which the recreational potential can b judges should be carried out uniformly over the whole area. (Mittmann, 1990).

It has always to be realized that the values resulting from a suitability rating procedure are relative, not absolute. They direct the attention to areas and sites that are worth to be further investigated in more detail. (Goodall, 1985). And how well the evaluation procedure is designed, and how realistic the different parameters represent the recreational value, the result can not be but a faint reflection of reality. Moreover, human behaviour partly is also governed by irrational motivations. This is also true for recreational behaviour. Urbanites may visit certain rural areas not because of the outstanding scenic quality or of high suitability for specific recreational activities, but just for sentimental reasons (Clout, 1976). The location of second homes sometimes may be less determined by the quality of the landscape and more by the accidental availability of abandoned farmhouses.

1.3. PRINCIPLES OF REMOTE SENSING AND AIRPHOTO INTERPRETATION.

As such landevaluation requires the collection and inventory of many basic data, which with conventional techniques and approaches may be very laborious and time consuming and thus expensive. Remote sensing can help to make the inventory phase of landevaluation more efficient.

Remote sensing.

Remote sensing is a system which permits determining information about distant objects without direct contact (Konecny, 1987), thus without actually touching it (Mulder, 1986; 1991; Kannegieter, 1987). In the meaning of *remote* emphasis is on *non-contact* rather than on the distance factor (Hempenius, 1978), although in the case of some spaceborne sensors the sensing may be done from a distance of even as much as 36000 km, thus really *remote* (Kannegieter, 1987), see also Bowden and Pruitt (1975).
This indirect contact must be established by means of energy fields (Konecny, 1987), and thus remote sensing employs such devices as the camera, lasers and radio frequency receivers, radar systems, sonar, seismographs, gravimeters, magnetometers and scintillation counters (Bowden and Pruitt, 1975). But, defined in a narrower sense remote sensing is restricted to the *practice of the registration of the electromagnetic radiation reflected or emitted by objects* at the surface of the earth (Kannegieter, 1987; Bowden and Pruitt, 1975; Hempenius, 1978), thus being essentially *earth remote sensing* (Konecny, 1987). Remote sensing then is done for the qualification and quantification and mapping of the earth and the phenomena that occur on it, and for the monitoring of processes on and near the surface of the earth (Hempenius, 1978; Kannegieter, 1987). From this surveying and mapping point of view only remote sensing systems that permit creation of images are of interest (Konecny, 1987). And although the human senses, such as vision and hearing, in fact also are forms of remote sensing, they are in some respects more limited (Kannegieter, 1987; Konecny, 1987). Not only because *real* remote sensing, as compared to human observation, makes it possible to employ radiation in parts of the electro-magnetic spectrum well outside the visible range (Kannegieter, 1987), but especially because the human senses do not record images, they are not considered as remote sensing systems in the true sense (Konecny, 1987).

Many understand that the interpretation of the data generated by remote sensing techniques forms an integral part of remote sensing. Remote sensing thus includes both data acquisition and data interpretation, or information extraction. (Mulder, 1986; 1991; Kannegieter, 1987; Hempenius, 1978).

Even though remote sensing at present almost automatically is translated into *all that is related to images obtained from space*, also images made from airplanes, including the ordinary black-and-white airphotos, belong to remote sensing (Van der Zee, 1985b; Hempenius, 1978; Konecny, 1987), and even ground-based remote sensing should not be ignored (Mulder, 1991). Amidst the modern electronic sensors in satellites the importance of photographic systems can not be denied (Graham and Read, 1986), and in many projects the *ordinary* airphoto still is the most important remote sensing means and is commonly used, in contrary to other techniques that often are still in an experimental stage (Van der Zee, 1985b), or are too bothersome, sophisticated or expensive to use, especially in small projects (Colwell, 1975) and in developing countries (Kilmayer and Epp, 1983). *The largest volume of remote sensing data acquisition is still in the analogue recording of images on photographic film* (Mulder, 1991). Sometimes even systematic reconnaissance flights and direct observation from small aircraft are included in remote sensing (Van Wijngaarden, 1988; I.Zonneveld, 1990a), even when no images are recorded.

Advantages (and disadvantages) of remote sensing.

When discussing the advantages, and disadvantages, of remote sensing, it is common to consider it in comparison to other, *conventional* techniques, often based exclusively on

collecting data and making observations in the field. However, the number of applications in which remote sensing has become the conventional technique is increasing.
In cases where the landscape is considered to be an important source of information, as it is in many studies related to recreation, remote sensing is an indispensable tool for a better understanding of that landscape, because it provides an integrative, a holistic, view of the landscape, with all obstacles removed that otherwise hamper the observer in the field. (I.Zonneveld, 1990a; Kannegieter, 1987; J.Zonneveld, 1960; Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). An observation point over the area that one wants to study is better than one in the area itself. Objects that are inaccessible for the observer in the terrain often are not so for the observer in the air. (PWF, 1977; Schrauwen and Terpstra, 1986). The overview makes it possible to study interrelationships between the different components of the landscape, which to an observer on the ground might not be apparent (Estes and Simonett, 1975; Kannegieter, 1987). Still, despite the overview not all objects of interest may be visible. Even if data can be obtained by statistical surveys, the results of such surveys are often rapidly obsolete, or they are available only in aggregated form for administrative units that are not always the most suitable ones for the purpose of the study. Airphotos in such a case can be a useful additional source of data. (Dodt, 1974).
Important in this respect is also that the overview of the situation in a relatively large area can be obtained in a relatively short time (Loedeman and Van der Voet, 1979; Bakker and Thewessen, 1986; Bakker and Heil, 1988). That situations can be depicted with objects, that are moving or changing, at one particular moment is another advantage (Van der Voet and Dijkstra, 1971; PWF, 1977; Schrauwen and Terpstra, 1986).

Thus with remote sensing in a short time with little man power a large amount of data can be obtained. There is no need for a whole team of surveyors to go into the field to collect data. (Stroband, 1971; Driebergen, 1981a; Schrauwen and Terpstra, 1986; Bakker and Thewessen, 1986). In most developing countries, but not only there, ground checking is becoming an expensive undertaking because of the high cost of fuel, vehicles and vehicle maintenance (Klilmayer and Epp, 1983), and also the high cost of trained manpower should not be overlooked (Dodt and Van der Zee, 1974).
But, *it is a mistake to imagine that the air photo interpreter has at his command information which cannot be obtained on the ground. If differences are recorded on the air photos it must be that field conditions responsible for these differences exist on the ground. These differences could be identified and mapped on the ground although, in many cases, the work would be exceedingly slow and tedious and might entail the use of elaborate equipment. Once differences have been noted and their distribution mapped on air photos, on the other hand, it is usually a simple matter to establish the exact nature of these differences by ground observation. The question is not, therefore, whether air photos can provide a solution where field work would fail, but rather one of comparing the difference in time and effort required to achieve the same results by the two methods. Sound interpretation of air photos can make arduous fieldwork superfluous.* (Goosen, 1967). In the air photo interpretation approach for soil survey, as compared with conventional field work, the density of soil profile observations is less while the value of the identification of the soils remains the same and the accuracy of the plotting of the soil boundaries is greater. For the conventional grid soil survey some standards have been adopted for the required density of observations, although these vary from country to country. One observation per cm^2 of map can be a fair assumption. According to conventional standards any map not having this density of observation ought to be reduced in scale until such is the case. Using air photo interpretation the grid method can be replaced by *selective sampling* in which the field observations sites are selected to get a representative sample of a large soil mapping unit, rather than as a means of locating the soil boundaries. In very complex areas even the grid method may not give satisfactory results, where the situation for the air photo interpreter may be quite clear. In semi-detailed soil surveys only 1/4 to 1/10 of the normal time is needed, and as a consequence the work capacity of the soil surveyors is increased by 400 to 1000% . This increase in efficiency is illustrated with a, perhaps extreme, example of an area in Colombia of 13 million hectares that was mapped with airphotos in a scale of 1:40000. The area of all field samples combined, surveyed in a semi-

detailed way, was 3% of the total area. Not a very high percentage but justified in view of the speed of the survey required, the planned scale of the final soil map (1:250000) and the existence of a uniform soil pattern over large distances. (Goosen, 1967).
Since some field observations will always be necessary to check abd complement the interpretation, a proper balance has to be struck between the two, both with respect to the accuracy as well as the cost aspect. What is true for the soil and vegetation surveys, is also valid for many other types of surveys. And then, in addition, not only the comparison should be made between the remote sensing approach and the conventional approach, expressed in costs, but it should also be considered what costs are saved if good planning can be based on data that are available in short time (Fagerholm, 1959).
Although the efficiency and cost aspects are often mentioned among the advantages, it is difficult to find in the recent literature an actual quantified estimate of cost reduction. For good comparison it is necessary to make cost models, which can be defined as the functional relationships between the cost per production unit of any of the different sub-processes of a total production process and the large number of factors which influence the production. Such cost models are on the one hand a function of *Basic Cost Standards*, being personnel-costs/time unit, equipment-costs/time unit, and material-costs/unit. On the other hand they area function of the *Production Standards*, these being the statistically derived data concerning personnel and equipment-time required to realise a certain production unit, including the materials thereby required.
Basic Cost Standards depend mainly on factors related to the executing organisation and considerable variation can be found in the basic cost standards of different organisations. Production standards are influenced only slightly by factors related to the executing organisation (for example, skill and productivity of the operators), but they are significantly influenced by factors pertaining to the project area (for example, topographic characteristics of the terrain, density of natural and cultural features, etcetera), by the product specifications (for example, amount of detail required, accuracy required, etcetera), and last but not least by the process parameters (for example, scale of photography, methods and equipment used). Production standards should therefore, to a certain extent, be independent of the executing organisation.
Figures of the total production costs, however important this aspect might be to the executing organisation, are less suitable for comparison purposes. For that, detailed information concerning the production standards rather should be used. (Jerie, 1976). However, such specified cost models are hard to find.
When MacConnel and Garvin (1956) state, that *to obtain vegetation maps by ground techniques would be prohibitively expensive*, and therefore turn to airphoto interpretation, they also state that good cost figures are not available, because space, some equipment, materials and many man-hours have been contributed by the agencies that cooperated in the study, without charging for the costs. But, when calculating only the labour and travel costs, a vegetation map of the whole state of Massachusetts, USA, was made at an average cost per square mile of $ 2.49. Since it never has been tried to do it by ground techniques alone, no comparison of costs can be made.

Another advantage of remote sensing is, that it provides the observer with a permanent representation of objects, phenomena and relationships as they exist at a given time (Estes and Simonett, 1975; Loedeman and Van der Voet, 1979; Schrauwen and Terpstra, 1986). When the landscape can be read as an *open book* by the experienced researcher, the remote sensing image can be considered as a photocopy of that book (J.Zonneveld, 1960). And although they are only a substitute of the reality they depict (J.Zonneveld, 1960), the permanence and fidelity of remote-sensor images permit the interpreter to intensively study an area in a more leisurely fashion and in circumstances more favourable than may be obtained during direct observation (Estes and Simonett, 1975; Van der Voet and Dijkstra, 1971; PWF, 1977; Schrauwen and Terpstra, 1986). Because the images are a permanent reproducible database, the same data can be analyzed again and again for various objectives and purposes (Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). And so, for mapping, even of single

attributes or single values of attributes, aerial photographs and satellite remote sensing images are essential and efficient tools (I.Zonneveld, 1990a).
Existing topographical maps for some aspects may serve as a source of information on the landscape as well. But often such maps are not enough up-to-date or too much generalized to be a realistic alternative for airphotos or satellite images.

An additional possibility that certain types of images provide, and which can not be found in direct observation from the air, is a three-dimensional view of the terrain and the objects under investigation (J.Zonneveld, 1960; Estes and Simonett, 1975). Stereoscopic viewing (creating the illusion of depth) allows to determine the shape and height of objects and makes it easier to identify them (Estes and Simonett, 1975).
Also, by certain other types of sensors specific characteristics of objects, that are not visible to the human eye, can be registered into images (Estes and Simonett, 1975).

Of course remote sensing also has some disadvantages. It can provide large amounts of data in a very short time, but then the elaboration and analysis of these does take more time and effort than expected, and often is difficult and boring (Loedeman and Van der Voet, 1979; Bakker and Thewessen, 1986; Schrauwen and Terpstra, 1986; Thewessen and Bakker, 1987). Not all information needed can be obtained by remote sensing, additional information collection often is necessary (Schrauwen and Terpstra, 1986; Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). But, although remote sensing can not substitute the collection of data in the field completely, it may drastically restrict the amount of field observations that are necessary and make this data collection much more efficient.

It must be always remembered that remote sensing is only a tool (Kannegieter, 1987), that, however glamorous and appealing it may be to some, can rarely if ever be viewed as an end in itself (Colwell, 1975). The images are means for research, not the aim of the research (Thewessen and Bakker, 1987).
Aerial photographs and satellite images are *surrogate variables*, just as maps, administrative statistics, guidebooks and other secondary data. Field verification is therefore desirable if not essential. (Goodall, 1985). But, the amount of fieldwork can be reduced to a minimum and made more efficient by good use of image interpretation. The point is to find a balance between the amount of interpretation work and fieldwork that satisfies both the budget and the required level of accuracy of information.

Different types of remote sensing.
From the foregoing it may have become evident that there are different types, techniques or methods of remote sensing, of which photography is the oldest and still most widely used type. Multispectral scanning (MSS) is another one that has proven its use in many fields already, but has hardly been used in surveys for recreation so far.
A very concise description of the two main types of remote sensing that are relevant in this respect will be given. It is just meant to provide the reader, that has no experience in remote sensing, with the minimum basic knowledge and terminology needed to understand the dicussion on the application of the remote sensing techniques in the following chapters.
It is not the intention of this study to provide a comprehensive handbook on remote sensing. There is already enough literature available that serves that purpose. For experts in remote sensing nothing new will be presented, they better pass on to the next section.

Aerial photography.
Although also on some space missions photographs of the earth have been made, the airplane still is the most commonly used platform for photography.
Aircraft used ranges from fast and high flying pressurized-cabin jet aircraft to the slow and low flying *hedge hopping micro-light* or *ultra-light* aircraft driven by the engine of a lawn-mower (Kannegieter, 1987; Mulder, 1991).

Aerial photography can be subdivided into vertical and (high and low) oblique photography (Schrauwen and Terpstra, 1986), see figure 1.18., and covers the whole range between the large format vertical photography, carried out with a special airphoto-camera from a special survey airplane by a specially trained airphotographer, and the oblique photo, taken with a universal small format camera from a conventional small airplane that is for rent on any airfield (Loedeman and Quaedflieg, 1979). They can be produced in different scales, depending on the focal length of the camera and the flying hight of the airplane. The scale of an airphoto can be simple defined as the ratio of a distance between two points measured in the photo to the distance between the same two points on the ground. The scale will determine what level of detail can be recognized in the airphoto.

In aerial photography the sensor materials used are film-emulsions. (Kannegieter, 1987). There are the usual negative film types from which positive products have to be made, either prints or diapositives. And there are diapositive films which, upon exposure and development immediately produce the end product: diapositive photos.

Photography can only be executed within the 0.4-0.9 µm spectral range. There are no film emulsions with sensitivity beyond this range.

Different types of emulsions that are commonly used are *panchromatic* (= normal black and white), *black and white infrared, full colour* and *false colour* (= colour-infrared).

What type of photography is best suitable in part depends on the requirements of the survey and in part on the budget that can be made available.

The *Manual of Aerial Photography* by Graham and Read (1986) is an excellent source for those interested in more details on any aspect of aerial photography. But also some books on remote sensing, such as those by Campbell (1987), by Sabins (1987), or by Cracknell and Hayes (1991), present a chapter on aerial photography that can serve as a good introduction to the subject.

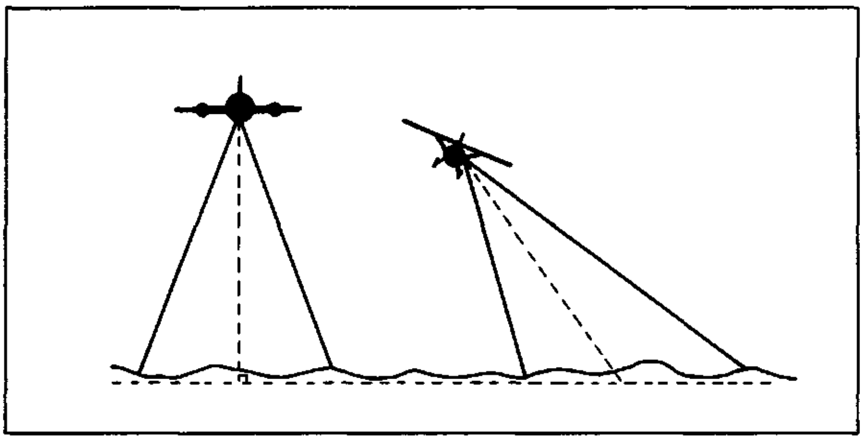

Figure 1.18. *Vertical (left) and oblique (right) aerial photography.*

Multispectral scanning.

Digital multispectral scanners register line by line (=scanning) the radiation *reflected/emitted* by the earth surface over a certain angle (=field of view) while moving forward. The scan-lines, which are perpendicular to the ground-track (flight-line), are cut up (sampled) into rectangular *ground-resolution elements* (GRE) (Kannegieter, 1987), or *scene elements* of which the size is usually expressed in m x m (Mulder, 1986). The radiation from each GRE is then analyzed by the sensor system for its radiation intensities in a number of spectral bands. These intensities are recorded in the form of digital numbers (DN's) on computer compatible magnetic tape (CCT), together with information on the location of the GRE within the total area scanned. (Kannegieter, 1987). The radiation intensity data (DN's), after application of the necessary corrections and enhancement techniques (Kannegieter, 1987), are transformed into picture elements or *pixels*, from which pictures can be generated (Mulder, 1986). A picture or image then is composed of individual picture elements arranged in rows and columns and each with its own brightness and grey tone or colour. A *pixel* thus represents one scene element of the earth's surface as one image point, comparable to one point on the line of the television screen. It is the smallest meaningful image point and often expressed in m^2 on the ground, that is, in the size of its corresponding scene element. The aspect of pixel size is also called *spatial resolution*. (Hempenius, 1978). The number of spectral bands in which the radiation is registered is called *spectral resolution*. Images can be produced of individual bands or of band-composites for visual interpretation. But the (corrected) digital data may also be used directly for computer aided classification. (Kannegieter, 1987).

Although there are airborne (= aircraft-based) MSS systems, most commonly used are the space-borne or satellite borne scanners. Well-known are the American Landsat satellites with a spatial resolution of 56 x 79 meter, covering *scenes* of 185 x 185 kilometer. The multispectral scanners in these satellites register in four specified bands. In addition to these conventional MSS bands the Landsats 4 and 5 carry the *Thematic Mapper* (TM) with seven bands and a 30 metre spatial resolution (Kannegieter, 1987, Mulder, 1991). The interval in which the satellites pass over the same ground-track, the so-called *temporal resolution*, is 18 to 16 days for the different Landsat types. (Kannegieter, 1987). Only Landsat 5 is now still in operation. Landsat MSS images are usually displayed as false colour composites in 80 meter pixels. The classification precision for certain classes, such as settlement, is still too low. (Konecny, 1987).
The French SPOT (*Systeme Pour l'Observation de la Terre*) satellite, of which there are two in orbit now, carries two identical scanners, each of which can be programmed in flight from the command centre in Toulouse for operation in either P mode, that is with one wide *panchromatic* band, or in XS mode, that is with three narrow spectral bands respectively. The spatial resolution is 10 meter in the P mode and 20 meter in the XS mode, and each SPOT scene covers 60 x 60 kilometer. Each scanning unit can be tilted in steps to up to 27 degrees on each side of the vertical, which allows each instrument to image any point within a strip of 475 km to either side of the ground-track. The advantages of this are, that it gives the possibility for stereo vision when combining one vertical and one side looking, or two side looking images, and that it increases the temporal resolution by reducing the period between two successive looks to only a few days, whereas it takes the satellite 26 days to pass over the same track again. (Kannegieter, 1987; Mulder, 1991). A significant difference between Landsat and SPOT is that in the latter an area is only scanned upon a specific request of a client, that has to be made well in advance giving specifications on area, time period, spectral mode and looking angle. (Kannegieter, 1987).
The NOAA and METEOSAT because of their spatial resolution varying from 1.1 x 1.1 km to 8 x 8 km (Kannegieter, 1987) are not relevant in the context of recreation studies. Neither are, for the time being, side-looking airborne radar (SLAR), nor thermography.
For more details on multispectral scanning and satellite imagery, see Kannegieter (1987; 1988), and Mulder (1988), or other general books on remote sensing such as that by Holz (1985), Lo (1986), Campbell (1987), Sabins (1987), Mather (1987), or Cracknell and Hayes (1991). Books specially on sources of remote sensing images are, for example, those by Carter (1986) and by Hyatt (1988). Especially on image processing Mather (1987), Mulder (1988) or Cracknell and Hayes (1991) could be recommended.

Image interpretation.

Image interpretation is the process through which information is obtained from images. It is the act of examining images for the purpose of identifying objects and judging their significance. Interpreters studying remotely sensed data attempt through logical process to detect, identify, measure and evaluate the significance of environmental and cultural objects, patterns and spatial relationships. The amount and reliability of the information obtained depends upon the training and aptitude of the observer and on the nature of the scene observed. (Estes and Simonett, 1975).
Therefore successful image interpretation in the first place requires a sufficiently high *specialist reference level* on the part of the interpreter with regard to the subject studied, as well as a sufficiently high *local reference level* with regard to the area to be surveyed. Both types of

reference level have to be built up before interpretation begins, even before the images are acquired or photography is executed. (Kannegieter, 1987; Estes and Simonett, 1975).

Because the bulk of image interpretation, especially in the field of recreation studies, still is done with airphotos, special attention will be paid to the principles and methods of airphoto interpretation. In general the same principles will apply to the interpretation of other types of images, though details may differ. Therefore a basic knowledge of airphoto interpretation is essential for all image interpretation.
Airphoto interpretation is based on the principles: *recognition*, *analysis* and *deduction and induction*. The interpretation will be more reliable if the recognition element grows, thus by a greater knowledge of the terrain concerned or similar ones. (J.Zonneveld, 1960). See also I.Zonneveld (1988).
The interpretation focusses on the analysis of *photo image characteristics*, features of a particular object observed in the aerial photograph, which may be used for its classification or identification. They can be distinguished into: *spectral characteristics*: grey tone or colour tone; *spatial characteristics*: shape, relative size, shadow, pattern and texture; *stereo characteristics*: stereo height as seen in the stereo model. Other features, visible in the photographs, which may aid in the classification or identification are: associated features and context. For a further explanation of these concepts, see Kannegieter (1987; 1988) and Estes and Simonett (1975).
With the help of his specialist and local reference level an experienced photo interpreter will be able to properly assess the meaning of the features observed in the photographic picture (Kannegieter, 1987; Estes and Simonett, 1975).
In carrying out his task, an interpreter may use many more types of data or information than those recorded on the images to interpret. Many sources (literature, laboratory measurement and analysis, fieldwork, and ground and/or aerial photography) make up collateral material. The amount of fieldwork required for a given remote sensing project varies and is dependent upon image quality, including scale, resolution, and information to be interpreted, upon the type of analysis or interpretation involved, the accuracy requirements for both boundary delineation and classification, the experience of the interpreter and his knowledge of the sensor, area, and subject to be interpreted, as well as upon the terrain conditions and area accessibility, and the existence of other source material. Field work often involves sampling for the verification of questionable interpretations and error corrections. (Estes and Simonett, 1975).

Even though all aspects of an area are irreversibly intertwined, the photo interpreter must begin some place, he cannot consider all features simultaneously. It is therefore generally agreed that the interpreter should work methodically, and reference is made to Stone (1956), who recommends a number of procedures to employ in airphoto interpretation, that are still useful today. (Dodt and Van der Zee, 1974; Estes and Simonett, 1975).

For objects that are dynamic in nature such as land cover and land use, up-to-date information is required. For a survey of the *present situation* therefore *recent* photography should be available.
Many objects that are dynamic through the seasons have one or more specific periods in which there appearance is most characteristic and makes them easy to identify on photographs. Whether it is possible to realize photography within such a critical period depends on a number of factors of which weather conditions (cloudfree, clear skies) is the most important. (Kannegieter, 1987). It will depend on the budget whether special airphotos or other images can be acquired for the survey, and specified according to optimal scale and timing, or whether use has to be made of already existing material that has been made for other purposes, and may not correspond directly to such optimal conditions. The result of the interpretation will be strongly dependent on this. (Dodt and Van der Zee, 1974).

Stereoscopic view.
One of the advantages of aerial photography is that they can provide a three dimensional (=stereoscopic) view on the landscape.

Most stereoscopic viewing for interpretation purposes is done using vertical or nearly vertical aerial photographs acquired with conventional aerial camera systems (Estes and Simonett, 1975). In such a conventional airphoto mission an area is covered by a series of parallel strips or *runs* of photos. In each strip the consecutive photos have an overlap, that is the ground area that is included in both photos, of normally 60% (Backhouse, 1974; Graham and Read, 1986). Stereo-pairs of such photos, the stereoscopic model, can be viewed with a lens stereoscope or a mirror stereoscope (Estes and Simonett, 1975; Graham and Read, 1986). For a more detailed explanation Graham and Read (1986) could be consulted, or any good manual on photogrammetry.

Application of remote sensing to land evaluation for recreational land use.

It has been stated that airphoto interpretation can be used to inventory the actual situation of various forms of recreational activities and their spatial behaviour and distribution patterns (Dodt and Van der Zee, 1984). And, in fact, airphoto interpretation is already used in many aspects of recreation research with more or less success.

Bakker and Thewessen made a survey on the use of aerial photographs among institutions and organisations in the Netherlands that carry out recreation research (Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). A further elaboration was made by Schrauwen and Terpstra and Terpstra (Schrauwen and Terpstra, 1986). It appears, that the interest in airphotos for outdoor recreation surveys is increasing. The number of studies in which airphotos are used increased from 7 in 1980/81 to 10 in 1982/83 and 14 in 1984/85. (Bakker and Thewessen, 1986; Thewessen and Bakker, 1987).
Application of aerial survey is recognized as a relatively cheap technique, if compared with the input of ground observation teams and extra manpower (Stroband, 1971; Driebergen, 1981a; Schrauwen and Terpstra, 1986; Bakker and Thewessen, 1986; Thewessen and Bakker, 1987).
But the scope of application of the aerial survey techniques seems to be somewhat limited. It is mainly used to collect quantitative data about a certain object or area. For example, application for watersports almost always aims at counting of boats to determine their number and distribution in the study area. (Schrauwen and Terpstra, 1986).
It has been realized that this is a limitation and that additional information is necessary (Schrauwen and Terpstra, 1986; Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). However, this and some other disadvantages that have been mentioned will also apply when only ground surveys are made (Bakker and Thewessen, 1986). All in all, more advantages are recognized than disadvantages (Thewessen and Bakker, 1987).

The range of applications of airphoto interpretation in this survey for the Netherlands is rather narrow. There are several other types of aerial survey and applications of airphoto interpretation that can be thought of as input into the procedure of landevaluation for recreational land use.
The most simple one possibly is that in which -with known requirements of LUT's- the land(scape) is screened for units or elements (=recreational resources) with characteristics that match these requirements. When the LUT's and their requirements are not (fully) known airphoto interpretation could be used to identify which LUT's are apparently relevant and also to which recreational resources they are linked. Once the recreational facilities have been identified, by airphoto interpretation or by other means, the characteristics of their sites can be analyzed by airphoto interpretation for common criteria.
Not only the present characteristics of sites of recreational facilities can be analyzed. The characteristics of the sites before the facilities were developed can give important information too.

Several recreational LUT's leave their marks in the landscape, have a serious impact on it. Some of this impact can be analyzed with the help of airphoto interpretation and the information thus obtained may contribute to a better land evaluation.

But, before these applications can be considered to be operational, they have to be clearly described and tested and their limitations indicated. They also have to be compared to other sources of information, for example topographical maps or field surveys, with respect to amount of information obtained, reliability of information, etcetera. In this respect it also has to be realized, that *in actual practice the material available to the interpreter is usually conventional panchromatic vertical photography, flown for other purposes, such as preparing and updating topographic maps. In most instances this will imply that photographic scales and/or overflight times will only occasionally and accidentally meet the specific requirements for optimum interpretability of land-use types.* Therefore the conditions under which actual photo interpretation is carried out almost precludes the direct and consequent application of advanced methods and techniques developed by research for land-use interpretation. (Dodt and Van der Zee, 1974). Thus it also has to be made clear in studies on recreational land use, whether the results obtained can be obtained with any conventional type of airphotos, or whether special purpose photography is required.
It may be clear, that the relevance of the use of airphotos becomes larger in situations where no or little reliable data on recreation exist and where developments are rather explosive, as is the case in several developing countries.
The following chapters will attempt to give a comprehensive overview and analysis of the possibilities and approaches.

1.4. AIM AND OBJECTIVES.

The first three parts of this chapter have dealt with the concepts of recreation, land evaluation and remote sensing. The combination of recreation and land evaluation, that is, land evaluation for recreation, has been discussed, and seems to be an appropriate approach to proper planning for recreation. Also the combination of remote sensing and recreation studies has been indicated as opening new perspectives. Now it is time to see whether both combinations can be joined together, whether remote sensing can be usefully applied to land evaluation for recreation.

Aim.

The aim of this study is:
to fully explore the possibilities of remote sensing as an input to land evaluation for recreation.

There two sets of basic questions have to be answered in this context.

1. *How can remote sensing be used to meet the data required for land evaluation for recreation?*
2. *What type of data and information are necessary for land evaluation for recreation, at what level of detail and accuracy?*

As already indicated in the section on land evaluation, the data required for land evaluation for recreation on the one hand are data to enable the identification and definition of relevant land utilisation types and their requirements. On the other hand are the data on the recreational resources, the land units and their characteristics or qualities. On that side the physical requirements, scenic quality and accessibility aspects all have to be considered.
From the first set of questions the second set is derived.

3. *Which of the required data can be obtained, and what is the level of accuracy or reliability of these data?*
   Can remote sensing satisfy the data requirements of land evaluation for recreation?
4. *How does remote sensing compare to other means of data collection? In other words, is remote sensing the best tool to use?*

These two sets of questions can be further subdivided into single questions. Answering these questions can be considered to be the objectives into which the overall aim can be subdivided.

Objectives.

Thus the objectives can be formulated as questions to be answered as follows:

1. *Can the recreational land utilisation types be identified via the facilities?*
2. *Can the recreational facilities be identified by remote sensing with a sufficient level of consistency?*
3. *Can remote sensing reveal to which resources the recreational facilities, and thus their associated land utilisation types, apparently are related?*
4. *Can such relations be defined into parameters that are both identifiable by remote sensing and relevant in the land evaluation procedure?*
5. *Can the recreational resources be consistently inventoried by remote sensing in this way?*

If no facilities for recreation can be detected, it does not necessarily mean that an area has no recreational use, nor that remote sensing cannot be used for land evaluation for recreation under such conditions. The marks that recreationists leave in the landscape, *the impact*, may be visible, or the presence of the recreationists themselves or of their vehicles. This leads to the following questions:

6. *Can the impacts of recreation on the landscape be inventoried with remote sensing and if so, can this provide information that is relevant for land evaluation for recreation?*
7. *Can recreationists and/or their vehicles or equipment be detected on airphotos with a sufficient level of accuracy, and if so, will this contribute to information that is relevant to land evaluation for recreation?*

Each of these questions has to be considered with respect to the type, scale and timing of the airphotos or other remote sensing images used. The question also arises, whether single coverages of airphotos alone can give sufficient information, or whether sequences should be used. This leads to the last question:

8: *Can the use of sequences of airphotos or other remote sensing images significantly contribute to the information aimed at in the previous questions?*

In the following chapters these questions will be answered, not necessarily in the order given here, at the hand of a number of case studies.
It is clear from the start that not *all* data necessary for the land evaluation for recreation can be obtained with the help of remote sensing. But it is thought that, once the possibilities *and* especially also the limitations have been established, this technique can be moulded into a powerful tool in support of recreational planning, especially for areas of which few data are available from conventional sources. The case studies are restricted to rural areas, and special attention will be given to applications in developing countries.
The emphasis will be on land evaluation on a semi-detailed or regional level because it is thought that there the main advantage of remote sensing over conventional methods can be found.

Accuracy

With respect to the data required for land evaluation at each stage it should be defined at what level of detail and with what accuracy they should be available. For the different remote sensing techniques it should be assessed what data they can provide at what level of detail and with what accuracy.
Accuracy can be expressed in terms of reliability and precision (Tempfli and Kure, 1980), that each relate to a different aspect of accuracy.

First of all a distinction should be made between the accuracy of the *interpretation* of airphotos or images, and the accuracy of the *measurements* made on the basis of that interpretation. The accuracy of the interpretation again may concern the accuracy of the *identification* of objects of interest as well as that of their *delineation*. The most appropriate term to use in this respect seems to be *reliability*. With respect to measurements the term *precision* is more appropriate.

Reliability of identification.

Reliability is the degree to which results are consistent upon repetition of an experiment or test (Grinde and Kopf, 1986), the consistency or stability of measurement. If the same thing or event is measured again, the results should be the same. (Vining and Stevens, 1986). It can be considered for repeated measurements or interpretations applied in similar situations or by different persons (Chenoweth and Gobster, 1986).

Thus, reliability may express the chance that the same interpreter will identify objects of the same type correctly and consistently in successive series of interpretations, or, that two or more interpreters will not significantly deviate from each other in their identification of identical objects. Of importance is both the specialist reference level and the local reference level of the interpreters.

If an interpretation is carried out by two or more interpreters, it is therefore necessary to establish the consistency among them. This type of reliability is usually called *inter-observer reliability* or *between-observer reliability*. Agreement can be calculated by determining the number of times the interpreters agreed divided by the total number of interpreted objects by all interpreters. (Vining and Stevens, 1986). Thus, reliability is *replicability*, or the degree to which different users come up with the same results (Yeomans, 1986). This can be rather easily empirically tested. To test the consistency of interpretation of one single interpreter is more difficult. In repeating the same interpretation, he will be influenced by his interpretation of the previous time. In applying the interpretation to another set of airphotos it never will be certain whether differences in interpretation are not caused by existing differences in the image.

Usually the reliability of an interpretation is checked by observations in the field and then expressed in a numerical *right/wrong* rate. The determination of such an *accuracy rate* alone is not sufficient however. Also the possible error factors have to be distinguished and analyzed, in order to find out whether errors are due to: lack of information and/or inaccurate information regarding actual appearance of objects; ignorance of processes involved in taking and processing aerial photography; low-level photo physiognomic differentiation of objects on available aerial photography; carelessness or tiredness on the part of the particular photo-interpreter. (Dodt and Van der Zee, 1974). From this analysis it then can be deduced whether a low degree of reliability can be subject to improvements by further training, or whether it is inherent to the type of object concerned. There appear to be no fixed standards with respect to the level of (in)accuracy with which an interpretation is still acceptable. This will strongly vary from case to case, corresponding to the aim of the survey. Often no specifications at all are given.

Reliability of delineation.

For objects with a certain areal extent not only the reliability of identification has to be considered, but also the reliability of delineation. Also in this respect the *replicability* of a series of interpretations of the same object by one or more interpreters is the central issue. Especially defining an amorphous shape on a photograph is a recurring problem. But in this case, more than with identification, the scale is important, because the actual length and location of a sinuous boundary is very dependent on the scale at which is measured. For most naturally occurring phenomena, the amount of resolvable detail is a function of scale, and increasing scale does not result in an absolute increase in precision, but only makes that more and more previously unresolved features are delineated. In addition, it has to be accepted that all natural boundaries are artificially defined by human beings. (Warner, 1990). Especially where boundaries are gradients or zones rather than sharply defined lines this may lead to differences between interpreters. Such differences directly relate to the results of area measurements.

Precision of measurements.

Precision is the quality associated with the refinements of instruments and measurements, indicated by the degree of uniformity or identity of repeated measurements. In a somewhat narrower sense, the term refers to the spread of the observation. (Warner, 1990). For example, in measuring distances along straight lines with an ordinary ruler the results in whole centimetres, and even in whole millimetres, will normally always be the same, but fractions of millimetres cannot be read, thus leading to a rounding error. Results of measurements of curved lines with a curvimeter are dependent on the level of generalisation of the line and on the reliability with which the line can be traced with the instrument, as well as on the final rounding error. The same applies to measurements of areas, whether done simply with a transparent millimetre grid or dot grid or with a (digital) planimeter. In essence, *precision* describes the instrument's reliability, the *quality of the operation by which the result is obtained.* (Warner, 1990).

There are two types of precision: absolute and relative. *Absolute precision* is the exactness of locating the position of a given point on the photo image to a surveyed ground position, usually given in a standard X, Y, Z coordinate system. *Relative precision* refers to the location of individual points relative to one another in terms of distances, angles and height differences. (Tempfli and Kure, 1980; Warner, 1990). In the context of surveys for land evaluation for recreation, it is the relative accuracy that is of interest.

The precision to which positions of points can be measured from a map or an airphoto depends on the scale. Also the skill of the individual that makes the photo measurements should be considered. From a practical standpoint, the operator's skill may influence accuracy more than the instrument used for measuring or the camera that produced the photograph. (Warner, 1990). If this then is linked to the aspect of reliability of delineation, it may be self-evident that in results of area measurement always allowance for a certain range of error should be made.

In the discussion of the application of airphoto interpretation and other remote sensing techniques in the following chapters, the aspect of reliability of the identification and, where appropriate, delineation will be a recurrent central issue. The aspect of measurements, and thus of precision and accuracy will not be applicable in all cases. Where appropriate, however, this aspect will also get due attention.

2. INVENTORY OF RECREATIONAL FACILITIES/ RECREATIONAL LAND USE.

2.1. THE POTENTIALITIES APPROACH.

The demand for recreation.

The answer on the question what recreational land utilisation types to consider as relevant for land evaluation is strongly related to the more general question that has to be answered in any study on recreation for planning or land evaluation, that is, the question of the demand for recreation (see also Van Lier, 1988). Because, *the possibilities offered by a site mean nothing if they do not correspond to the needs or wants expressed by the majority of the population concerned* (Duminy, 1967). A statement that is still valid to day.
Many recreation professionals, architects, planners and policy makers were strongly convinced that all people need recreation, or even more extreme, that all people need certain types of outdoor recreational activities and facilities (Beckers, 1985). But, it has been discussed whether there is indeed a real (biological) *need* for recreation, or whether it is just a *want* or *preference*, and it was concluded that recreation is not a fundamental need, based on biological laws (Van der Voet, 1985; 1986). Also it is very difficult, if not impossible, to apply the concept of need from a sociological point of view in a valid and operational way. It has therefore been suggested to replace it by estimation or preference, or see it as equivalent of the economic concept of demand. (Beckers, 1985). But, whether recreation is a real *need* or just a *want* is not really relevant in this context, since as Clawson and Knetsch (1966) already stated, *the demand and the need approaches are not necessarily in conflict.* An additional question has to be whether such a want or need always has to be completely satisfied at all costs (Van der Voet, 1985).
The expression of the needs or wants for recreation is the demand. For (outdoor) recreation it concerns the demand (qualitatively and quantitatively) for various forms of and facilities for (outdoor) recreation. Answering this question of the demand means the assessment of the pressure for improvement or realisation of activities or functions. (Van Lier, 1988). Recreation is not always the result of rational choice behaviour. When activities are related to individual people and not to numbers, then continuously people appear to change their choices. (Van der Voet, 1985). But, because the expression of an individual's demand for recreation is not as relevant as the spatial expression of the total demand as it appears in the use made of specific recreation sites (Patmore, 1973), the search for the factors behind recreational behaviour may be left to sociology and psychology. For other approaches, the resulting actual demand can be taken as the starting point. (Van der Voet, 1986).
But, taking demand as a starting point presents the problem of the measurement of demand for recreation (see also Van Lier, 1988). Because the observation that demand is variable both in time (changes in type) and space (regional variations), is also flexible in so far as it can be deflected or created, and in general will continue to expand (Cosgrove and Jackson, 1972), is still true at present. Also that such changes are both subtle and difficult to predict, and vary greatly from country to country (Goodall and Ashworth, 1985). Recreational patterns inevitably have a distinctive national flavour, conditioned not only by factors of social tradition, standards of living and climate, but also by the fundamental space relationships of land and population (Patmore, 1973).

Factors influencing demand.

Even when not investigating in depth the various factors that determine the demand for recreation, it is useful to briefly review them and the way in which they will influence demand in the future. The demand for outdoor recreation depends on many factors, that are in large

measure external to recreation itself (Clawson and Knetsch, 1966). They are rooted in the social and economic situation of a region (Geigant, 1962).
The distinction into three groups of factors made by Clawson and Knetsch (1966) is still a useful one to clarify the matter.
1. *Factors relating to the potential recreation users as individuals.*
2. *Factors relating to the recreation area itself.*
3. *Relationships between potential users and the recreation area.*
See also figure 2.1.

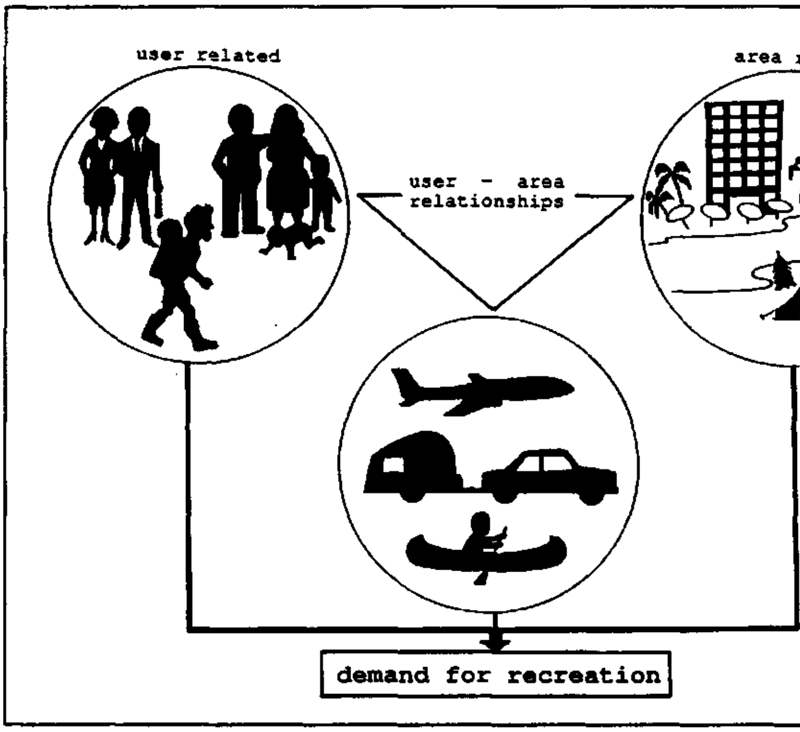

Figure 2.1. *Three groups of factors influencing the demand for recreation.*

User related factors.
The user related factors, or social and economic (and psychological) factors (Van Lier, 1988), comprise: total number and geographic distribution; socio-demographic variables such as age, sex, profession, rate of urbanisation, family size and composition, average incomes and the distribution of income among individuals; average leisure available and the time distribution of that leisure; the specific level of education of the users, their past experiences and present knowledge relating to outdoor recreation and, last but not least, their tastes for outdoor recreation. (Clawson and Knetsch, 1966; Stabler, 1985; Jansen-Verbeke, 1987; Dietvorst and the Pater, 1988; De Vink, 1988; Theuns, 1989a; De Jong et al., 1990). Based on these factors people can be classified into various sub-groups (Van Doren and Lollar, 1985) or lifestyles (Gunn, 1988; Dietvorst, 1990a; 1991). But, these groups are dynamic, their characteristics constantly changing and so also their demand for recreation (Van Lier, 1987; 1991), which is still further differentiated (Dietvorst, 1989c; 1991). *The fickleness of fashion and the rapidity of change have to be reminded* (Patmore, 1973). See also Chapter 1.2., the section on identification of relevant land utilisation types.

Demand thus is influenced by numerous interacting factors. Profession and education do correlate so strong with income that it is difficult to empirically determine the influence of each of them separately. The same partly applies for the factor age. Increasing welfare and leisure are conditioning factors for larger expenditure on recreation, but changing tastes, attitudes and interests are the actual causal factors. The latter create a certain demand, the former make it possible to satisfy it. (Theuns, 1989a). Still, income alone can not explain the increase in demand for recreation. The availability of leisure is also important, especially the introduction and increase of a compact vacation period with continuation of salary or wage has brought about big changes in the patterns of recreation and tourism. (Theuns, 1973a; 1989a).

For example, in the Netherlands the majority of employees in 1929 only had two days of vacation. In 1962 13 days; including the free Saturdays that would make two-and-a-half weeks of vacation. At present for the majority a vacation period of four weeks is possible. (Theuns, 1989a).

The demand for recreation can be considered as derived from the available leisure time, but on the other hand to a certain degree is also a factor that helps to determine this amount of leisure time (RMNO, 1988).

For the coming 10 to 25 years the amount of available leisure time will be determined by the demographical developments, the composition of the households, the organisation of the labour-process and by economical and technological developments (Van Doren and Lollar, 1985; RMNO, 1988; De Jong et al., 1990). The complexity of these social and economic processes can be reduced to two main factors: a general decrease in the spending budget on the one hand and an increasing amount of free time, either by choice or necessity, on the other hand (Dietvorst and De Pater, 1988). The reduction of working time implies an increase in free time (= time free from job-bound obligations), but not necessarily an increase in leisure time. Extensive time-budget analyses have revealed that leisure time has decreased slightly, because there has been an increase in travel time, and more time being spent on training. (Dietvorst, 1990b; Dietvorst and De Pater, 1988). Also reduced incomes have encouraged people to spend more time doing their own home improvements or repairs instead of employing professionals. In addition, free time is not increasing at the same rate for everybody. Persons who use free time actively have not experienced an increase in net free time (Dietvorst, 1989d; 1989e; 1990b), whereas a large number of people has got a lot of free time, but often no money to make active use of it. For them the distinction between leisure and working time has disappeared. (Dietvorst, 1987; Jansen-Verbeke, 1987; De Vink, 1988; RMNO, 1988).

Thus, the expected increase in leisure time needs not automatically result in increase of outdoor recreation. Already Patmore (1972) stated that activities in and around home occupy the bulk of disposable time (Theuns, 1989a), and it is to be expected that also a large part of the additional time will be spent in and around the house (RMNO, 1988). For the majority of Dutch families about 35% of the yearly time for recreation is available only for activities that do not require long continuous periods, especially indoor activities. About 40% of recreation time is available in the form of weekends, but this does not exclude the possibility that a large part is spent with activities to which the daily recreation has to be restricted. Only about 17% of the yearly recreation time is available as vacation time. (Theuns, 1989a).

The vacation participation, that is, the percentage of a population going on vacation, increased from 41% of the Dutch population in 1966 to 65% in 1985. (Theuns, 1989a). It is thought to be unlikely that this participation rate will grow further with respect to summer vacations, but additional vacations and short trips are expected to increase (Dietvorst, 1990b), because there is a tendency towards more but shorter periods for recreation (Van Lier, 1990; 1991; Mittmann, 1990).

In this vacation participation the income factor appears to be dominant. But profession and education may significantly influence the choice of vacation destination and the type of vacation. (Theuns, 1989a). And so does age (Jansen-Verbeke, 1987; Dietvorst, 1990b; Dietvorst and De Pater, 1988). Another factor that may cause deviations from the income dominance is the family composition. Not only do vacations with children become more expensive, but also the possibility to avoid the expensive peak-season is missed with school-going children. (Theuns, 1989a). And in addition, although the traditional family (working husband, housewife with two or more children) is by no means in the minority, deviating types of households (single persons, double-income couples, single-parent families) are growing in importance. This group is generally referred to as *new households*. (Dietvorst, 1987; 1989f; 1990b; De Vink, 1988). This differentiation in household types can be reflected in *recreation styles* (Dietvorst, 1990b).

Thus a continuous differentiation of the demand results from the cumulative effect of various separate societal processes (Dietvorst, 1989d; 1989e).
There is *individualisation*, a break-through of the traditional family behaviour (each person his own activity) (Dietvorst, 1987; 1991; RMNO, 1988; De Vink, 1988; Van Lier, 1990), women's emancipation (Dietvorst, 1987; 1989f; 1991), as well as increasing participation in culture (Dietvorst, 1989f; 1991). Traditions loose their importance and leisure behaviour becomes more superficial, more subject to fashion trends (Dietvorst, 1987; 1989f; 1991; RMNO, 1988). There is a shift from formal to informal recreation (Dietvorst, 1987; 1989f; Dietvorst and De Pater, 1988; Jansen-Verbeke, 1987; RMNO, 1988; De Vink, 1988). *Passive holidays* have given away to *active holidays* (Tarlet, 1990; Dietvorst, 1990a). Some other expected changes in recreation are: from stationary to mobile or route-related; from group-related to individual pursuits; from intensive to extensive (Dietvorst, 1989d; 1989e; 1989f). The diversity of recreation activities per person will increase, conflicts between types of recreation will increase too. (RMNO, 1988).
The recreation needs of the people have changed from a facility oriented experience to more dispersed recreation activities (Mittmann, 1990).
New sports emerge, contact with nature in a more or less active way, *eco-sports* (Tarlet, 1990). There still seems to be a need for *new* attractions, the urge for new experiences, for discovering unknown scenery and places, and for trying out new activities (Jansen-Verbeke, 1987; Dietvorst, 1988).

Many of the characteristics of the human group from which the demand stems can be derived from existing statistical sources. Changes in these characteristics through time or differences in them between regions can be translated into the consequences that they might have on the demand for recreation. However, simple correlation with single variables such as, age, income and education are not sufficient any more. Better explanations are suggested to be found in the different types of life-style. (Dietvorst, 1987; 1989a; 1989b; 1989c; 1991; Jansen-Verbeke, 1987). This is a field of research for sociologists (Dietvorst, 1989a; 1989b; 1989c). These life-styles then could be correlated with recreation styles. An attempt to make a typology of such styles for vacationists can be found with Dietvorst (1990b).
The experience and the taste factor are more difficult to capture than any of the other human characteristics. Preferences for recreational activities and tourism destinations are obviously strongly dependent on fashion waves and, therefore, can be of a temporary kind (Jansen-Verbeke, 1987).
The different user related aspects that influence the demand for recreation have been summarized in figure 2.2.

Area related factors.
The area related factors, or supply factors (Van Lier, 1988), consist of: the innate attractiveness of the area, as judged by the individual user (this relates to scenic quality); the intensity and character of its management as a recreation area and the capacity of the area to accommodate recreationists (this may be comprised in the physical suitability and the number and type of facilities); the availability of alternative recreation sites and the degree to which these are substitutes for the area under study as well as the climatic and weather characteristics of the area are factors determined by the general geographical setting (Clawson and Knetsch, 1966; Stabler, 1985).

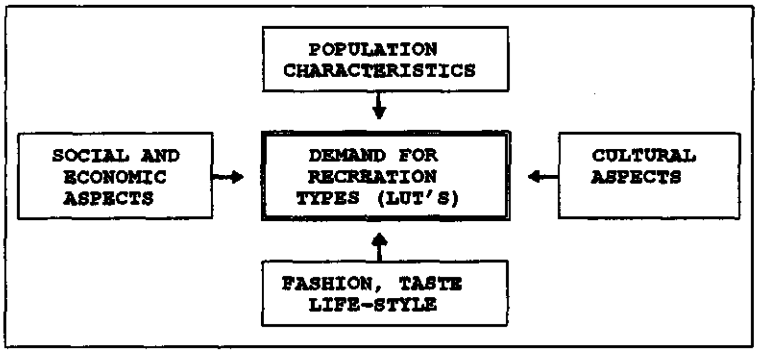

Figure 2.2. *User related factors determining the demand for recreation.*

Awareness of opportunities is also a component which has shown to affect visits to facilities. Choices are influenced by people's perceptions of places and their preferences for alternative locations. (Coppock, 1982).
The changes in preferences for recreational activities also reflect in the development of recreation areas and facilities. The number of *developed* destination areas and attractions has been multiplied greatly in recent years (Gunn, 1988). Because of the preference for sportive and individual pursuits at present a three star hotel cannot afford to have no fitness-room, sauna, swimming pool and squash court any more (De Vink, 1988).
It has to be realized that recreationists not only use specially designed facilities of often large scale, but also all kinds of recreational possibilities in areas with a dominant non-recreational function (Dietvorst, 1989a; 1989b; 1989c).
Many of the characteristics of the landscape can be analyzed from topographic or thematic maps, although for detailed information often a ground survey may be necessary, or, whenever possible, airphoto interpretation.

User-area relationships.
The user-area relationships are predominantly related to accessibility and can be expressed in: the time required to travel from home to the area and return; the comfort or discomfort of the travel; the monetary costs involved in a recreation visit to the area; and, the extent to which demand has been stimulated by advertising (Clawson and Knetsch, 1966). Part of the accessibility may be seen as a supply factor: presence and quality of roads. Part is also a technical factor: availability of motorcars, improvement of the motorcar through the years. The technical developments in the transportation sector (train, car, plane) make travel faster and relatively cheap. (Theuns, 1973a). The 60's are in Western Europe the era of increased mobility through increased car-ownership (Theuns, 1985; 1989a). The distances between urban areas and their outlying rural hinterland zones have shrunk in terms of real time. Thus once-remote areas have come to be within easy driving distance of most large urban centres. (Yeomans, 1986). The recreation *zones* (see also figure 1.17.) have expanded outward (Theuns, 1989a). This applies to both day trips as well as vacation journeys. Obviously mobility patterns are changing. Short holidays away from home are gradually being replaced by day trips. (Jansen-Verbeke, 1987).
Within the recreation sector the cost of transport is relatively high, compared with the total expenditure on recreation. Dependent on the kind and duration of the vacation, the share of travel expenses ranges from 10% to 50%. Moreover the costs in terms of travel-time appear to be a factor of even more importance. (Bergsma, 1985). With respect to journeys there is a trade-off between time and money. By investing time the journey can become cheaper, but also relatively slower and longer. There is a positive relation between income and mobility, between income and vacation participation, and between income and distance travelled. (Theuns, 1989a).

Technical improvements in the air transport sector have increased its share in recreational travel. It makes it possible to exchange time for money and even that only relatively, since the prices for air fares have decreased drastically. The longer the stay, the less heavy the travel costs weigh on the total budget. On shorter distances there are still alternatives for the airplane, but on longer distances not. (Theuns, 1989a).

However, recreational travel does not exclusively respond to economic considerations. Analyses of recreational journeys in the countryside have shown that participants on such trips often do not take the shortest route to their destinations (which may in fact be multiple) or follow the same route on outward and return journeys, that stopping places are often not known in advance and that numbers of journeys do not always decline with distance

(Coppock, 1982). And, although motor car and airplane tend to dominate most recreational travel, other modes of transportation need to be not overlooked (Gunn, 1988).

Information on accessibility can be partly derived from topographic or road maps, if they are reasonably up-to-date, but about the time and the comfort involved in the journey some empirical data have to be obtained.

Interrelation of factors.

Of course all these factors are interrelated one way or another: profession is influenced by education and in turn influences the income; income may influence the place of residence and vice versa and both are related to mobility, etcetera.

Analysis of these factors can give a clearer insight in the structure of the demand for recreation and make it possible to say something about its development in the future. A formula may be used to present this in a clear way. For example the one presented by Van Lier (1988):

$$P = f(a1..ak ; b1..bn ; c1..cm) \quad \text{in which:}$$

P= the participation in a certain type (or group of types) of outdoor recreation;

a1..ak = supply factors in the area (number and type of facilities, accessibility, etcetera);

b1..bn = social,economical (and psychological) factors of the population of the area (income, profession, age, etcetera);

c1..cm = technical factors (motorcars, play equipment, etcetera)

But the problem remains, how to express and measure the different parameters and how to determine their relative weights.

What is clear however, is, that three measures of demand have to be distinguished: actual, latent and potential demand.

Actual, latent and potential demand.

Actual demand, also called *expressed, effective* or *existing* demand is the current level and structure of demand revealed by the present pattern of participation in recreation (Rodgers et al., 1973), see also figure 2.3. It is only part of what might be termed *total* demand (Stabler, 1985). This total demand may not become effective because of constraints imposed on people by the existing scale and location of recreation resources (Patmore, 1983; Stabler, 1985), the supply side, or because of lack of purchasing power (Theuns, 1989b). Changes in the supply, for example, new resources or better accessibility, may lead to marked changes in the demand pattern (Patmore, 1983), as will a general increase in income. Also a reduction of prices on the supply side may result in an increase of effective demand (Theuns, 1989a).

Part of the actual demand may be *substitute demand*, a diversion of demand from one type of activity to another type (Theuns, 1989b), as a result of existing constraints.

Latent demand is that part of the total demand that is suppressed or frustrated by an existing lack of opportunity (Patmore, 1983; Theuns, 1989a; 1989b), by the inadequacy of the present supply of (and accessibility to) facilities and resources, or by a lack of purchasing power. See also figure 2.3. It is *hidden demand* (Rodgers et al., 1973). By its very nature, latent demand cannot be readily measured, for it refers to a projected rather than an actual situation. (Patmore, 1983; Stabler, 1985). But, despite the inherent practical problems to assess the latent demand, the concept remains important to the provider of recreational facilities (Patmore, 1983).

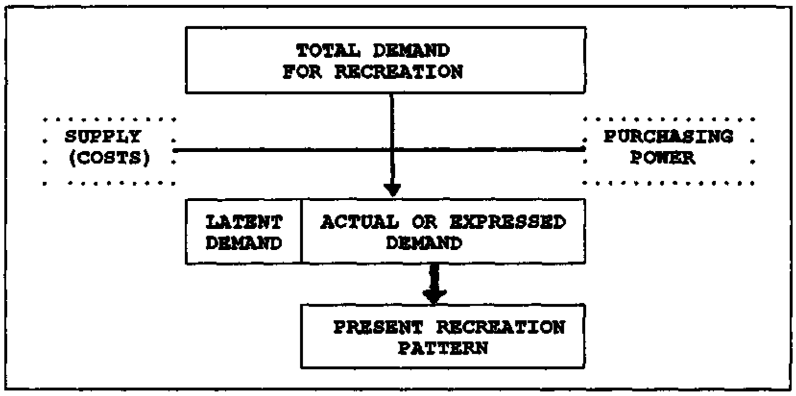

Figure 2.3. *Actual and latent demand for recreation.*

Induced demand is demand which is created as direct result of the provision of a supply of facilities. That is, if a new recreation facility is made available, an entirely new demand may be generated for it. (Theuns, 1989a; 1989b). It may result in a reduction of latent demand and an expansion of expressed demand, but also in substitution within the actual demand.
For the provider of recreational facilities, the ultimate concern is with *potential demand*, the demand that should occur at a given time in the future. It is compounded of existing expressed demand, of changes in expressed demand arising from structural changes in the population and its demographic characteristics as well as of changes with respect to real incomes and leisure, and of latent demand released by changes in the range and nature of facilities (Patmore, 1983; Rodgers et al., 1973). Marketing, promotion and advertising are activities that may influence the demand for recreation (Goodall, 1985).

In addition to the demand for specific recreational activities, which can be called *primary* demand, a *derived* demand for ancillaries (covering clothing, equipment and services), travel, and facilities can be distinguished. With respect to sailing, for example, the primary demand is the enjoyment of the experience of racing or cruising. But to do this one requires a boat, launching and/or mooring facilities, chandlery services, navigation equipment, fuel, clothing, footwear, etcetera, which are inputs into the *product* sailing. Derived demand should not necessarily be thought of as subordinate. There are some forms of recreation in which a derived element may become the primary one. (Stabler, 1985). The constraints experienced in turning latent demand into actual demand are often constraints in satisfying the derived demand.

Determining the demand for recreation.

All this different aspects of demand do not make it easier to determine it.
In order to establish the potential demand for recreation, first the present pattern of recreational demand, the actual use, has to be determined. Then the factors influencing that demand have to be analyzed. Does the use of one type of facility imply the use of other types? What are the motives behind this use? What is the role of the spatial environment in making the choice on the location for recreational activities? (Dietvorst, 1989a; 1989b; 1989c; see also Rodgers et al., 1973). Only when sufficient information on these factors is available, the growth and change over the planning time-scale can be predicted, although it still may be very difficult (Rogers et al. 1973; Gunn, 1988).

Different approaches to determine the demand.

To analyze the demand side there are several approaches. Economic methods of assessing demand concentrate on the willingness to pay. They are somewhat narrow and unbalanced, and restricted in their applicability. A dominant element in many economic studies is the travel cost, mainly because it appears to be relatively simple, elegant, and conceptually acceptable. More direct methods are the *interview approaches*, that attempt by direct questioning of users to establish their valuation of recreation benefits, or their leisure expenditure pattern. But, expenditure studies are not true demand studies, they are more studies of the manifestation of demand. (Stabler, 1985).

Instead of the economically determined demand curve, Kroon (1986) suggests to determine *utility curves* for the use of recreational areas, in which not only direct monetary costs are incorporated, but also all other kinds of efforts. To establish realistic curves, however, a lot of data have to be obtained directly from (potential) recreationists.

At the places of residence of users household surveys are made of existing patterns of participation in recreational activities (Rodgers et al., 1973; Bernelot Moens, 1985), but it is very labour intensive and time consuming to carry out such a survey, even if done by a sample enquiry (Patmore, 1983; Stabler, 1985; Van der Voet, 1986). The success of such surveys is strongly dependent on the ability and willingness of people to provide reliable and valid information (Kroon, 1986).

For the Netherlands, data on participation rates in different sports, on visits to sports events and recreational facilities, visits to cultural facilities, practising artistic activities and use of some forms of media (books, video) (Bernelot Moens, 1985), are not comprehensive, but only comprise a selection of activities. (See also Blok et al., 1986).

The sample is too small to permit more detailed consideration of minority activities or of variations at regional scale (Patmore, 1983; Stabler, 1985). But, such large-scale demand studies, that examine the whole pattern of demand of the total population over a large range of leisure activities, can outline the general patterns of recreation at a national level with reasonable confidence. Repetition of such surveys often is not done, however, because of the large costs, and so trends through time are difficult to establish. (Patmore, 1983).

Studies at a regional level reveal more clearly the fundamental role of the spatial variation in resources in influencing both levels and patterns of participation in recreation. Local distinctions of recreational habits may be related to inequalities of local opportunity and latent demand may lie concealed in areas with restricted facilities. (Patmore, 1973; Kroon, 1986).

Another approach concentrates on a particular activity and seeks to isolate the population pursuing it and to examine its characteristics in far more detail than would be possible in an overall approach (Patmore, 1973). But this does not result in a comprehensive overview of demand.

Surveys can also be made at the sites where recreation is undertaken (Patmore, 1973; Stabler, 1985; Gunn, 1988). This includes inflight surveys, exit surveys, entry surveys, highway counts, enquiry surveys and counts of travellers in hotels and at theme parks, etcetera (Gunn, 1988). Thus, for the Netherlands, statistical data are available on the number of visitors to a large number of attraction parks, zoo's, visitor centres, castles, etcetera, as well as to musea, theatres, cinemas, and similar facilities. Data on the number of overnight stays are available for all lodging accommodation, but information on the purpose of the stay is not available. (Bernelot Moens, 1985).

Participation rates.

One way of expressing the demand is by the percentage of population participating in specific activities (Stabler, 1985). Participation rates are basic for the calculation of the demand for facilities for various types of recreation. Even when such rates apply only on present facilities. (Van der Voet, 1986). The interview approach in this respect will only give alleged participation, but enables to supplement this by information on socio-economic characteristics of the participants. However, participation in recreation is no simple concept, not even when limited to activities that

currently take place, to the expressed demand. The simple distinction between participation and non-participation is rarely sufficient in itself and some measure of the frequency of participation is needed. (Patmore, 1983).
Because surveys into particiaption rates are not often frequently repeated, there is little precise knowledge of the actual growth rates of individual activities. A short-cut method is to look at club membership totals or club affiliations to national organisations, and most time series data relate to such material. (Patmore, 1973). However, only for formal activities numbers of membership may be easy to obtain and may be used as an indication. (Van der Voet, 1986). There are a lot of recreational activities that can be done without being member of anything. Moreover, membership does not say anything about actual participation. (Van der Voet, 1986).
Still, for particular activities the membership approach can give a good indication. So it was observed in the Netherlands, that in sports fishing the number of memberships of fishing associations as well as the sale of licenses had decreased. This was especially related to a relatively strong decrease in the number of young sports fishermen, probably because of a strong competition of a large number of alternative leisure activities. (Dietvorst, 1989d).

If measures of satisfaction rather than participation are sought the problems become even larger. The *substitutability* of activities is depending very much on the satisfaction they give. Therefore at least a subjective assessment of relative satisfaction may be necessary when alternative strategies for the investments of resources in recreation facilities are considered. (Patmore, 1983). However, mere volumes of mass participation, a popular method of evaluating *success*, do not necessarily translate into satisfaction (Gunn, 1988).

Preferences.
The best way to determine the preferences for recreation is to ask the people themselves. The proportion of people, whose preferences for a specific category of attraction or activity coincide, may then be used to rate the actual appeal of all attractions or activities in that category. The degree of attractiveness could be defined by the percentage of the population to which these features appeal. (Ferrario, 1979). But, direct preference surveys by the interview approach are generally expensive (Goodall, 1985). Moreover, the danger of such approaches is that preferences may be overstated or understated, depending on consumers' perception of availability of facilities, or whether they will be actually required to pay or not. Also, hypothetical questions will get hypothetical responses. (Stabler, 1985). Therefore results of preference surveys have to be interpreted with care. For example, when from enquiry surveys is was derived that recreationists prefered extensive recreation and a stay in nature because of rest and silence, analysis of the actual behaviour revealed that a large part of the recreationists cluster together and prefer crowdedness and man-made facilities (Sas, 1988). It thus should be assessed which discrepancies exist between expressed motivations and actual behaviour (Dietvorst, 1989a; 1989b; 1989c).

Recreation behaviour.
A major approach to identify preferences relies on the study of overt behaviour, that is, a study of participation or visitation rates. Such studies, however, do not only reflect what recreationists actually do, but what they are able to do, which might not coincide with what they really prefer doing. (Goodall, 1985). Because the behaviour of the recreationist is the result of choice processes in which not only the wishes and motives of the recreationist, but also the spatial possibilities, and the image that the recreationist has of them, plays a role. (Van der Voet and Haak, 1989). It is this behavioural pattern which might be defined as effective demand or consumption (Stabler, 1985). It is conceivable that much information on use and behaviour can be obtained using observational techniques (Stabler, 1985; Vining and Stevens, 1986). A missing element in behavioural approaches, however, is the reason for the behaviour. Another disadvantage is that the behaviour of non-users or non-participants is not recorded. And the reasons for not visiting an area are as important as reasons for visiting and could be critical in planning or measuring those

areas. Moreover, behaviour may not be observed at projects which have not yet been constructed. (Vining and Stevens, 1986). Also, an attraction cannot be evaluated solely on the basis of vagaries that had determined its visiting patterns for the particular period of time (one day, one week) that it could be surveyed (Ferrario, 1979).

Another approach to behaviour studies are time-budget studies, which try to establish the time available and used for recreation pursuits (Stabler, 1985). However, there is a considerable lack of empirical data on the time-space behaviour of recreationists, and research in this field is difficult to execute (Dietvorst, 1990b). A well-known method to get an impression of the time-space budget of individuals is that of diary-analysis (Koetsier, 1982). But, research into the actual behaviour in time and space needs to be linked to that into the recreational experience of people (Jansen-Verbeke, 1982).

The method of the potentialities.

Since with the enquiry survey approach (*demand approach* or *users approach*) it is far from easy to establish the demand for recreation, and the observation of actual behaviour or time-space-budget analysis are not much easier to carry out, it is worthwhile to investigate the possibilities of approaching the demand indirectly by way of analyzing the supply side.

In such a *supply approach* it is difficult to start at the level of recreational resources. To get a comprehensive overview of what has to be considered as recreational resources, and in which order of preference, by interviewing people is all but easy. Therefore a first step could be to inventory *which areas of land and bodies of water are presently used for outdoor recreation and to what extent* (Clawson and Knetsch, 1966), but also this step is far from easy (Van der Zee, 1987). This was observed already by Defert (1954), who also remarked that sample surveys and enquiry surveys to find out about touristical activities are expensive, and therefore suggested that it might be better to start from the *touristical potentials* (*les potentiels touristiques*), or *opportunities* (Koetsier, 1982), of a place or region. Deferts *method of the potentialities* (*la méthode des potentialités*) starts with inventories and maps of hotels with numbers of beds, of swimming pools, of tourist offices, of ski-slopes, bathing beaches, objects worth visiting and other touristical or recreational facts. In most cases this means an inventory of derived recreational facilities, the mapping of the *physical framework* (Defert, 1954), the physical infrastructure of recreation or *recreational infrastructure* (Van der Zee, 1986). It is thus a *facility approach* in fact.

That knowledge of existing facilities for recreation is a vital element in the planning process was also stated already by Palmer (1967). Because of the specific character of recreation the points of supply are at the same time the points where the demand is satisfied: production and consumption are located on the same place (Defert, 1954; Bergsma, 1985; Theuns, 1988a). Thus, a map of facilities gives an indication of the spatial pattern of demand.

And if it is not known how many people have spent the night in a certain place during the season, at least the number of beds that is used by or available to visitors can be established. The capacity in number of tourist beds then is used as an indicator of how many tourists could have actually visited the place. (See also Kiemstedt et al., 1975). And so capacity can be used also for other types of facilities as an indicator for their (potential) use. For example, the number and capacity of restaurants, the number and size of assortment of souvenir shops, the transport capacity of cable lifts, the capacity of swimming pools, the capacity of gasoline stations.

Yet, a map of the production capacity does not say anything about actual visit, thus the expressed demand; that may be larger or smaller than this capacity. In the case of touristic saturation (peak season) all facilities will produce at top capacity. But outside the peak season the use of facilities will be lower. A sample survey then may be used to establish the actual visit as a percentage of the total capacity. (Defert, 1954).

Another disadvantage of taking the inventory of facilities as main approach is that there are types of recreational use that do not need special facilities and therefore cannot be captured in an

infrastructure map (Jansen-Verbeke, 1982; Van der Zee, 1986), they have to be approached by different methods. And in addition to special facilities for recreation facilities in the social and cultural sphere that are also, but not exclusively, used by recreationists, are of importance (Maier, 1972).
It goes without saying, that latent demand and possible future developments are not revealed, but that will be difficult too with the other methods mentioned.

Even though a complete and comprehensive overview of the recreation pattern of an area may not be achieved by it, the potentialities approach is a useful tool for a quick overall reconnaissance, and airphoto interpretation, complemented by field observations in sample sites, can be used to easily carry out such an inventory. Therefore the following procedure can be suggested:

1. An inventory and mapping of recreational facilities, according to type and capacity, is made as a start. (See also Dietvorst, 1990b; Dietvorst and Jansen-Verbeke, 1986).
2. Further (sample) surveys may then be used to give an indication of the extent in which the facilities are used and thus give a weight factor to each facility.
3. The spatial pattern of such (weighted) facilities can then be related to the characteristics of the original resources from which they apparently are derived.
4. Comparing these resources with other elements of the land(scape) in the same area and similar elements in other areas may give insight in the factors that determine whether a land unit or landscape element becomes a recreational resource or not. (Van der Zee, 1987).

The first two steps will help to identify recreational land utilisation types and establish their relevancy, the last two steps are instrumental in determining what are their apparent requirements with respect to land and landscape characteristics.

For an inventory of certain types of facilities existing sources of information can be used. For example, hotel guides, camping-site guides, tourist maps and the like. This is the *practical armchair method* suggested by Ferrario (1979). However, such sources may not always guarantee completeness. Some guides only comprise facilities that conform to certain standards. Some managers may not bother to get registered and do not give information. There can sometimes be a considerable gap between *officially registered* accommodation and actually available accommodation, especially where there is ample (small) private enterprise. In addition, in many regions and countries developments are very rapid, which makes it difficult to keep the information up-to-date.

Also for the Netherlands there is an enormous lack of data of the recreation sector. Of many facilities no nation-wide data are present, and if they are, there are considerable differences in the way they have been collected (with respect to definition, number of attributes, etcetera). (Dietvorst, 1989a; 1989b; 1989c; Noor, 1989). Data on the use of outdoor recreation projects are available only in a limited and incidental way. (Van Hoorn et al., 1988a; 1988b).
In the part on recreation in the Atlas of the Netherlands (Blok et al., 1986) only the most important recreation possibilities are mapped, the ones with more than 250000 visitors per year. The capacity of the lodging accommodation is presented in units of 500 sleeping places, and that of day recreation facilities in units of 2000 persons. (Blok et al., 1986). The nation-wide maps in the holiday atlas of the Netherlands (Karssen, 1986) are not much better. Still they gives a first impression of the uneven distribution of such facilities over the country, that can be related to the distribution of the population on one hand and the availability of original resources on the other. Tourist maps of larger scale, for example the region maps in the holiday atlas of the Netherlands, show more detail and make it easier to identify apparent relations to resources. Still, also these maps are based on inventories that are not necessarily complete and comprehensive. Some features are included, for example windmills, that not necessarily always have a function for recreation.

Tourism statistics that give data on the regional distribution of capacity in lodging accommodation and other facilities may suffer from the same inconsistency and incompleteness. Moreover, data are often aggregated according to administrative regions, which may make it difficult to clearly relate facilities to resources. For example, in the Netherlands a lot of data are published aggregated per *tourist area*, which need not be contiguous, neither necessarily be contained within provincial boundaries (see also Blok et al., 1986).
If for developed countries, such as the Netherlands, it is already very difficult to get a comprehensive and up-to-date overview of recreation facilities from existing sources or databases, *for developing countries the expectations certainly should not be too high.*

It has been suggested, (see for example, MacConnel and Stoll, 1969; Van der Zee, 1982) that airphoto interpretation can be used to easily carry out an inventory and give a general impression of what types of recreational facilities occur in an area and to what specific elements in the landscape they apparently are related. It may be self-evident that not all characteristics that are important in determining the suitability for a certain type of recreation can be interpreted from airphotos (Van der Zee, 1986).

The recreational facilities.

Before starting the discussion on how well the recreational facilities can be interpreted from aerial photographs, and possibly from other remote sensing images, it may be useful to first discuss the different types that can be distinguished and attempt a classification.

In the first chapter the distinction into user-oriented and resource-oriented facilities has already been explained. Following Gelgant (1962) and Defert (1954) the recreational facilities have been subdivided into *primary* and *secondary* facilities (Van der Zee, 1971). This subdivision can be applied to both user-oriented and resource-oriented facilities. The primary touristical facilities serve the basic needs of the recreationists and comprise access and stay accommodation. Accessibility is needed under all circumstances. Stay accommodation, the facilities that serve the possibility for staying in a certain place, only becomes essential when recreationists are attracted by original resources far away from their home settlement. In addition to all kinds of overnight accommodation, also restaurants and other places where food and drinks are served can be considered to belong to these primary, basic needs serving, facilities.
The secondary (or complementary) facilities are those serving the entertainment of the tourists (Defert, 1954). Even when a site is rich in natural resources, has sufficient hotels and pensions, and is very well accessible, a tourist may hardly still be able to spend his time actively. Therefore facilities -Defert calls them *collective facilities*, Christaller (1955) mentions *additional supporting enterprises*- are necessary such as: golf courses, swimming pools, tennis courts, riding schools, casino's, (souvenir)shops, bars, etcetera. These facilities above all serve the *secondary*, additional, complementary or *derived* touristical consumption. (Defert, 1954). Cosgrove and Jackson (1972) use the term *created resources* for this, but that can be only applicable when no relation with original resources exists. Otherwise they should still be considered as more or less *derived* facilities.

The segregation between lodging accommodation on one hand and facilities for special recreation activities on the other can also be found with Kiemstedt et al. (1975). Gunn (1988) divides the supply side into: transportation, services, attractions and information/promotion. Transportation can be considered to be equal to access, thus primary, facilities. His services may comprise a bit more than the stay accommodation, even this includes food and drink services, but still can be considered as essentially primary facilities. Attractions are clearly secondary facilities, if not resources. The information/promotion is maybe something of a different order, but could be comprised in accessibility in the wider sense and then becomes a primary facility. Theuns (1989a) mentions accessibility, the various categories of stay accommodation including

restaurants, and sports and entertainment facilities. These do fit into the classification of primary and secondary facilities.
The distinction into primary, secondary and additional elements by Jansen-Verbeke (Dietvorst, 1990b) is an entirely different one, more comparable to that into original resources and derived facilities, and should not be confused with the classification of facilities as used here.

In an increasing degree primary and secondary facilities are not offered separately anymore, but combined in comprehensive *products*. For example, resorts offering not only accommodation, but also all kinds of entertainment facilities. (Tarlet, 1990). It has to be realized, that the quality of individual recreational facilities is also determined by the way in which they are integrated into a larger whole, in a *touristical-recreational complex*. Such a complex is not a simple addition of attraction, facilities and supporting infrastructure. It should be integration rather than aggregation. Thus, cycle-path networks assume the presence of small restaurants and points of interest, and stay accommodation cannot do without adequate infrastructural facilities. In addition to that it has been observed, that recreation uses a lot of facilities or infrastructure under multiple use or joint-use conditions. (Dietvorst, 1989a; 1989b; 1989c).

The distinction between the primary and secondary character of facilities may have become less pronounced. For example, it can be argued that restaurants do not only have a function in satisfying primary needs, but also an entertainment function. The same applies for other stay accommodation. Nevertheless, the subdivision of facilities into main categories can still be comprised in the scheme of figure 2.4.:

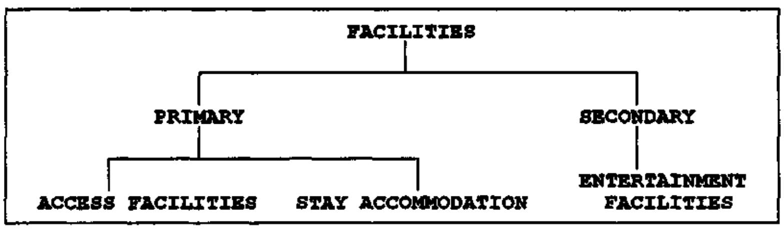

Figure 2.4. *Classification scheme of facilities.*

Stay accommodation.
The facilities that make it possible for recreationists to stay in a certain place, often a stay overnight is implied, come in many types. They range from the most luxury hotels to the most simple camping-sites. (See also Culpan, 1987; Gunn, 1988). The relative importance of each type is different from one area to the other. Also an evolution in the course of time can be observed. In the first period of tourism in Europe hotels were used predominantly. Only after 1930 camping in tents is found to be a good overnight accommodation (Christaller, 1955). Tents since then have been gradually superseded by caravans.
In the Netherlands, from the sixties onward the share of hotels and pensions in holidays has decreased to only 8% in 1984. Caravan holidays have increased to 32% in 1984.(De Jong, 1986). The caravan park in the Netherlands increased from 2000 in 1956 to 73000 in 1968 and to 408 000 in 1981 and since decreased to 400 000 in 1984. (De Jong, 1986; Van Duin and Loos, 1969). Of the total overnight accommodation in the Netherlands in 1986 6% is in hotels, 32% in camping enterprises on places reserved for tourists, 48% in camping enterprises on places with permanent occupancy, 10% in bungalows and summer homes on camping enterprises, 3% in other overnight places on camping enterprises and 1% in boarding houses, youth hostels and youth hotels (Bemelot Moens, 1990).

Of the French holiday makers in 1984 39.4% stayed at parents' and friends'; 17.4% in tent or caravan; 16% in rented rooms or homes; 13.7% in second homes; 5.9% in a hotel and 7.6% in other accommodation (Tarlet, 1990).
In addition to renting sleeping places near recreation areas only in vacation periods, there has been the large increase of so-called second homes of all kinds on rented or purchased sites (see also Maas, 1971; Clout, 1976), that in many areas is still continuing. In this context also the shift in emphasis from mobile caravans to stationary caravans has to be mentioned.
At the same time an evolution of the accommodation associated to camping can be observed. The caravan parks and camping-sites get equipped with more luxury sanitary facilities, camping-shops, restaurants and an increasing number of secondary facilities such as swimming pools, tennis courts, bars and disco are considered as indispensable. In many cases also second homes are built in complexes that are equipped with such secondary facilities.
Thus, camping-sites, caravan parks and bungalow parks developed into almost self-contained resorts for which the relation to the original resources may have become weaker. Thus, resorts today are as much attractions as facilities at the same time. Accommodation and food service functions continue to be important, but resorts are now known as much for their tennis, golf, sailing, fishing, boating, swimming and winter sports. (Gunn, 1988; see also Culpan, 1987).

It has been stated that the bulk of commercial services and facilities for recreation and tourism is not at remote destinations, but along travel routes, especially at cities because they rely on a variety of markets in addition to tourists (Gunn, 1988). Still, many of the primary recreational facilities are not located in the settlements. For example, on the Dutch Wadden Sea Islands hotels, youth-hostels, and vacation-colonies, are often located outside the villages close to the beach. Cottages (or summer homes) are spread all over the dune areas, wherever people have been able to obtain a plot or, as result of a more recent development, they are grouped together in bungalow parks. Camping-grounds and caravan-sites also mostly are located at some distance from the village. (Van der Zee, 1983).

For the categories of more formal lodging accommodation: hotels, youth-hostels, etcetera, existing sources of information can give a fairly reliable indication of the capacity, although, as already mentioned, some doubts have to be expressed with respect to completeness. With respect to camping accommodation the official capacity and the actual capacity may differ often more than less. But especially in the categories of less formally organized accommodation: private summer homes or furnished rooms rented to tourists, an overview of the capacity is hard to get. For most categories exact information on location is lacking. (See also Noor, 1989).

Entertainment facilities.
Entertainment facilities come in such a large variety that it will be impossible to give a comprehensive list. Some major categories may be distinguished.
First there are the sports facilities such as golf courses, swimming pools, tennis courts, riding schools, etc. They serve the more formal pursuits or activities for which special equipment needs to be rented or instruction obtained (see also Gunn, 1988).
Then there are the facilities that serve more informal pursuits. They comprise parks, gardens, picnic places, promenades, marked walking routes, etc. A special informal pursuit favoured by many recreationists, (window) shopping, has given rise to a range of shops in tourist places and not only souvenir shops (see also Gunn, 1988).
Pure entertainment or amusement facilities are cinemas, theatres, fair grounds, amusement halls, casinos, bars, nightclubs, etc. They may be further subdivided according to whether they are frequented predominantly by day or by night and to whether they mainly serve the adult public or are also suitable for children. Musea could be included in this category in as far as their existence is derived from recreation. But, many musea have to be considered as attraction, as a resource rather than a facility.

Entertainment facilities may further be subdivided according to whether they are dependent or independent of the weather. Especially in areas where weather conditions are not guaranteed optimally for outdoor recreation, weather independent entertainment facilities are important elements of the touristical-recreational complex or product.

Many entertainment facilities are relatively user-oriented and will be found in the settlements in the recreation area or associated to large camping-grounds or bungalow parks. Other facilities demand more space or are typically resource-based and therefore are found outside the settlements.

Sometimes the tendency exists that the importance of the original resources is superseded by that of the secondary facilities. For example, in wintersport places where the *après-ski* activities become more important than the actual skiing (Defert, 1954). This tendency can also be observed in the development of bungalow parks that kept pace with the taste of the public. The consumers wanted more comfort and luxury and had enough money. The old fashioned summer homes, once reached by bicycle and with rucksacks for a two week holiday, are only memories now. They have been replaced by the big camping-sites with neatly aligned bungalows and these in turn are giving way to the subtropical paradises in which the aspects of comfort and luxury are emphasised and in which only the very big exploiters can invest. Subtropical temperatures and a slide in the swimming pool are no longer sufficient. Continuous improvements are necessary, creating luxury swimming paradises with palms, small streams, exotic decoration, etc. Centres that lack these facilities will get hard times in the competition. (Jassies, 1985).

Access facilities.
Although roads reserved for recreational use *-scenic drives-* are very much the exception (Patmore, 1983), and multiple use more the rule, the transportation infrastructure has also to be considered as important recreational facility (Van der Zee, 1983). Both user-oriented as well as resource-oriented facilities need to be accessible.
In the context of accessibility the motorcar plays a predominant role. Many people's greatest pleasure is the constantly changing countryside panorama seen from a moving car (Patmore, 1983). But other modes of transportation should not be neglected (Gunn, 1988). In addition to driving for pleasure, the by far most popular outdoor recreation is simply going for a walk (Patmore, 1983).
Thus, an inventory of roads, classified according to their motorability, lies at the base of an accessibility analysis. In addition paths and tracks should be included, classified according to their suitability for walker, cyclist and horseman. Possible incompatibilities between different ways of recreational mobility, for example, walker or horseman versus cyclist, has to be taken into account too, as well as the barrier function that some traffic lines may have for certain categories of recreationists (see also Van der Voet and Haak, 1989).
Not only the lines of access should be looked at, also access points are of importance, because there a change from one type of mobility to another, or to another type of activity is possible. For example a parking place, where people can change from driving to walking, or to just sit and enjoy the view.
For water-based recreation the different waterways, classified according to their navigability for different types of vessels, are the lines of accessibility. Landing stages or mooring-sites, marinas and sites to launch a light boat from a trailer are the additional accessibility points.
The accessibility of sites within a recreational area, the internal accessibility, is of as great importance as the accessibility of the recreational area as a whole to the outside world, the external accessibility. In the context of the external accessibility highways, railroads, airports or airstrips, harbours and ferry-dams are important.

Identifying the recreational land utilisaton types via the facilities.

The method of the potentialities suggests that an impression of the spatial pattern of recreation can be obtained by means of an inventory of the facilities. This recreation pattern, however, not necessarily also gives information on the recreational land utilisation types. Some facilities are not specifically related to land utilisation types but rather to recreation in general. Especially with the primary facilities this is the case, unless *stay recreation* can be considered as a land utilisation type. The secondary facilities and some transport related facilities are often, but not in all cases, more specific indicators of certain land utilisation types.
All in all therefore, the question of objective 1, whether the recreational land utilisation types can be identified via the facilities, in general can not be answered positively.
A fair, but far from comprehensive, impression of the spatial pattern of recreation at large, and of only a limited number of specific recreational land utilisation types, see also the appropriate paragraphs in the next section of this chapter, can be obtained in this way. Still, this interesting enough to explore the possibilities to inventory the facilities with remote sensing.

2.2. THE INTERPRETATION OF RECREATIONAL FACILITIES.

The use of remote sensing in the method of the potentialities implies the interpretation of the recreational facilities. This raises the question whether the different types of facilities can be interpreted with a sufficient level of consistency. To give the answer on this question is objective 2, and it will be done at the hand of a number of case studies and interpretation of airphoto coverages of numerous different areas. Since the majority of the interpretations in this field have been done with normal airphotos, the discussion will concentrate on this. Where different methods of remote sensing have been used this will be clearly specified.
For the different types of facilities it will be indicated by what criteria they can be identified. The description of these criteria often will make clear already whether the interpretation of a category will be more or less easy and what rate of accuracy can be expected. To really establish how accurate an interpretation has been it will be necessary to compare it with other sources of information on the same category. Because the accuracy of secondary data-sets is sometimes also questionable, field observations are the only way to really test the accuracy of the interpretation.
The number of field observations to do is a function of budget as well as of the level of accuracy wanted and the type of sampling. When using a random sampling technique statistical formulae can be applied to determine the proper size of the sample. This can also be applied to stratified random sampling. However, with airphoto interpretation often selective sampling is done on basis of the interpretation in order to still further reduce the number of field observations. But then the statistical formulae can not be applied any more.
A number of interpretations referred to in the following sections could not be verified in the field. Some other case studies included field observations, but it was not always possible to establish interpretation accuracies on the base of that. For example, when the airphotos are not very recent it is often difficult to establish whether a difference between interpretation and reality is the result of a mis-interpretation or of a change in the situation, unless with very intensive fieldwork. Therefore one special case study was done in the rural area around Enschede, the Netherlands, on recent airphotos and including a complete field verification in order to establish quantified accuracy rates. For a discussion of the interpretability as such, thus without field verification, the date of the airphotos is not really relevant. Most airphotos taken in peace time after World War II are of good to excellent quality. Therefore observations on case studies done on older material can be as valuable as those on more recent material.
Results obtained in case studies in Europe may not seem directly representative for developing countries, because there facilites can be of a different size and appearance and the setting can be completely different too. But the results can give an impression of the rate of accuracy that can be obtained by a skilled interpreter that has both sufficient specialist reference knowledge as well as local reference knowledge.

The details of the material and case studies referred to in the following sections are given in the Annex.

Assessing the accuracy of an airphoto interpretation.

The assessment of the accuracy of an airphoto interpretation is not a simple matter, it is not just a question of right or wrong that can be easily expressed in a percentage. A percentage of what? A percentage of the total items interpreted that appeared to be correct? Or the percentage of the units in the field that appeared to be correctly interpreted. These are two sides of the medal, but they are different sides. An example may illustrate this issue.

Accuracy of interpretation of farms in the Enschede area.

In the interpretation of the area around Enschede it was tried to distinguish farms from houses and buildings with other functions. Main criteria for identifying a farm as such are the presence of fodder silage pits or towers, manure pits, and numerous additional larger and smaller buildings -barns and sheds-. Also clear traces of access to adjoining fields are a good indication for a still active agricultural function.
Many cases are clear, but other cases challenge both the skills in interpretation as wells as in definition of the category. They may not only be difficult to identify on the airphoto, but also hard to classify even after inspection in the field. What about the small farms with only a marginal agricultural function, and about the farmer that just quit farming but stays living on the farmstead and still keeps some animals for a hobby?
Is his place more a farm than that owned by someone with a job in town who also keeps sheep or horses as a hobby? There is a kind of twilight zone between the purely agricultural and the purely residential functions and it is in this zone that most of the mis-interpretations and mis-classifications will occur.
The great variety in building styles adds to the confusion. Farms occur in a range from the traditional Twente style to the ultra-modern style of farm building. On the other hand old farmhouses built in the typical style of Twente are renovated and reconstructed as residence, new luxury residences are constructed in the style of such old farmhouses. They may be recognized as being non agricultural because of the nicely designed gardens and the absence of any silage or manure pits. But some modern farms also have nice modern bungalow style residential units associated with them, surrounded by designed gardens.
In total 293 farms were interpreted in the study area, and only 220 were observed in the field. Does this imply an accuracy of 75% ? It does if all the 220 had been interpreted as farm, but that is not the case. Of the 293 farms interpreted only 209 also in reality were farms, 71%. But viewed from the other side, of the 220 farms found in the field, 209 had been interpreted as such, a score of 95%, not bad at all. See also figures 2.5. and 2.6.

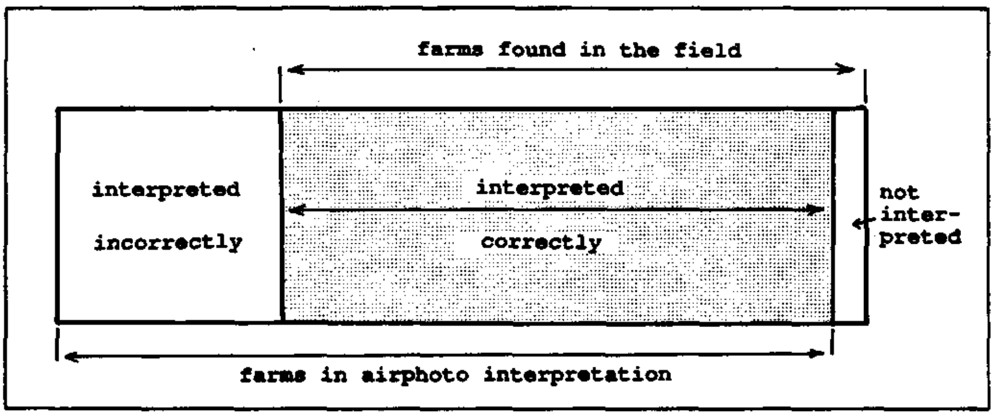

Figure 2.5. *Interpretation accuracy of farms in the Enschede area.*

Wright or wrong in this respect remains a relative question.
Some of the cases of mis-interpretation concerned former farm buildings which now served as a base for an agricultural contractor, the barns and yard still full of large agricultural equipment. In some cases even from field observations it was not definitely clear whether a farm was still in function as such or not. It was not possible to carry out interviews at every place to find out about the main occupation of the residents.
It was also considered to be a mis-interpretation when the interpreted farm appeared to be only a barn or a stable instead of a full farm. If these cases, which are not real farms but very closely associated with agriculture, are considered to be correct interpretations, the score rises from 71 to 78% .
If also the cases in which a residential function is associated with some (hobby) farm activities such as keeping horses or sheep, or with the presence of a big barn or workshop are counted as correct the score becomes 83%. The remainder consists of 45 cases in which the residential function is clearly dominant, although the building is in the Twente farm style, new or old, and of some cases in which a former farm has got the function of youth centre or children's farm or something similar. A mis-interpretation of function rather than form, but still, 17% incorrect. This type of mis-interpretation is hard to improve with sharpened criteria after re-interpretation. It is understandable but is it also acceptable?

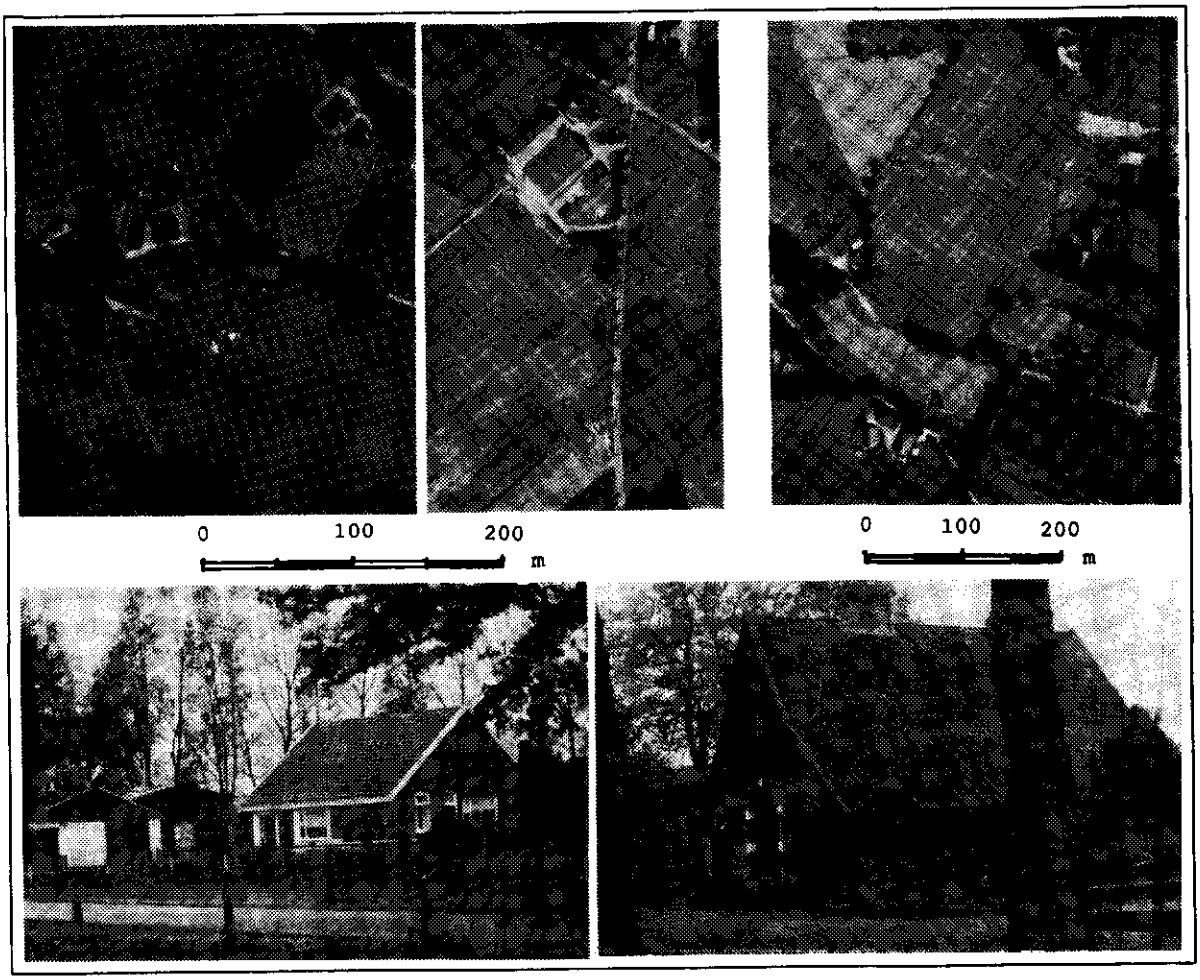

Figure 2.6. *Examples of interpretations of farms in the Enschede area.*
Top left and middle enlarged to 1:5000, left: Twente style farms, adapted to modern farming practises; middle: modern style farm. Top right: 1:7500; A = farms, R = residential (former farms or farmstyle-built). Below left: residential with large sheds, one with hay and straw: farm? Below right: residential in traditional farm style.

Looking again at it from the other side, of the 220 farms observed in the field, some may not have been interpreted straightforwardly as farms, but in a number of cases a doubt between agricultural and residential function was indicated, implying that they should be included in the sample for field verification. If these cases can also be considered as correct interpretations the score becomes 97%.
It depends on the aim of the survey what rate of mis-interpretation is still acceptable. If the interpretation is meant to provide a database from which to take a sample for an enquiry survey on farm activities, it is not a real problem that also some non-agricultural units are included. They can be separated in a later stage. The number of sites not included in the interpretation could be more of a problem, but in this case the error remains within acceptable margins, especially if also question-marked interpretations are incorporated. If, however, the interpretation is meant to map the location of the pure agricultural units, the number of mistakes is far beyond the acceptable rate of error. Still, even if the aim is known, it is difficult to establish criteria for acceptable accuracy.
The expression from the other side, that is, the percentage of objects observed in the field that were interpreted correctly, may be interesting, but most often only the first approach is used. It is seldom possible to carry out a complete field check, only a sample of the interpreted objects is checked and the accuracy found for that is extrapolated to the whole interpretation.

When not point objects such as farms or houses or second homes are concerned, but objects which cover a certain area, such as camping grounds, sport fields and the like, or objects that cover a certain length: roads, paths, waterways, assessing the number of correctly interpreted objects as a percentage of the total number of objects may not be satisfactory. In such cases the percentage of area or length that has been correctly interpreted may be more relevant. This again will depend on the aim of the survey.
If, for example, 25% of the land use categories occupy 70% of the area and only this 25% are correctly identified, then on an areal basis the accuracy would be recorded as 70%, even though 75% of the land use units were not correctly identified (Collins and El-Beik, 1971a). Whether the results are acceptable or not then depends on whether the aim is expressed in terms of area correctly identified or in number of categories identified, and on what range of error is considered to be still acceptable.
When it is numbers of units or categories correctly identified, it is the reliability aspect of accuracy that is dominant. When areas and lengths are concerned, or exact locations, then in addition to reliability also precision is required.

The results of a trained photo or image interpreter, that is familiar with the topic as well as with the area concerned, will be much better than that of a trainee, that is new to both the topic and the study area. When working in a team it is therefore necessary to calibrate the interpretation accuracy of the individual team members. This influence of the individual performance of the interpreter, as well as that of the scale of the airphotos, can be illustrated with the example of house counts in ITC standard course fieldwork case studies in Southern Italy (Koroma et al. 1978) and South-western Spain (De Voto et al., 1979; Mukonyora, 1980; Quader, 1980; Tin Sein, 1980; An, 1980).

The accuracy of house counts by airphoto interpretation.
The house counts were carried out by airphoto interpretation and checked by field observations in the context of fieldwork projects of the Rural Survey course of the ITC. All settlements were concentrated settlements, none of the participants was familiar with the area, but all had been trained on the topic of study. For all settlements first a segregation into residential and non-residential functions was made. A settlement plan was sketched in which *blocks* were delineated that had to serve as counting units as well as field observation units. For each block the number of houses was counted on the airphoto. Then for each settlement a number of blocks was taken at random for a field count. The difference between photo count and field count is expressed as a percentage of the photo count, in order to be able

to use this as a correction factor. A positive percentage means that the photo count has to be reduced, a negative percentage that it has to be increased.

In the case study in Southern Italy for four interpreters four different factors were found: -4,5%, 5.8%, 7.0% and 34.7%. When an accuracy range from +10% to -10% is accepted, only one interpreter needs to improve considerably. But when a range from +5% to -5% is required, only one stays within that range. However, the results do not necessarily reflect only the skill and ability of the interpreter, since each interpreter looked at different settlements. In some settlements it was much easier to distinguish individual houses than in others, because of the difference in structure of the settlement and because of different quality of the airphotos. Some settlements were on first quality 1:17000 scale, others on second rate copies on 1:±24000 scale.

In the first case study in South-western Spain (De Voto et al. 1979), three interpreters, using 1:20000 airphotos all of the same quality, obtained different overall results: 21.6%, 7.7% and -12.9%, but with a range that differed again per individual settlement. Some of this differences might be explained by the fact that each interpreter looked at different settlements. Therefore to really compare the individual performance of interpreters their interpretations of the same settlement should be compared. This was done in the second case study in Spain. Four interpreters interpreted the same three settlements, and their results were compared. When comparing the overall personal results in the form of dwelling units counted per pair of interpreters, the smallest difference was 1.3%, the largest 13.0%. These differences varied however per settlement. When applying the F-test and t-test on the series of interpretations and counts by the four different persons, no statistically significant difference could be established. Still, the results of this comparison could be used to bring the results of the individual interpreters even closer together. (Mukonyora, 1980; Tin Sein, 1980).

In the Spain case studies the results of the field check were fed-back into a re-interpretation and a re-count in order to establish what rate of error was due to lack of experience and what simply is inherent to the fact that not everything can be deduced from an airphoto. After re-interpretation, in the first Spain case study the inaccuracy factor became 4.9%, 0.9% and -5.3%. Thus, after using a set of field observations as training set, the interpretation accuracy comes much more within acceptable ranges than before. Still, the difference between the individual interpreters remains more than 10%. (De Voto et al., 1979). Also in the second Spain case study the problem of lack of local reference level was partly solved by the field checks in the first settlements, after which prior to further field observations, first the other settlements were re-interpreted. The difference between first and second interpretation varied from one person to the other, ranging from 1.6% to 24.7% difference, in absolute numbers 13 and 227 respectively. Those that were already reasonably accurate the first time could hardly improve any more, but those that had been less accurate showed great improvements. Their results became more consistent and the error rate smaller. The differences between interpreters in the re-interpretation became much smaller than in the first interpretation, although according to the statistical tests applied no significant difference between the first and second interpretation could be found. (Mukonyora, 1980; Quader, 1980; Tin Sein, 1980).

Of some settlements also airphotos on 1:10000 were available and interpreted in the first Spain case study. When comparing the results of both first interpretation and re-interpretation of the 1:20000 and the 1:10000, in two cases only slight differences were found: 1.1% and 0.9% for the first interpretation, -0.2% and 1.8% for the re-interpretation. This led to the conclusion that a larger scale not necessarily leads to a higher accuracy. It was observed, however, that the interpretation was much easier and less strenuous on the larger scale. Only the third interpreter showed large differences: -19.9% for the first interpretation, -5.1% for the re-interpretation, but it was concluded that with additional training sets also this interpreter could be brought more in line with the results of his colleagues. (De Voto et al., 1979). Also in the second Spain case study the two scales were again compared. Already after the interpretation of the first three settlements it became clear that there was no significant difference in the interpretation results, but that interpretation was much easier on the 1:10000. Therefore it was decided to only use 1:10000 for the rest of the study. Of those settlements of which no original 1:10000 airphotos were available, sections of the 1:20000 photos could be enlarged to that scale without loss of quality. Thus, only the 1:10000 interpretation eventually was checked in the field this time. The difference between the first interpretation and the field observation still showed large variation between individual interpreters: 28.3%, 11.0%, 7.6%, 1.9%, but the re-interpretation brought the rate of error within the at that occasion accepted range from +5% to -5% : 4.8%, -0.5%, 0.5%, 0.3%. (Mukonyora, 1980; Quader, 1980; Tin Sein, 1980; An, 1980).

Collins and El-Beik (1971b) observed, that on airphotos of 1:10000 the various types of housing in the city of Leeds could be identified with an overall accuracy of just over 90%. For some categories a 100% accuracy was achieved, but for other categories scores of 92% and 68% were obtained, either over-estimated or under-estimated.
In both this and the Spanish and Italian case studies it is the reliability aspect of accuracy that has been considered. It is clear that when the individual performance of the interpreter already is of considerable influence on the results of something relatively simple as a count of houses, in the interpretation of airphotos for recreational phenomena the identification will be even more strongly influenced by specialist reference level and local reference level. Such reference level can only be gradually built up. Where different persons have to work together on an interpretation, they have to use a common training set in order to bring their accuracy on more or less the same level, or at least to be able to calibrate their personal deviations. And when it is possible to start with a small representative pilot area and then check that in the field first, the results of the interpretation of the rest of the area in general will be much more reliable.
Also of importance is what knowledge on the area of study is already available before the interpretation starts. When it is known that the area studied is a typical recreation area, certain objects will be identified as recreational easier than when they occur in an area that is a typical non-recreation area. The results in the following sections and chapters have to be considered in this context.

The interpretation of stay accommodation.

For the discussion of the airphoto interpretation of the stay accommodation a further subdivision into three main groups is made to make the discussion easier. The first group is that of the hotels and restaurants and similar accommodation such as youth-hostels and vacation colonies, boarding houses, places offering *bed-and-breakfast*, etcetera. The second group is that of camping-grounds and caravan-sites and the third group comprises the summer homes, or cottages, or second homes. The first two categories in general accommodate groups. The first category does so in buildings, the second one on terrains with some central facilities to which people bring their own (mobile) lodging accommodation in the form of tents and caravans. The third category comprises the more dispersed forms of accommodation, even though at present second homes also occur in complexes.

Hotels and restaurants.

This category comprises buildings exclusively used for (recreational) stay accommodation as well as the bed-and-breakfast offered at, for example, farmhouses as part of a multiple-use function. Of the stay accommodation under such a multiple-use function of course identification by airphoto interpretation cannot be expected. But also no fixed set of clues can be given for the interpretation of the buildings that are in more exclusive use in this category, because hotels and restaurants can be housed in any type of building. Hotels range form gigantic towers in urban areas, via the old fashioned *Grand Palace Hotel* style or renovated mansions, to simple bungalow style motels. Restaurants can be found in ultra modern buildings, but also in former farm buildings, windmills or on ships. So what to look for in airphoto's?
Still, although it may be very difficult to definitely identify a hotel or a restaurant as such with a high degree of accuracy, it often is possible to indicate which buildings might qualify for this function and which definitely not. The size and style of the building can give a first indication, associated features such as relatively large parking places, certain secondary facilities, and often also the location may enhance this. Presence of associated entertainment facilities may

even reveal that the stay accommodation is, at least predominantly, used for recreational purposes rather then by businessmen. Some examples.

Ameland and Loosdrecht, the Netherlands.

Thus, on airphotos of the central part of Ameland, a renowned Dutch recreation island, all buildings outside the agricultural area and the villages that are too large to be individual summer homes can be assumed to serve recreational purposes, either as hotel or boarding house or restaurant, simply because that is the only likely function to expect there on basis of local reference knowledge. A further specification can not be given though without field information. Because of their location near the end of the road to the beach, some smaller buildings can be interpreted as (souvenir-) shops/kiosks or snack-bars (small restaurants). Although the large buildings with their sometimes intricate ground plan are also represented on the topographical map and could have been classified as recreational also from that, the airphoto's with their stereo view and the greater amount of detail that they reveal give a much clearer idea about the potential function of the buildings. See figure 2.7. The stereo view and enlargement facility of the mirror stereoscope also gives a much clearer impression than a (poorly) reproduced airphoto in monoscopic vision.

In the villages the assumption that all large buildings have a recreational function is less valid, because a number of other functions can be expected to have large buildings too: school, church, townhall, supermarket, etcetera. Only when these can be positively identified with certainty, then the remainder may qualify as hotel or restaurant.

Also in the example of the Loosdrechtse Plassen area the interpretation hotel/restaurant is attached to the larger buildings with a complex ground plan and associated with a parking place. Most of them have a waterfront with a view on the lake. See figure 2.7. (Van der Zee, 1973).

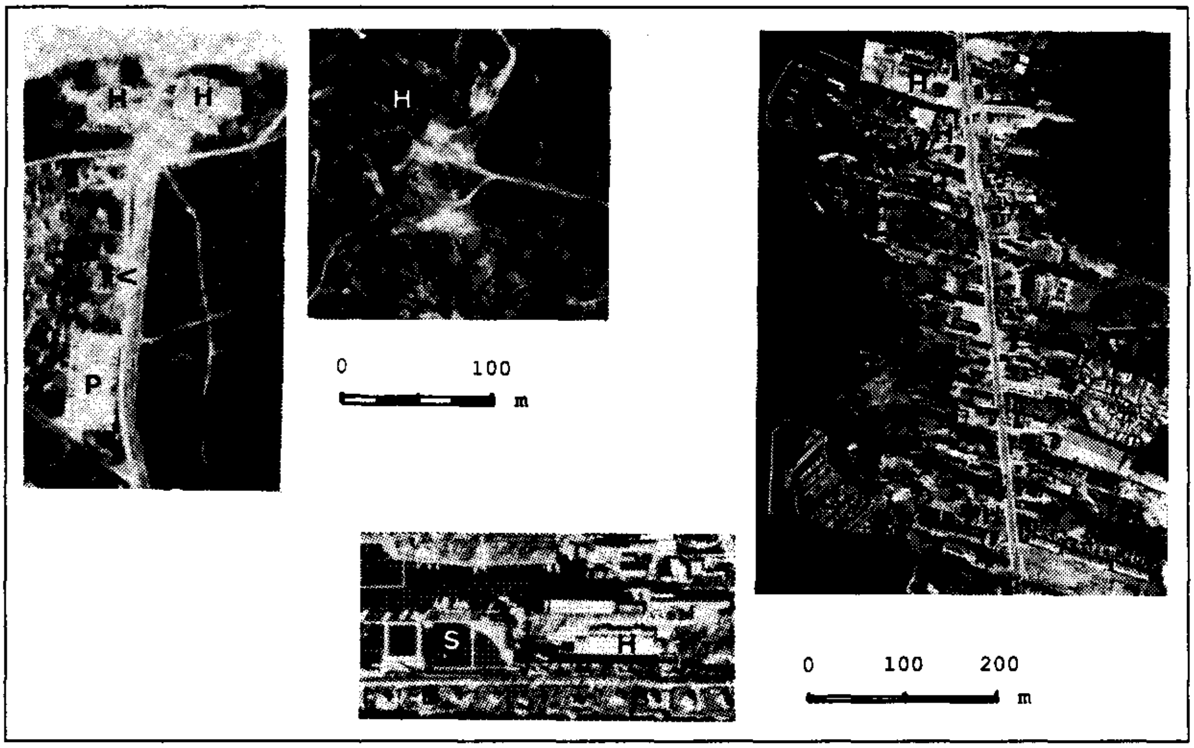

Figure 2.7. *Hotels/restaurants on airphotos of Ameland and Loosdrecht.*

Top left; at both sides at the end of the beach road on Ameland, large buildings with ample parking space are hotels/restaurants (H), along the left side some small buildings (<), restaurants or shops, (P) is a large parking place. Top centre: a large building with complex groundplan in the dunes of Ameland, a hotel or holiday home. Right: Large buildings (H) associated both with parking places as well as with marinas in Loosdrecht are very likely to be hotels/restaurants. Below: also in Loosdrecht another lerge building (H), this time also near to a swimming pool (S), which ,however, may also be associated with the second homes or bungalows (B).

Lake Proserpina, Spain.

At the southern shore of Lake Proserpina, in Southwestern Spain, on the airphotos a large building is observed, by its location apparently associated to a number of tennis courts and some unidentified peculiar features, that after field observations appeared to be trap shooting ranges. The building appeared to be the clubhouse of the association. That the building was not a farm, nor a residence was clear during the photo interpretation. An industrial function could also be excluded, but for the rest quite a range of possibilities was still left open. See figure 2.8.

Among the houses in the Proserpina settlement a number of bars and/or small restaurants were found during the field visit. But even in the re-interpretation no indications could be found to clearly distinguish them from the second homes around. The few buildings along the Northern part of the lake are simple kiosks. They had not been interpreted as such, but also no other function was identified for them. They were left as question marks in the interpretation, to be checked in the field. See figure 2.8. (Van der Zee, 1982).

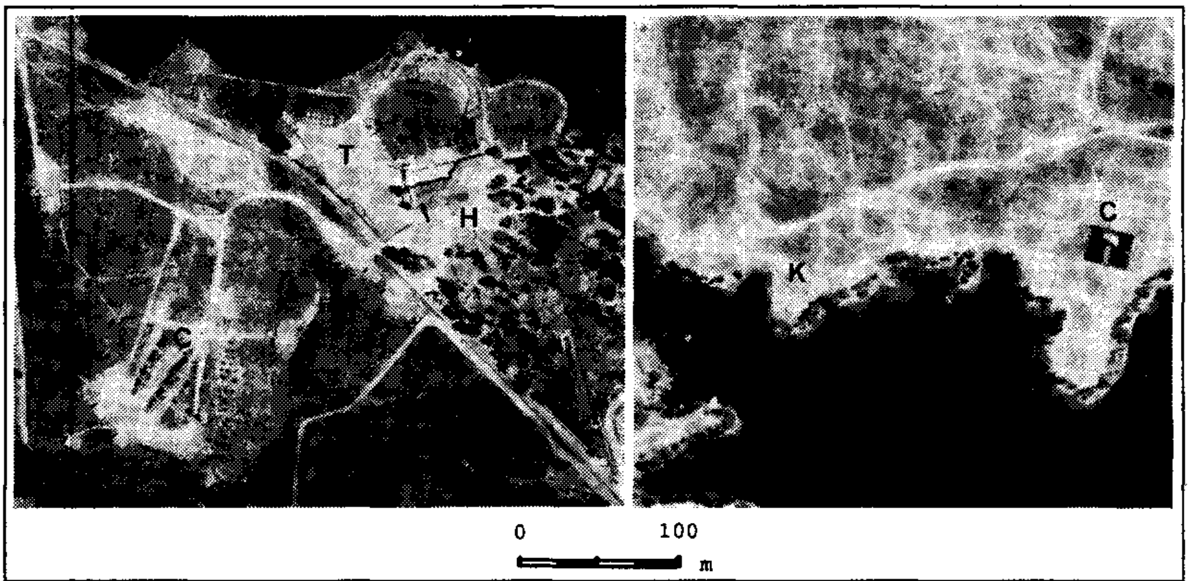

Figure 2.8. *Clubhouse and kiosks on airphotos of Lake Proserpina.*
Left: the clubhouse (H) near the semi-circular trap-shooting ranges and tennis-courts (T); on the other side of the road the camping ground (C), not in use in this time of the year; right: at the northern part of the lake the chapel of San Isidro (C) and some kiosks (K), that are hard to detect because of the bright reflection of the bare soil, the terrain shows the scars of heavy use.

The area around Enschede, the Netherlands.

In the area around Enschede five restaurants (of which two hotel-restaurants) were interpreted on the basis of the criteria: large building with attached one storey extensions (convention or party rooms), an intricate ground plan and associated with large parking places and sometimes entertainment facilities of some kind (playground, midget golf). See for example figure 2.9. top right. Of the buildings in the interpretation one actually was labelled as *special building* and not as restaurant, and one building appeared to be not a restaurant but a building with offices and workshops for the management of a large recreation area. See also figure 2.9. top left. Thus, although four were interpreted and four were found in reality, still only an accuracy of 75% , although such a figure is meaningless when based on a small sample as this one.

Only one hotel is found in the study area. It was interpreted as luxury residence, which happened to be its former function: luxury summer residence. The expansion of its capacity by apartments built in the forest can absolutely not be detected on the airphoto. See also figure 2.9. below left and right.

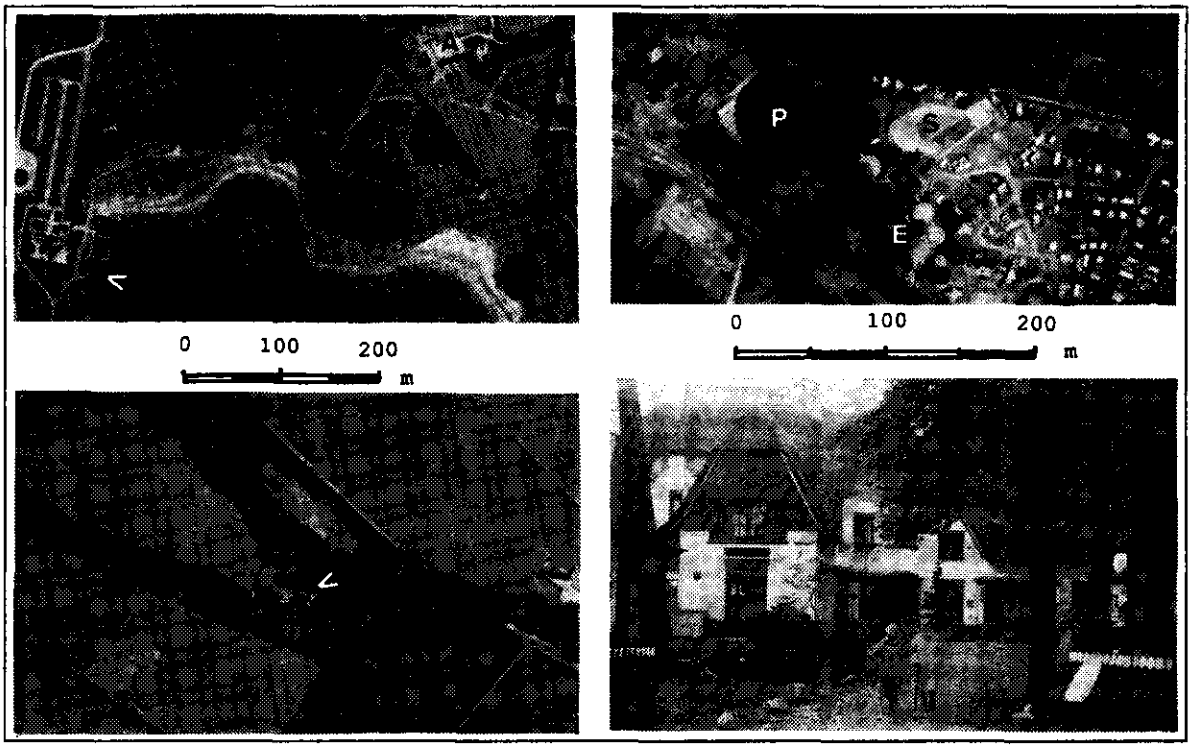

Figure 2.9. *Hotel and restaurants on airphotos of the Enschede area.*
Top left: a restaurant at a recreation area (<) and the administration office and workshop of the terrain management (A); top right: a hotel/restaurant (H), near an entertainment park (E) with canoe pond (P). The swimming pool (S) belongs to the camping ground at the utmost right; below: left, the hotel (<) in the woods seen from the air, right the same from the ground.

The Mae Sa valley, Thailand.

In the Mae Sa valley in Northern Thailand overnight accommodation for tourists is offered not as hotels, but in the form of bungalows or cabins grouped together in resorts often in a garden-park setting in which water is an essential element. Additional facilities such as a restaurant, convention room, playgrounds, kiosks or souvenir shops may be present. Resorts may also be used for a day-visit only.

Eleven resorts have been identified (Suwan and Nurbaya, 1986) and analyzed on the 1:15 000 airphotos of 1983. Some examples are given in figure 2.10. Some of the resorts are so new that they do not appear yet on the photos or are less developed than they were at the time of the field observations. The garden-park environment is only clear in some cases. In many cases just terraced fields and tree plantations can be identified that do not differ from those with a purely agricultural function. Small ponds are also not exclusively occurring in resorts. The arrangement of buildings in a resort often makes clear that it is not an ordinary settlement, but only if they are present in large numbers. Therefore, though in individual cases indications may be rather evident, no criteria can be found to consistently identify all the resorts.

Of the restaurants, some are associated with the resorts and can be identified as one of the larger buildings there, the others are all located along the main road and no criteria can be found to distinguish them consistently from other buildings. (Van der Zee, 1988e).

The Puncak area, Indonesia.

In the study of Adrian (1991) of the Puncak area in Indonesia, hotels were distinguished from the cheaper forms of accommodation such as *penginapan* (only overnight accommodation), youth hostel (aimed mainly at young visitors), and inns (also offering facilities for meetings and convocations). When the accommodation is owned by the government or a company, and its facilities provided exclusively to own employees and clients, it is called a guesthouse or *wisma*. Also restaurants were distinguished.

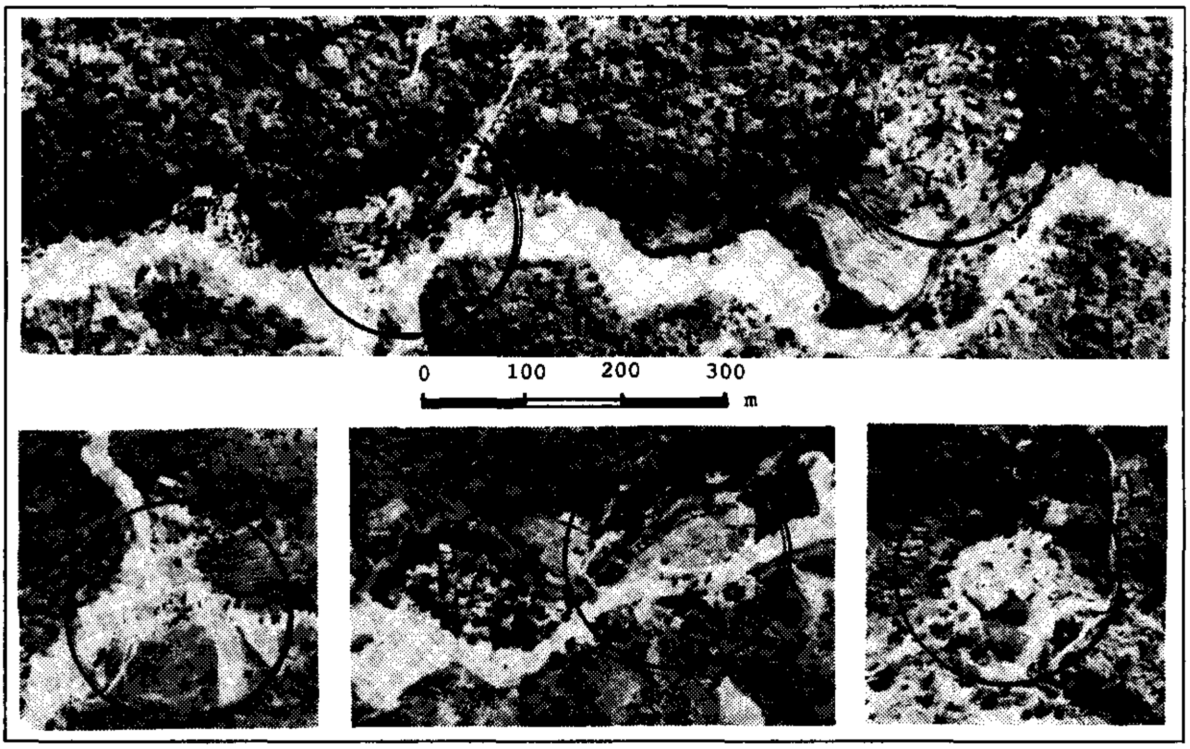

Figure 2.10. *Resorts on airphotos of the Mae Sa valley.*
At the top in the circle to the left: the Botanical garden; to the right the Mae Sa Valley resort; below: left, a newly emerging resort, hard to identify as such; centre, in the circle a resort consisting of a chain of cabins along a lawn, to the right a normal agricultural settlement; right, a resort on the slope of a narrow valley.

In the airphoto interpretation of the different types the size of the building is one criterion used. Hotels are the largest in size, guesthouses again larger than youth hostels and inns, and these again larger than second homes. Hotels and guesthouses, as well as second homes occur in a beautiful garden setting, restaurants usually not. Most of the stay accommodation, except the second homes, is located along the main road. The association with parking lots and a number of parked cars add to the almost certain identification of hotels and restaurants.
With the criteria given, this type of accommodation could be identified easily, especially because the interpretation was supported by good local reference level. Only the *wisma* could not be identified as such by airphoto interpretation, because the only difference from the other types of accommodation is the ownership.

SPOT image of the Mae Sa area.
Also the use of SPOT images for the inventory of recreational facilities has been evaluated in the Mae Sa case study. (Van der Zee, 1988e). Of the study area a panchromatic SPOT image of January 1987 was available. For the analysis it was produced in scales 1:50 000 and 1:25 000. In addition to the normal panchromatic image, also images with a low respectively high value stretch and one with edge enhancement (Laplace + original) were produced.
Of the recreation places considered the (known) location could be pinpointed on the image without problem in most cases. But, perhaps with the exception of one resort, the images do not permit an identification of the site as being a recreation place or at least as a special kind of place. The low and high value stretch do not offer any advantages for this purpose. The edge enhancement makes the image clearer, but still does not allow identification. Both spectral and spatial resolution are insufficient for this purpose. This corresponds to the conclusions about the possibilities of SPOT for the identification of settlement and infrastructure in south-eastern Sri Lanka (Van der Zee, 1987b), see also Naithani (1990).

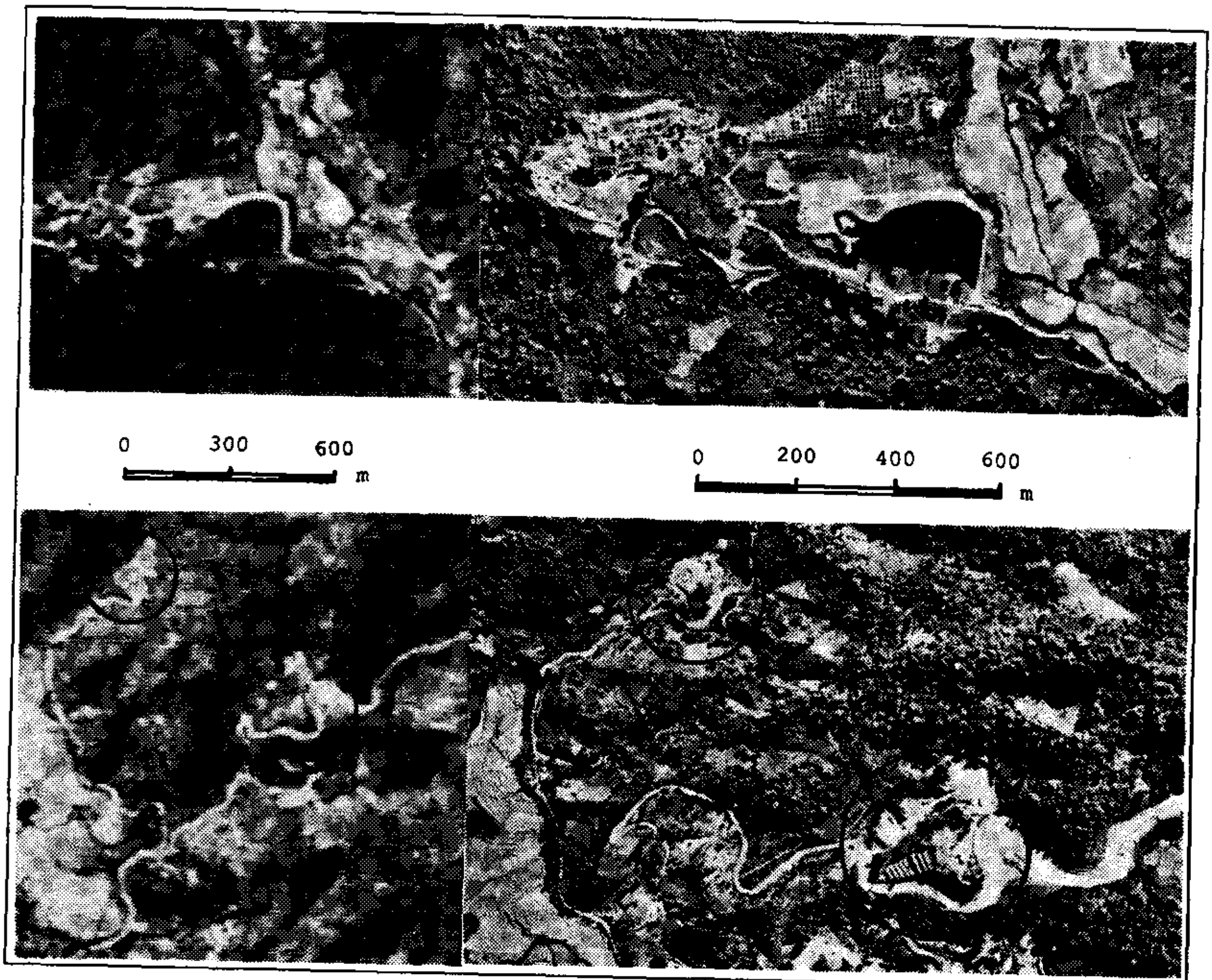

Figure 2.11. *Resorts of the Mae Sa valley on airphoto (right) and SPOT (left). At the top the Erewan resort to the left of its lake, below in the circles two other resorts.*

The case studies show that this category of stay accommodation can not always be interpreted from airphotos with high reliability. But, especially in rural settings, it is possible in the interpretation to single out buildings that could belong to this category and concentrate the fieldwork on only these, thus making a more or less complete inventory still possible with a minimum of effort. High precision in the determination of size and location is not required. Relative location with respect to other facilities and resources is more important, and this presents no problem. Thus, airphoto interpretation can still be useful. However, satellite images are not suitable whatsoever for the interpretation of this category.

This answers objective 2. With respect to objective 1, no direct relation to specific land utilisation types can be established, unless *stay recreation* can be considered as such or associated features point at certain recreational activities. It is also not always certain whether the use is predominantly recreational or not.

Camping-grounds.

Camping-grounds range from very simple ones, with only the basic sanitary facilities, to the very luxury ones, which in addition to these facilities also comprise camping shops and restaurants as well as an increasing range of entertainment and sports facilities. Also camping at the farm should be included in this category, somewhere at the simple end of the range. For the interpretation of the associated features mentioned, see the sections that directly deal with them. The basic characteristic for the interpretation of camping-grounds and caravan-sites remains however the pattern of small light-toned objects representing the tents and caravans, associated with at least a few larger and darker toned buildings representing the sanitary and other common facilities. Some examples.

Ameland and Loosdrecht, the Netherlands.

In the case of the example of central Ameland (Van der Zee, 1973), the scale of 1:18000 does not permit to distinguish the large family tents from caravans, but the service buildings can be identified without problem. On the topographical map of 1:25000 the camping-grounds are indicated by a point symbol that does not indicate their extent, and by individual small symbols for the service buildings. One area, not indicated on the topographical map as a camping-ground, obviously serves as camping-ground for a group (boy scouts, school?), because on the airphotos clearly three large tents and a semi-circle of smaller tents can be identified (see figure 2.12. top left at arrow). No secondary facilities can be found associated with the camping-grounds in this example. May be at the time of photography (1968?) the demand for that was not yet great, or in the near environment of the camping-ground enough entertainment opportunities can be found. See figure 2.12.

On the airphotos of the Loosdrecht area (Van der Zee, 1973) a caravan-site can be identified because of the pattern of small light-toned rectangular objects, that by these characteristics and their size can be identified as caravans. Since the airphotos are taken in March and April, thus early in the season, it implies that these are stationary caravans. The distinction between a large stationary caravan and a simple summer home is difficult to make, even on the 1:8000 scale photos. See figure 2.12. right.

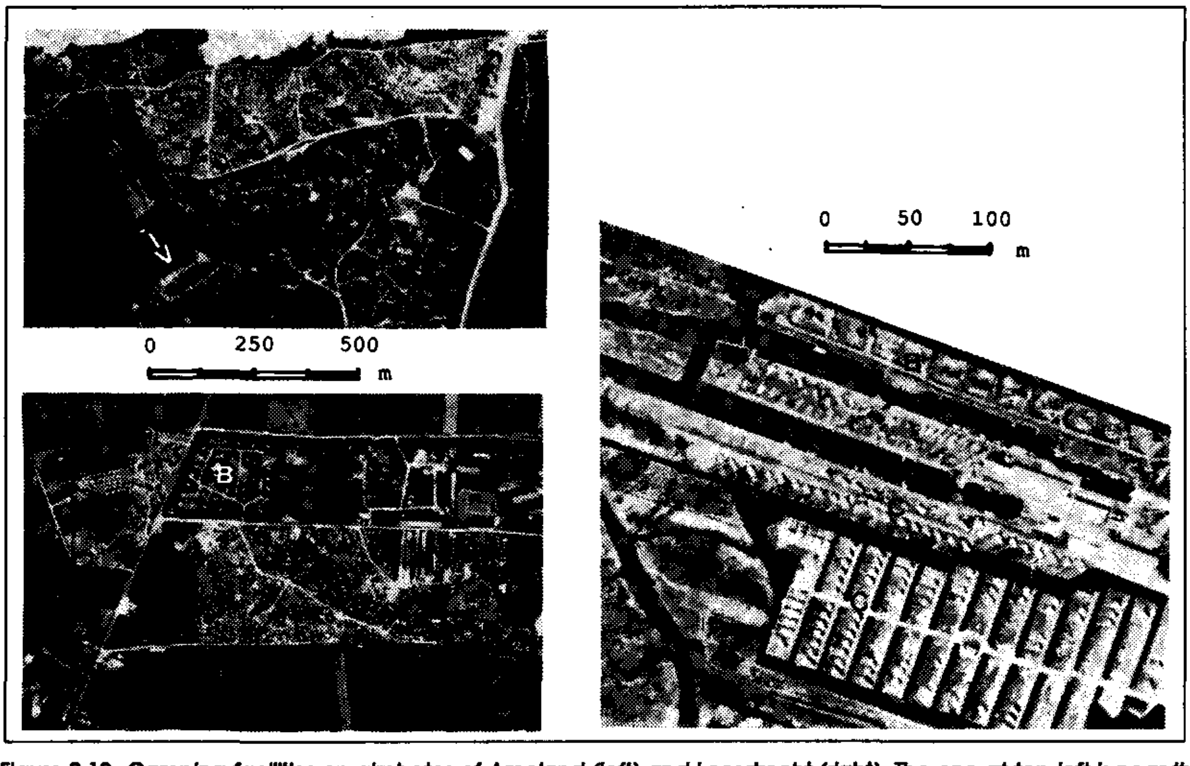

Figure 2.12. *Camping facilities on airphotos of Ameland (left) and Loosdrecht (right). The one at top left is near the beach, compare with figure 2.7.; the one down left is a bit more inland, the wider spaced and larger objects are bungalows (B); at Loosdrecht (C) is the camping with caravans, (B) are bungalows.*

The Enschede area, the Netherlands.

In the countryside around Enschede four camping-grounds were interpreted, in total comprising some 20 hectares. Only one is indicated as such on the topographical map. Three of the camping-grounds could be identified easily on the 1:7500 airphotos because of the well known pattern of small light-toned objects. In two cases these objects are arranged on small fields surrounded by rows of trees or hedges. Larger buildings are camping-shops, sanitary buildings, workshops, residence for the manager, office, etc. The exact function can not be

identified by airphoto interpretation. In all cases the camping-grounds comprise a swimming pool on their terrain, as well as some kind of sports fields. These facilities are clearly identifiable. See figure 2.13. and also figure 2.9.
In many cases the individual objects, which can be unmistakably identified as caravans, are rather large and have complex shapes such as the L-shape. Also they often are associated with flat light-toned areas (= paved terraces) and with gardens. These are indications that they are stationary caravans. During field inspection it appeared that in some cases two caravans have been joined together and the difference between such a complex stationary caravan and a real summer home is but a small one. It also appeared that some of these stationary caravans are permanently inhabited.
Because sometimes two caravans are combined into one unit, and other times two closely placed caravans are still two separate units, it is not always easy to clearly identify and count all individual units. In one case the interpretation and the field count gave the same result, in two other cases the time gap between date of photography in the peak season and date of field observation in the autumn of one year later, resulted in an amount of changes in the situation that made it impossible to use the field count as a check for the photo count. For the identification of the area as being a camping-ground and even to delineate its extent, this is not a problem. A 100% accuracy was obtained.

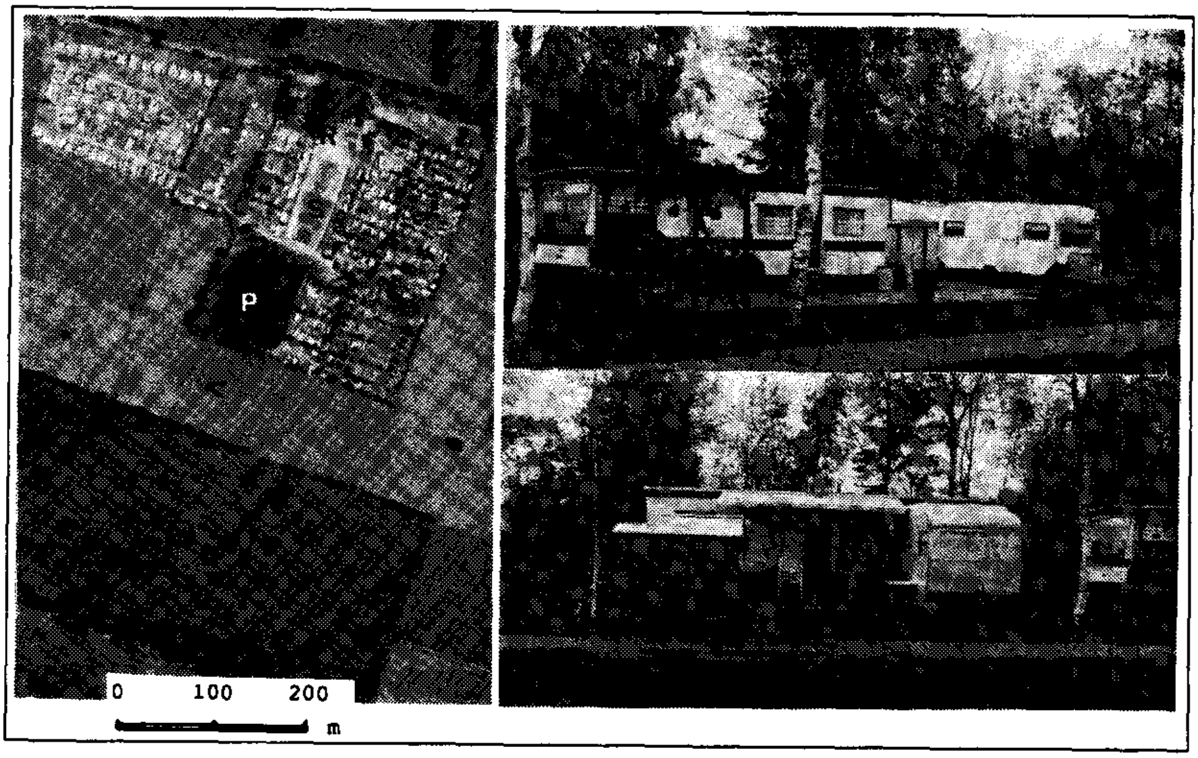

Figure 2.13. *Camping-ground on an airphoto of the Enschede area (left) and some ground views (right). On the airphoto the difference between the new extension of the camping-ground and the already well-established part (more rows of trees) is clear. (P) is a fishing pond, (S) the swimming pool, together with the restaurant (R) the origin of the camping. To the right some examples of really stationary caravans.*

If accurate information on the occupation rate of the camping-ground is required, field observations should be made simultaneously with the photo flight in order to be able to determine the accuracy rate of the interpretation. For a case study which is dependent on already available airphotos that is not possible.
If no stationary caravans or tents are present, and touristic use of a camping-ground is very seasonal, on airphotos of the off-season it may be difficult to identify a camping-ground as such. The (municipal) camping-ground to the South of Lake Proserpina in Southwestern Spain was not interpreted as such. On the airphotos it shows as a number of tracks and small

buildings (Van der Zee, 1982), that in their configuration may suggest a non-residential and non-agricultural function, but for the rest leaves a lot of possibilities open. See figure 2.8. However, the fourth camping-ground found in the Enschede case study at the time of photography was not occupied, but still could be identified by the peculiar arrangement of the small hedged-in fields and the association with a farm-style building, a swimming pool and a sportsfield. Part of the fields showed light tones, as if recently mown, the rest was darker grey. It appeared that this camping at the time of photography just had changed hands and was being transformed from a normal camping into a nudist camping. A fence around part of the terrain is clearly visible on the photograph (stereo and shadow). All the former camping guests had left with their caravans and the new ones had not arrived yet. Only a part of the former terrain was going to be included and therefore was mown. The rest (1.6 ha) that was not mown was to return to agricultural use. See figure 2.14. at the right.

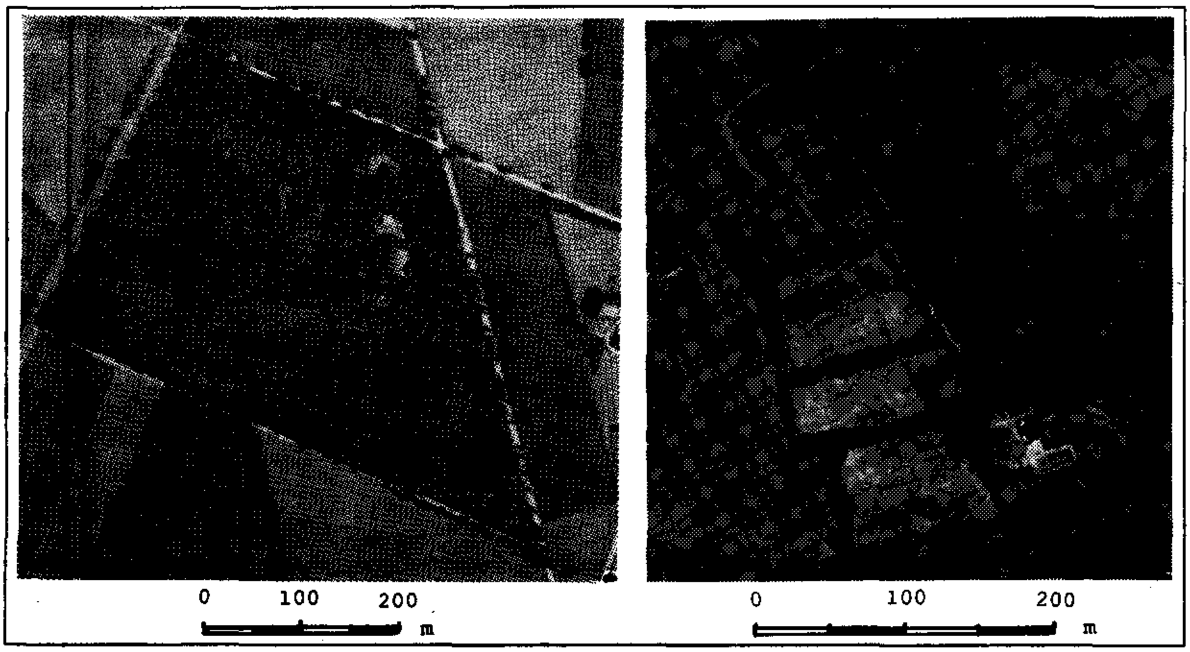

Figure 2.14. *Camping-grounds that are hard to identify on airphotos.*
Left: the scouting terrain; right: the camping-ground in the transfer process,all fields are empty, but the demarcating tree rows are characteristic; also note the rectangular swimming basin.

Sometimes special groups or associations, such as scouting, have terrains of their own on which, in addition to other activities, also camping is practised. The number of facilities is very small, however, and the time in which the area is occupied relatively short. Therefore the chance that some of the activities will be visible on airphotos, as on the Ameland airphotos, is rather small. One such area was found in the Enschede case study region: a districts scouting terrain of 13 hectares, composed of heath and woodland and one small building, that was interpreted as summer home, but appeared to be the scouting clubhouse. Re-interpretation did not reveal any criteria by which the function of this terrain could have been identified. See figure 2.14. at the left.

Not only that camping-grounds and their different components can be identified as such by airphoto interpretation, but airphotos can also be used to verify whether regulations that have been made with respect to proper management of such terrains are effectively applied. Dodt and Van der Zee (1984) illustrate this with the example of a camping terrain at the Baltic coast, that has been photographed on 19-6-1975 on a weekday outside the holiday season at scale 1:10 000 in false colour. The first step is a mere inventory of the number of units (=tents and caravans) on the camping area, as well as the number of vacant places, the average area available per unit, the size of the parking place, playgrounds, greenery and the provision with sanitary and other facilities. An occupation density can be calculated.

It is observed, that a distinction between units according to type (tent, caravan, camper) and size is not too difficult, at least not on this scale and type of photo, and that only on camping-grounds with numerous shade trees the counting accuracy may become less satisfactory. No mention is made, however, of the actual accuracy rate of the interpretation.
In addition also a qualitative categorization of the camping can be made and by applying data obtained from sample enquiries or normative occupation rates per unit the number of visitors can be estimated and a gap in the tourist statistics be filled.
Especially on false colour also the condition of the vegetation can be assessed as well as its special character, for example as fences. By studying images of weekdays outside the holiday season an estimate between permanently occupied units and available places for touristic units can be made.
Such specific studies, however, almost imply the use of airphotos that are specifically made for this purpose, and that, when restricted to the use of existing coverages of airphotos, some objectives may not be satisfactorily met. The costs of such special airphotos, including the costs of interpretation and elaboration, then have to be balanced against the costs of obtaining the information wanted by other means.

All in all, the various case studies indicate that an inventory of camping-grounds can be done rather completely and consistently by airphoto interpretation, though not with a 100% accuracy everywhere. Indicating the location of the camping-ground relative to other facilities, settlement and infrastructure, as well as to resources, is no problem at all. Delineating the extent of camping-grounds can be done fairly precise. In the context of land evaluation no cadastral or photogrammetric precision is required.
Thus, objective 2 can be answered positively. Objective 1 can be answered positively especially when *camping* is considered as a land utilisation type, but often also the relation to other recreational land utilisation types is clear.
For establishing occupation rates on camping-grounds field observations have to be synchronized with the airphoto flight. Such a study can not be done with reasonable results with already existing photography.

Second homes.
Especially when people like to revisit the same recreation area away from their home settlement time and again, they may find the need to have a fixed place of their own to stay there whenever they like. By obtaining such a foothold they are more or less tied to a restricted area, but on the other hand also always assured of a place to stay and often more comfortably.
Second homes come in a large variety. A second home is defined as any overnight accommodation that someone keeps permanently for himself or his family in addition to his primary home with the objective to stay there temporarily whenever he pleases. They may be simple structures, built by individuals in or near their favourite recreation area and originally not designed to be used as permanent residence. But they can also be luxury modern bungalows or villas, that are perfectly suitable for primary residence as well. They can be small farm buildings or farm labourers houses that have lost their function and are taken over by urban dwellers for recreational use. The second homes that are built as such may occur individually dispersed over the countryside, or concentrated in clusters of recreational settlement. They may be used by the owner and his family only, or they may be commercially rented to third parties.
Included in the definition of second home are also garden houses, tent houses, stationary caravans and tents, abandoned motorbuses, train or tram wagons, house boats or other boats. (Van der Zee, 1971; see also, Maas, 1971; Clout, 1976; Patmore, 1983).
With such a large variety of types it is difficult to give standard criteria for the interpretation of second homes. For those that occur grouped in complexes it may not be too big a problem. But for those that are individually dispersed it is less easy to distinguish them from other buildings in the countryside that have different functions.
In order to really assess the possibility to consistently interpret this category a complete information of the actual location of second homes should be available for comparison. For

the municipality of Weststellingwerf in Friesland, the Netherlands (see also figure A.1. in the Annex), such information was available on a map for the situation in 1967, and this could be compared with the interpretation of airphotos of 1962 and of 1967 (Van der Zee, 1971). This example will be presented in some more detail. In addition, other examples will be discussed.

Second homes in Weststellingwerf, the Netherlands.

Of 47 sites occurring on the map of the 1967 the situation could be studied in the 1962 airphotos. Of course in 1962 not all of these sites need to be second homes yet. With respect to building style 15 places were identified as (former) farm buildings, that is, the roof of the barn is clearly higher than that of the residential part, and 32 places as (former) land labourer's houses or other houses. With respect to location only 5 were found in a village, 24 along a road, 8 connected to the road by a short access lane and 15 at a larger distance from the road at a long access lane or sand road.

Of the 47 second homes that were studied on the 1962 photos 34 also occurred on the photo coverage of 1967. Comparison of the two sets is somewhat difficult however because of the difference in scale (1:25000 to 1:8000) and season. The photos of 1962 show the trees in full leaves, that may obscure some detail. The 1967 photos are from March with still leafless trees. Therefore, when comparing the sites, some differences may be the result of real changes in the course of the time, but some may also have to be attributed to the fact that in the larger scale features can be observed that in the smaller scale are overlooked, or to differences caused by the difference in season. Still, some criteria could be found to distinguish the second homes of 1967 from their neighbouring non-recreational buildings. The lack of abundant barns and sheds and the presence of a well-kept yard that gives the impression of a smooth lawn or nice flower garden are some of them. The absence of irregular spots of different tone, that near still functioning farms indicate the sites where the silage pit or dung hill has been, is another one. Some sites show these characteristics in both situations, some only in the 1967 situation. Unfortunately these criteria cannot be used to consistently interpret second homes in this region, because they are not found at all places that are known to be second homes, and they do occur on places that are known to be not second homes. The characteristics mentioned are all an indication for the disappearance of the agricultural function of a site. For some places this change in function can be so recent that this did not yet bring about changes in building and yard. For other places the loss of agricultural function not necessarily implies that they have changed into a recreational function. Change into primary residence is another possibility that may occur. (Van der Zee, 1971).

There seems to be no real possibility in this case to establish criteria with which consistently second homes can be differentiated from buildings with other functions.

Summer homes in central Ameland, the Netherlands.

In the case of central Ameland, what has been interpreted as summer homes or cottages are structures of a more or less normal house size, but located outside the nucleated settlements. They can be distinguished into two types. The older ones are built on former common land on the inner side of the coastal dune belt that has been divided amongst the farmers who had a share in it. These farmers were glad to sell it because the land had only marginal value for agriculture. Some of them were more aware of the recreational value than others. They sold the land in small lots, whereas others sold all theirs in one lot. This explains the difference in density in the pattern of summer homes. Since construction was done as private enterprise and not all at the same time, different building styles are present. See figure 2.15. The newer summer homes, constructed after the second World War, are all of the same bungalow type in neatly laid-out bungalow-parks that are probably associated with, at least adjacent to, camping-sites. (Van der Zee, 1973). See, for example, figure 2.12, below left: (B).

Second homes in Loosdrecht, the Netherlands.

In de Loosdrecht area a lot of houses can be seen on the narrow strip of land that is left over between the lakes. Because of their location, no doubt primarily chosen because of the watersport -be it sailing, motor boating or angling-, in the interpretation it has been assumed that they are second homes, although a function as permanent residence can not be

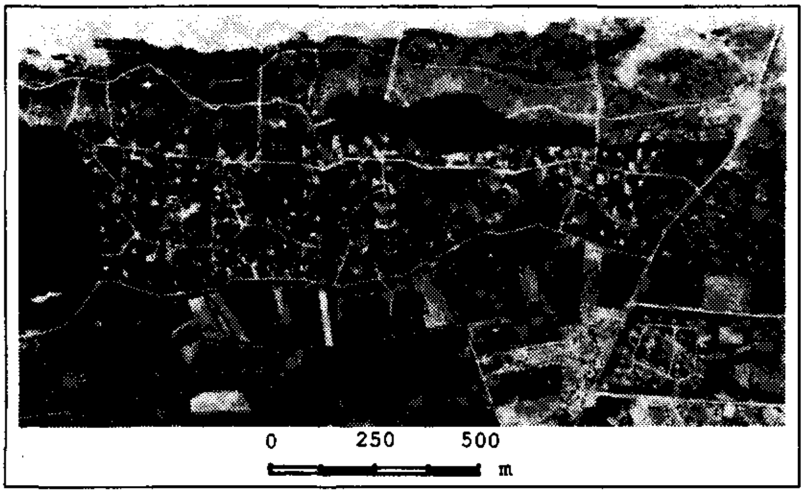

Figure 2.15. *Summer homes on Ameland.*

excluded. The same applies for the houseboats that can be found in the area. Most of the second homes have a small jetty or landing stage to moor a boat, see figure 2.16, below right. The orientation of the private homes in certain places indicates that the recreationally important stretch of water is on one side of the narrow strip of land only. The location of some of the houseboats suggests that they are there only for the winter season. In addition to these individual second homes a complex of bungalows can be clearly identified. Whether they are individual property or are for rent can of course not be deduced from the airphotos.
In one part of the area the landscape consists of a waterbody separated by a strip of land from the main lake, but having access to it by a number passages. In the waterbody itself are a large number of very narrow ribbons of land, left-over after the peat digging in a previous century. It provides an intimate scale of landscape for residence. Thus the area is ideally suited for those who love watersports and therefore want a base from which to operate near the large water surfaces, but at the same time sheltered with respect to wind and waves as well as to the views of fellow recreationists. On the narrow strips of land numerous private second homes, houseboats or caravans can be detected. At some places platforms can be seen on which in summer caravans will be placed, that in winter are stored somewhere else. The fact that access is only possible by boat is a strong indication of the recreational function of these structures. For primary residence the requirement of at least good accessibility by motorcar is assumed. (Van der Zee, 1973). See figure 2.16, upper part.

Second homes in the Enschede area.
The assessment of the accuracy of the interpretation of summer hómes or second homes in the case study area of Enschede is no easy matter at all. In the interpretation there were 15 summer homes, in the field 11 were counted, but in only four cases interpretation and field observation concerned the same building. A small building in a somewhat remote location, away from the main roads and in a forest or forest-edge setting were the main criteria for the interpretation of summer homes. In 15 cases these criteria led to the interpretation of a summer home, in a number of other cases this interpretation was made with less certainty and not excluding the possibility of other functions. A number of summer homes was missed in the interpretation because they were obscured by trees. In only a few of these cases re-interpretation revealed that they are visible on the airphoto after all, so that the interpretation could have been a bit more accurate and complete but certainly not 100% .
The criteria for the interpretation of summer homes appear to be not really exclusive and it is no wonder that in reality the interpreted objects are found to be (allotment) garden sheds, horse stables, club houses of dog training or scouting associations and the like. On the other hand, also in the field it was not always easy to establish whether a certain building was a second home or not. Typical summer homes are small wooden cabins located in woodlots away from the main road, but some of such structures appear to be permanently inhabited.

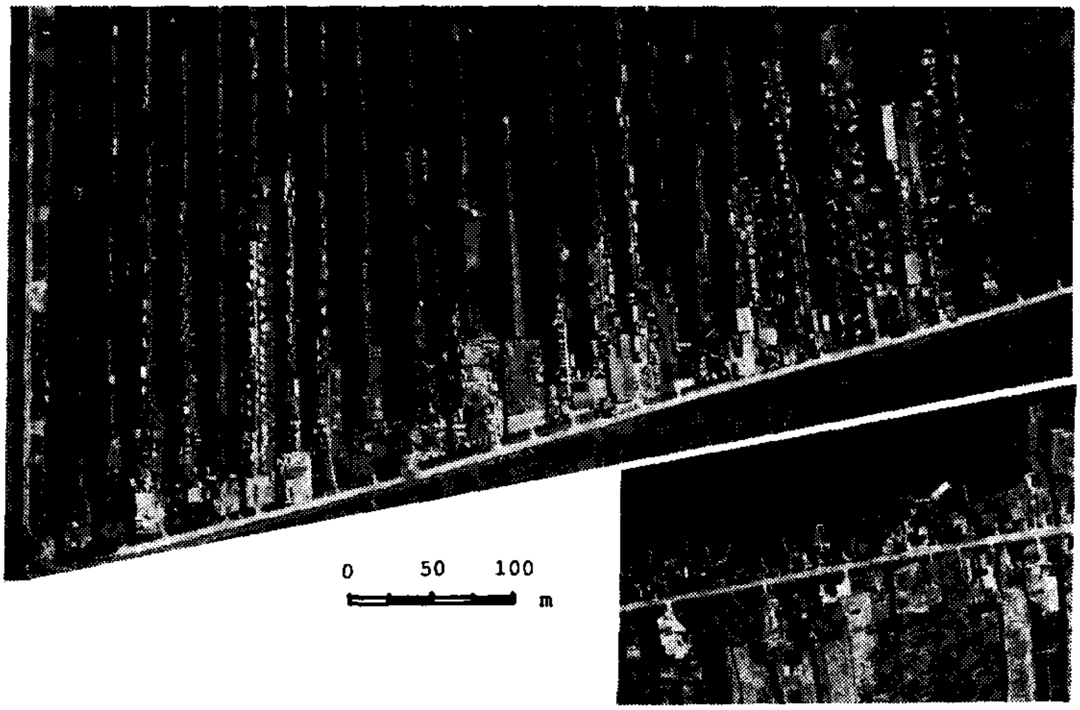

Figure 2.16. *Second homes in the Loosdrecht area.*

But second homes may also occupy the buildings of a former (small) farm and then are hard to distinguish from primary residence in the same type of building. If during the field observations on a normal weekday in November signs of actual inhabitance were observed, it was concluded that the house was permanent residence. It was not always possible to verify, but some interviews revealed that indeed many (former) summer homes have turned into primary residence. In many of such cases the interpretation criteria for second homes are still valid, only the function has changed. Almost half of the interpreted second homes were found to be permanently inhabited.

When considering only the definite summer homes in the interpretation and in the field, the accuracy of the interpretation is very low: 27% of the interpreted cases is correct, 36% of the cases observed in the field are correctly interpreted. If the interpretation of possible summer homes is taken as correct too and the uncertain summer homes in the field considered as certain, these percentages increase to 33% and 75% respectively.

If also the permanent residence in former summer homes could be considered as correct interpretation then 61% of the interpretation is correct. Still, not a very high accuracy. Of course, with such small numbers not too definitive conclusions can be drawn. And the matter can be also viewed from another direction. Although the number of summer homes correctly interpreted as such is not high, only a few were completely missed in the interpretation. And none of them has been interpreted as a farm or a permanent house, but always as something special. Thus the objects that, in the context of the interest in this specific topic, would deserve special attention during the field observations have been almost completely indicated in the interpretation.

Recreational settlement at Lake Proserpina.

Where individual second homes in the countryside may be difficult to identify as such, it becomes easier when they are grouped together in a recreational settlement. The case of Proserpina, near Mérida in south western Spain, gives a good example of how a recreational settlement can be distinguished from a normal settlement by means of airphoto interpretation. See figure 2.18.

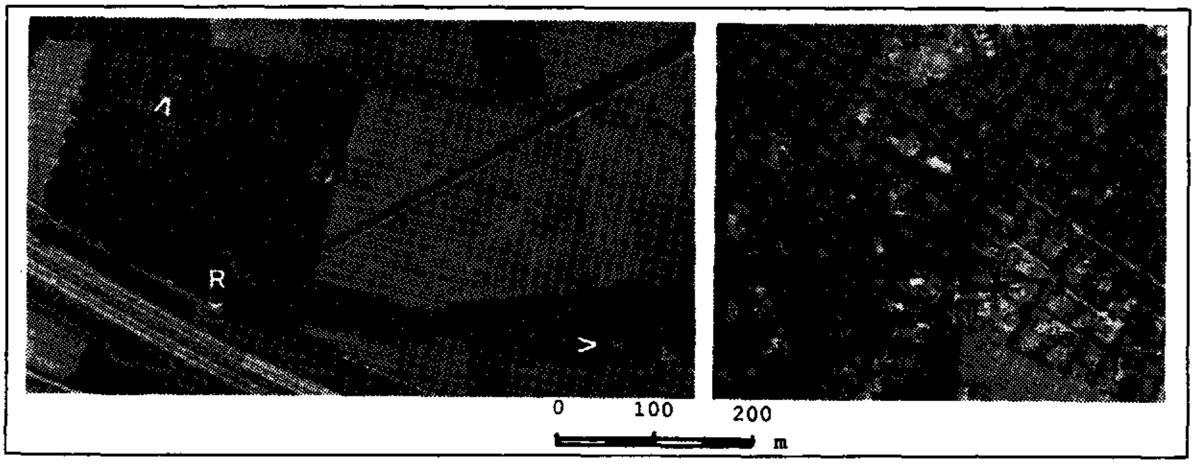

Figure 2.17. Examples of second homes on the Enschede airphotos.
Left, some isolated houses in the woods, (R) appeared to be permanent residence, the others (>) were second homes; the diagonal linear feature is an abandoned rail road. Right, a concentration of houses in the woods, originally second homes, but the majority has become permanently inhabited.

In the off-season the settlement is somewhat abandoned. With only a few exceptions the houses are second residences -*chalets* or summer homes- belonging to people living in Mérida or Badajoz, the two major cities in the region. Because people live here only during weekends and in the summer, there is no real church, no school and no shops. It also explains why the settlement does not appear in the census nomenclature.

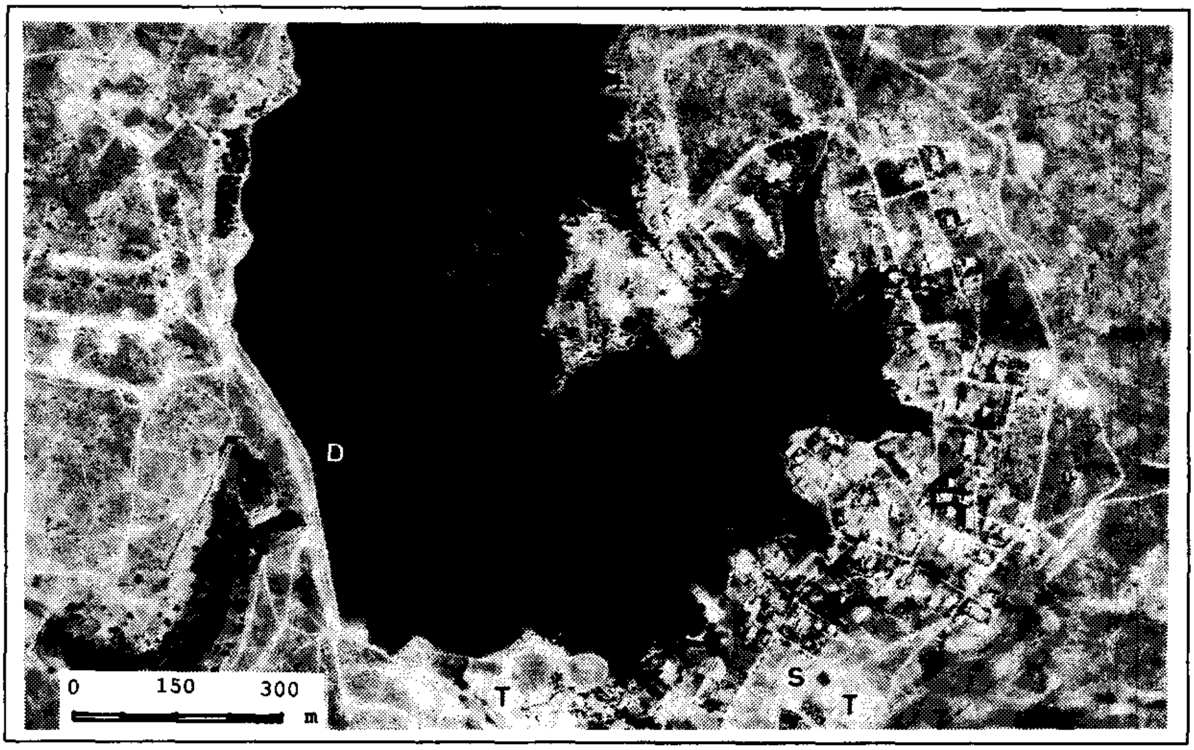

Figure 2.18. *The recreational settlement at Lake Proserpina.*

The settlement, located on the shores of Lake Proserpina, an ancient Roman reservoir (D = the Roman Dam), is rather new. It did not appear on the topographical map of 1941 nor on the aerial photographs of 1956. It also does not appear in the nomenclature of the population census of 1970. Comparing the settlement with other settlements in the region by airphoto interpretation made clear that it was a very special type of settlement. The lay-out is very spacious; there are no compact streets along which houses are aligned side-by-side, but single houses standing in the centres of large lots, surrounded by fences or walls. There are no disorderly backyards with numerous sheds, chicken houses, donkey stables and the like, but nicely laid out gardens and often a swimming pool. The houses show various architectural styles quite different from the standard types found in other settlements.

No church could be identified, rather strange for a Spanish settlement. But instead a number of peculiar buildings, apparently having special functions, were found, as well as some secondary facilities such as a large swimming pool (S) and a number of tennis courts (T). See also figure 2.8.

Some second homes were also found in the countryside around Mérida, near the villages or near small streams. Presence of swimming ponds and/or well designed gardens have been used as criterion in the photo interpretation, but appeared not to allow a consistent identification of all second homes, whereas some primary residences showed the same characteristics. (Van der Zee, 1982).

Second homes in Northern Thailand and on Java.

In the Mae Sa area in Northern Thailand many second homes are found. They belong mainly to rich people of Chiang Mai or Bangkok and mostly consist of a nicely built house in a beautiful garden-setting with many flowers (Suwan, 1986; Van der Zee, 1987). As such, some can be clearly identified on the airphotos, see figure 2.19 for some examples, but many cannot be distinguished from other houses or buildings (Van der Zee, 1988e).

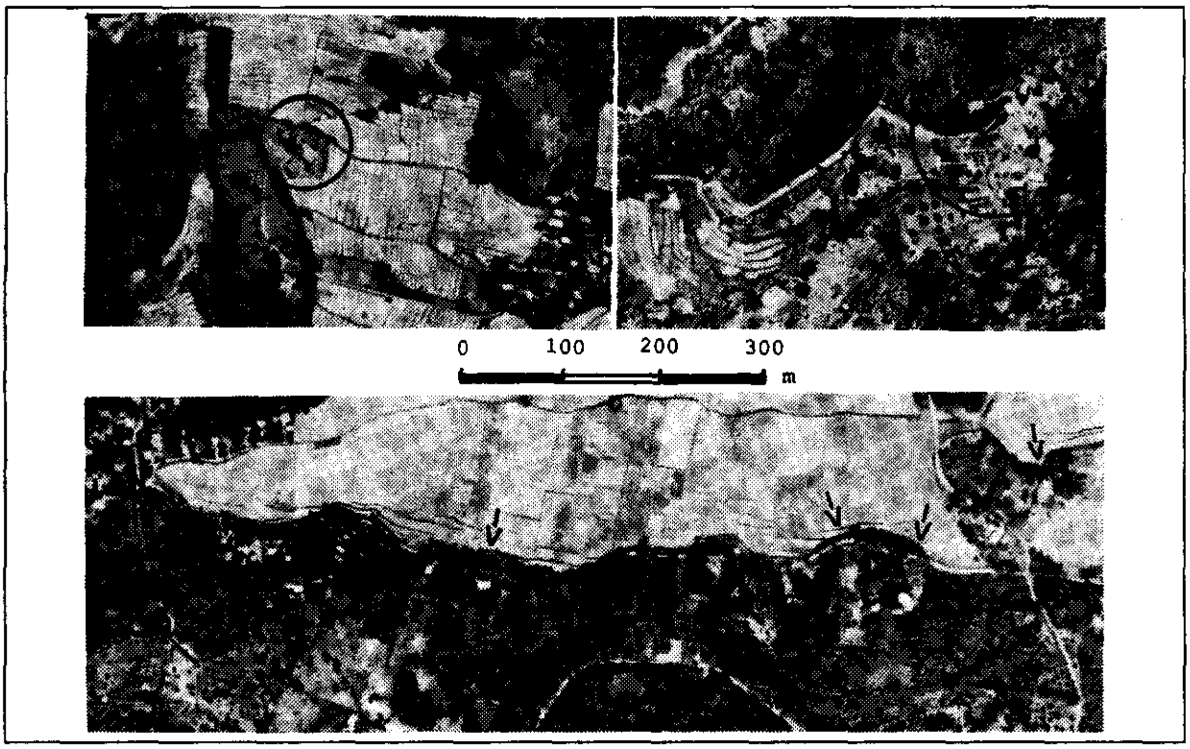

Figure 2.19. *Some second homes on airphotos of the Mae Sa area.*

Also in the Puncak area on Java, Indonesia, many second homes are found, that mainly belong to rich persons from Jakarta, Bandung and Bogor. They are nicely built houses usually in a beautiful garden setting. They are mostly dispersed, but in an increasing degree *resorts* emerge, in which second homes are built and managed in a group by one company together with additional facilities such as restaurants, convention rooms, sport fields and the like, after which the individual units are sold to the public.

In photo interpretation the major problem is to distinguish second homes from luxury primary residence. Most of the single family houses in the area are rectangular when seen from above.

The simplest rectangular shape normally is associated with the less expensive homes. Most of the second homes however are of a complex form. Also they are surrounded by a larger and nicer garden than first homes. Location in the hilly area also is an indication for second home rather than first home. Size and location also serve to distinguish the second homes from small hotels and restaurants, see the discussion of these category. Using the criteria mentioned most of the second homes have been correctly identified in the photographs, with only a few mis-interpretations.
A *resort* can be distinguished from a settlement of primary residence because of the different, more regular, pattern and because a complex of primary residence in overall appearance in the photograph has a lighter tone. This is caused by the lower density of buildings in a *resort* than in a complex of primary residence. As a consequence the gardens and thus the area covered by vegetation is larger, resulting in a darker overall appearance in the airphoto. (Adrian, 1991).

All in all it is clear that airphoto interpretation can not be used to make a consistent and comprehensive inventory of second homes everywhere, though on some places it may be more accurate than on others. Even by simple field observation often it is not easy to definitely identify second homes as such. But it is possible by airphoto interpretation to mark all buildings or objects that could be second homes, and in this way make a more efficient field observation programme possible, including interviews with occupants when necessary. Once identified, the analysis of the position of the second homes in relation to recreational facilities and resources can be relatively easily be done with airphoto interpretation. Such an analysis can also give useful inputs in land evaluation, even if the inventory of second homes is not complete.
Thus, even though the question of objective 2 can not be answered positively in this case, airphoto interpretation can still be quite useful. With respect to objective 1, a link with a specific land utilisation type can only be established if *stay recreation* is considered as such.

The interpretation of secondary facilities.

In order to structure the discussion of their interpretability a bit, the secondary facilities have been subdivided into sports facilities, facilities for informal pursuits, and pure entertainment facilities.

Sports facilities.

Identification of a site as being a sportsfield is one step. Interpretation of the type of sport practised on the field is another. Whether that step is possible not only depends on the scale and the quality of the airphoto, but also on the fact whether a field is exclusively used for one sport or not. And of course the interpreter has to be at least familiar with the basic principles of the sports concerned.
Line patterns on the fields may clearly indicate for which sport they are meant. The type of goals or nets are another indication. Thus on airphotos of 1:3000 as well as of 1:10560 scale of an area in the United Kingdom football fields or soccer fields could be clearly distinguished from rugby fields because of the distinct line patterns and of the different type of goals that could be seen in stereo as well as by their shadows. Presence of covered stands or of uncovered stands are indications of the relative importance of the fields. Their location at the edge of a built-up area makes them clearly classify as user-oriented facilities. (Van der Zee, 1973). Football (=soccer) fields can also be recognized if no lines or goals are visible, because of the peculiar pattern of bare spots in the grass cover, mainly in the goal areas and through the centre. An experienced interpreter can even pick them out on 1:50000 airphotos. But in general they are too small to be detected on satellite images, especially when the surroundings are rather complex. Still, in the SPOT image of Bandung, Indonesia, presented in the case study by Pollé (1988) one large and two smaller stadiums can be detected, because of the contrast between central grass field and surrounding building structure.

Sports fields in the Enschede area.
In the Enschede case study 18 areas of sports fields, single fields or in complexes associated with parking lots and clubhouses (57 ha in total), were interpreted correctly. One single field was missed in the interpretation, a small new extension to a sportsfields complex was not yet present at the time of the airphoto and two fields had disappeared since, but their existence at the time of photography could be verified. In number of areas correctly identified this means an accuracy of 95%, in number of hectares identified correctly even 97%.
Many of the fields could be identified as football (soccer) fields, but also quite a number of fields was less distinct as to the relation to the sport. Also hockey and korfball fields are present and many fields have a multi purpose use. One complex could be clearly identified as a baseball field by the peculiar pattern.
A stadium complex with associated parking lots and buildings was, of course, unmistakably identified.
Also in this case study the majority of the fields and complexes is located at the fringe of the built-up area and thus can be classified as user-oriented. Some single fields are associated with camping grounds, thus still user oriented.

In the 1:3000 UK airphotos also some other fields of smaller size are present. In some of them the line patterns are clear and reveal that they are tennis courts and outdoor basketball fields. This helps in identifying the fields on which for one or the other reason the line pattern is not clear. In some tennis fields even the nets are visible because of their shade. (Van der Zee, 1973). In the Proserpina case study tennis courts were identified, even though the line pattern was not too clear, because of the nets and their relative size and also because they occurred grouped together in clusters. See also figure 2.18. However, some individual tennis courts near second homes were identified as well.

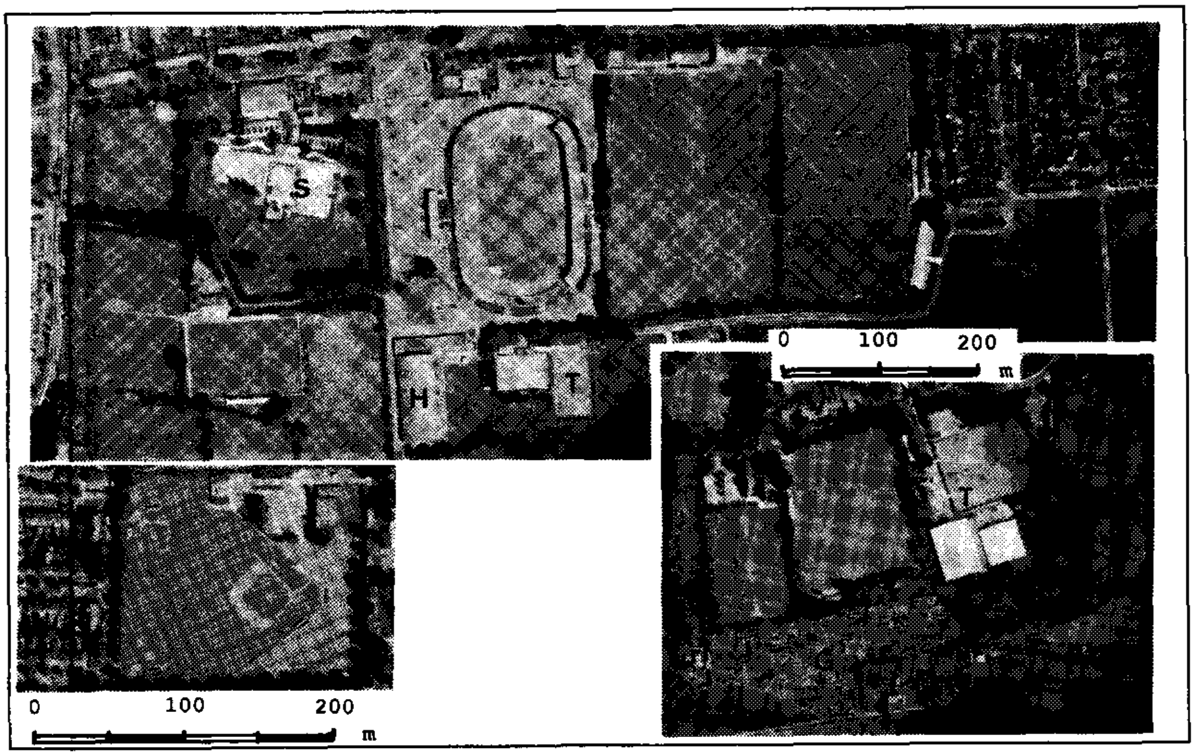

Figure 2.20. *Examples of sports fields and tennis courts on airphotos.*
At the top a complex of sports fields with a stadion, a sports hall (H), a swimming pool and hall (S) and tennis courts (T). Below right, a smaller complex of sports fields with a complex of tennis courts and a tennis hall (T), adjoining a complex of allotment gardens (G). Below left, a typical baseball field is a piece of cake for the experience interpreter.

Tennis courts in the Enschede area
Also in the Enschede case study tennis courts were identified. A few single fields, associated with large houses in the countryside and obviously private, but mostly grouped in complexes associated with parking lots and a clubhouse. However, also quite some tennis courts were missed in the interpretation. That is, they have been interpreted as sports fields in general, or as associated parking lot, but not as tennis field.
Out of seven areas, four were interpreted correctly, three were misidentified. In terms of hectares the accuracy is only 50%. Also the three tennishalls in the area were not identified as such on the airphotos, but rather as industrial halls.

Swimming facilities.
Swimming facilities can be specially constructed swimming pools, swimming basins that are separated from but in contact with open water, or just simple demarcation lines setting apart a section of a waterbody for swimming and bathing. They can be large, public swimming pools, or small private ones.
Small private swimming ponds normally can be seen in airphotos as small dark circular, rectangular or in some cases irregular features, waterbodies, surrounded by a very light rim, the concrete edge. Location in a garden of a house or a villa adds to confirm the interpretation. (Van der Zee, 1973). In the Proserpina case study many of such swimming ponds have been identified. In addition also a large swimming pool was interpreted, because of its rectangular shape within which a gradual transition from dark to light grey tones representing the change in water depth in the basin, see figure 2.18. This is a feature that is commonly observed also in other cases. The stereo effect often also helps to identify the basin of a swimming pool, even when there is no water in it in the off-season.

Swimming pools in the Loosdrecht and Enschede areas.
In the Loosdrecht area several swimming basins in the lake can be detected. Very clear light-toned straight features separate the basins from the lake and from each other. Larger light-toned areas are paved terraces. Some small service buildings are associated. In one case one basin clearly has a shallow part as reflected by the lighter grey tone in the airphoto.
Floating lines used as demarcation of swimming sections of a larger water area may be detectable in airphotos and are often associated with a sandy shore line. In the Loosdrecht area such a demarcation could be observed on 1:17000 scale airphotos. (Van der Zee, 1973). See also figure 2.7.
In the Enschede case study area five swimming pools were interpreted and correctly so, and in the field no swimming pools were encountered that had been missed in the interpretation. Therefore a 100% accuracy score for this category. Apart from one big swimming pool complex adjacent to the stadium, figure 2.20., the other pools are all associated with a camping ground. See also figures 2.9., 2.13. and 2.14.
Several small private swimming pools were also interpreted, but because they were not all accessible for field checking no accuracy analysis can be made.
For the only swimming hall in the study area, figure 2.20., no conclusive criteria could be found to identify it by airphoto interpretation.

Some other facilities.
On a stereo pair of airphotos of 1:5000 scale of an area in the United Kingdom there is no mistake possible in the interpretation of a golf course or golf links, presuming of course a certain basic knowledge of this sport. See figure 2.21., top left. Neatly short-cut *greens* are associated with the bright white spots of the sand *bunkers* and areas with more rough grassy vegetation as well as some small (dark toned) ponds and trees and shrubs. Even a group of players can be seen as they move along. Their position has shifted when comparing one photograph of the pair to the other. (Van der Zee, 1973).
Also on other airphotos golf courses are easily identifiable. Even on satellite images they can be detected because of their peculiar pattern of areas with diffrent reflection characteristics. For example the SPOT image of Bandung, Indonesia (Pollé, 1988), or the SPOT and TM data of Johannesburg, South-Africa, presented by Malan et al. (1988). In visual interpretation they can

be picked out rather easily, but attempts to supervised classification, leave alone automatic classification, are bound to fail because of the complexity of the pattern.
A mini golf course or midget golf course is such a peculiar facility that it can be easily identified on airphotos of not too small a scale, provided of course that the interpreter has a basic knowledge of this type of facility. The holes and associated obstructions are often incorporated in slabs of concrete that are laid out in a garden-like surrounding. On airphotos they show as light-toned elongated spots without stereo height.
In the Enschede case study one was correctly interpreted, associated with a restaurant and playground. In the case of central Ameland one has been identified on 1:18000 scale airphotos, see figure 2.21., top right (4x enlarged).

The skeet or trap shooting ranges (*tiro al plato*) at the southern shore of Lake Proserpina (Van der Zee, 1982) could not be identified by airphoto interpretation because of lack of specialist reference knowledge. But they had been marked as a peculiar feature that needed field observation, because no other function could be thought of. See also figure 2.8.

Two skating rinks, grass covered areas that can be flooded in winter to create an ice surface, are found in the Enschede study area. One was interpreted as such on the airphotos. The other was known, but on the airphoto no clues could be found that would make identification by interpretation possible. With such a small sample it makes no sense to state that the accuracy thus is 50%.

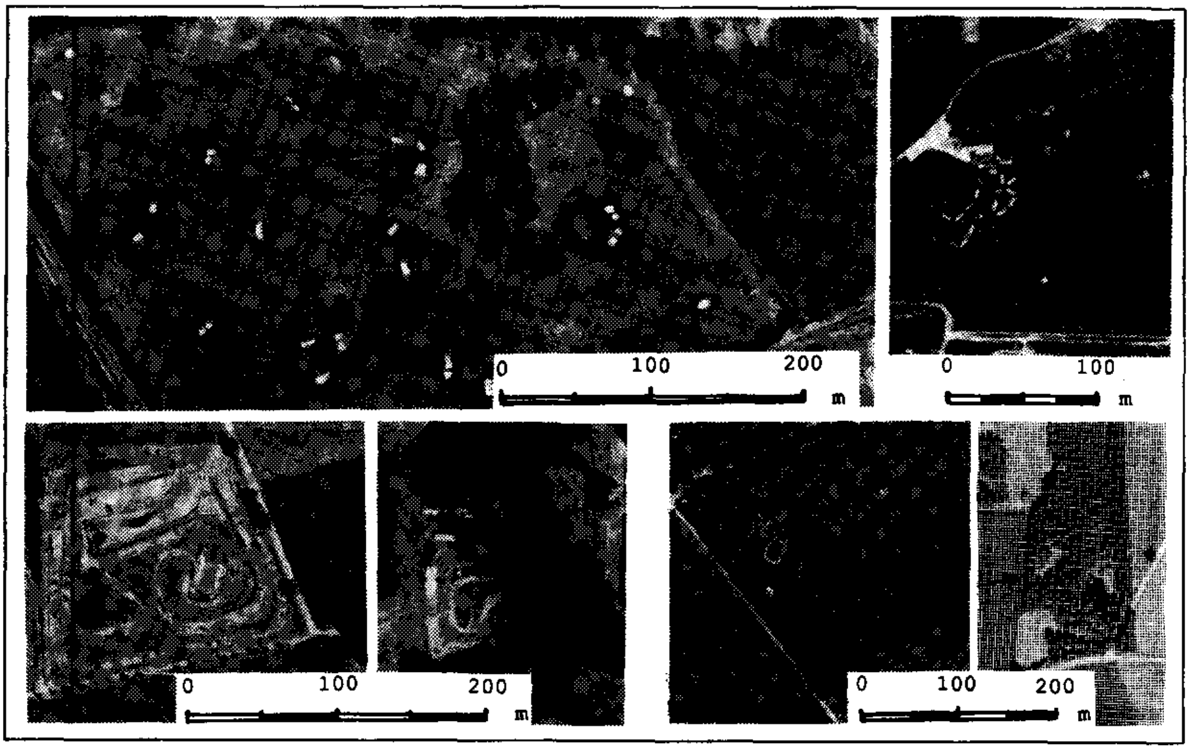

Figure 2.21. *Some other recreational facilities on airphotos.*
Top left: a golf course; top right: a mini-golf course; below left: to the left a motor-cross terrain, to the right a cycle-cross terrain; below right: two dog-training terrains, the club houses indicated by arrows, the terrain at the left was identified as such by airphoto interpretation.

One terrain for motor crossing and one for bicycle crossing were interpreted and correctly so in the Enschede study area. See figure 2.21. below left. Also the motor-cross terrain that had been identified on the airphotos just north of Lake Proserpina in Spain could be verified in the field. The peculiar pattern of the tracks is decisive in the interpretation.

Dog training terrains in the Enschede area.

Dog training apparently is a popular sport in the Enschede region. One terrain for the dog training sport was identified on the airphotos, because of the peculiar path pattern along some obstacles and its location away from settlement in a woody-heathland setting, see figure 2.21., below right. But five more areas were found in the area that had not been interpreted as such. Thus only an accuracy of 17%, or 32% if the hectares involved are considered. In the re-interpretation one of the terrains showed visible features such as small obstacles that might have made correct interpretation possible but that were overlooked the first time. On three of the terrains a small building was interpreted, not as a clubhouse but one as residential and two as recreational buildings in all cases not definitive but with a question-mark added. A fourth building in re-interpretation appeared to be clearly visible on the airphoto but was simply overlooked the first time.

Horse riding facilities in the Enschede area.

Also horse riding is popular in the Enschede area. Many indications can be found for it on the airphotos. Some small bare or sandy fields with high board fences around were found. Other grassy fields had oval or circular worn-out tracks evidently referring to horse training practise. Sometimes the obstacles for horse jumping could be observed. But then, in the field, one year after the airphoto had been taken, such horse-riding fields could be found on a slightly different location. Apparently they are sometimes incorporated in the farms rotation scheme. Also many more of such fields were identified in the field than on the airphotos, and even after re-interpretation no conclusive criteria could be found for their interpretation. The same applies for the many horse stables, some of which could be interpreted because of associated features, but many more were missed simply because of lack of peculiar criteria.
In addition, such facilities may pertain to both commercially operated horse riding centres as well as to private persons practising this sport or hobby.
Thus, it is concluded that airphoto interpretation can not serve to get a decent inventory of this type of facilities. It only served to bring to the attention that this recreational activity might deserve some attention in a land evaluation.

It is clear that no general conclusion can be drawn on the interpretability of sports facilities. Some types of facilities are so commonly known and/or have such characteristic features that they cannot be missed in interpretation. Other types require a lot more specialist reference level and some are simply not very conspicuous. How much is missed and how seriously that will affect the land evaluation will depend from case to case.
Despite the shortcomings of the airphoto interpretation approach in this respect, it still may be useful to get a first impression of the availability and especially the spatial distribution of various types of facilities in this way, before deciding on other ways of obtaining the information needed.
Thus the question of objective 2 has been answered with this conclusion, be it not in all cases positively. Since it is also clear to which recreational activity, thus land utilisation type, the different facilities are related, also the question of objective 1 can be answered positively in this case.

Facilities for informal pursuits.
Watersport facilities.

Although the name may suggest otherwise, watersport activities are mainly of an informal kind, and therefore their facilities are included in the category of facilities for informal pursuits.
Facilities for watersport predominantly comprise all kinds of structures meant for mooring and storing boats. For that reason they might also be included in the category of accessibility infrastructure, just as for example parking places. But because in the case of watersport it directly concerns a recreational activity, that has not been done.
The facilities can be subdivided into the small, individual facilities and the large, public or commercially operated facilities.

Watersport facilities in the Loosdrecht area.
In the Loosdrecht area, the many complicated jetty systems or marinas, clearly identifiable on the airphotos, are an indication of enterprises concerned with boat-renting or with the renting of lying-sites for private boats. These facilities are designed to moor a large number of boats on a small area while at the same time providing shelter against the prevailing wind direction. see also figure 2.7. In summer the boats are moored in these marinas, but in winter most boats are stored ashore either in the open, where they can be seen in the airphotos, or in a boat house. Many of these boat houses can be recognized in the airphotos. Not all of them need to be ashore, some of them are merely covered mooring sites, having the possibility of lifting the boats out of the water in winter.
Private boat houses are small, only having place for one or two boats. In one case a boat house combined with a garage under one roof could be identified on the airphoto because of the entrances. Individual second homes or permanent homes each have their own small jetty, see also figure 2.16.
In some lake areas artificial islands have been constructed to provide extra mooring facilities for watersports. An example of that can be seen on the airphotos of the Loosdrecht area. Its shape clearly indicates that it is artificial. The intricate configuration makes it possible to find a lee side under all wind directions and also creates a kind of protected harbour. The single building on the island will have some sanitary facilities. (Van der Zee, 1973).

From this and other case studies, that will not be discussed in detail here, it is concluded that in the interpretation of most types of watersport facilities sufficient consistency and completeness can be expected. Only the storage of small boats and windsurf boards on private yards or in private sheds may largely escape interpretation. For the purpose of land evaluation for watersports this may not be too much of a problem. More important is that with airphoto interpretation better than with any other means of inventory an overview is obtained of the location of the facilities relative to other facilities and infrastructure and especially to the resources.

Walking facilities.
Walking is one of the most popular recreation activities, that need very little infrastructure. The infrastructure that is used moreover needs not be exclusively for recreational use. Recreation is just one of the joint users or co-users of a multipurpose infrastructure. Therefore a large part of the accessibility infrastructure may also be more or less suitable for this activity. Whether and how much it is really used for recreation, in this case walking, cannot be assessed by airphoto interpretation. In addition it has also to be taken into account that on multi-traffic infrastructure the different uses are not always compatible. Walking is not pleasant on country roads with busycar traffic. Also this can not easily, if at all, be assessed by airphoto interpretation.
Still, there are instances in which path networks can be identified, also on airphotos, that mainly, if not exclusively, serve recreational purposes. Where straight paths in forest areas can still be primarily meant to serve forest exploitation and management, more curvilinear paths may be interpreted as being recreational. Whether they can be detected on airphotos depends on their width, the type of forest, on the scale, but especially also on the time of photography.
On a pair of airphotos of 1:5000 taken in April somewhere in the United Kingdom in a patch of forest winding and curving paths can be clearly seen through the then still leafless tree crowns. (Van der Zee, 1973).
But in the Enschede case study area in several cases footpaths in forest areas could not be interpreted on the airphotos. See figure 2.22. In figure 2.13. a footpath could be detected on the airphoto (<) connecting the camping-ground to the nearby nature area in which also some paths are visible. But in most cases in which paths were identified on the airphotos, they could not be found in the field, or they appeared to be firebreaks, closed off for visitors by wire or fence. Therefore the few cases in which paths were identified correctly have to be considered as just incidental. A consistent interpretation of the footpath network in the countryside does not appear to be possible.

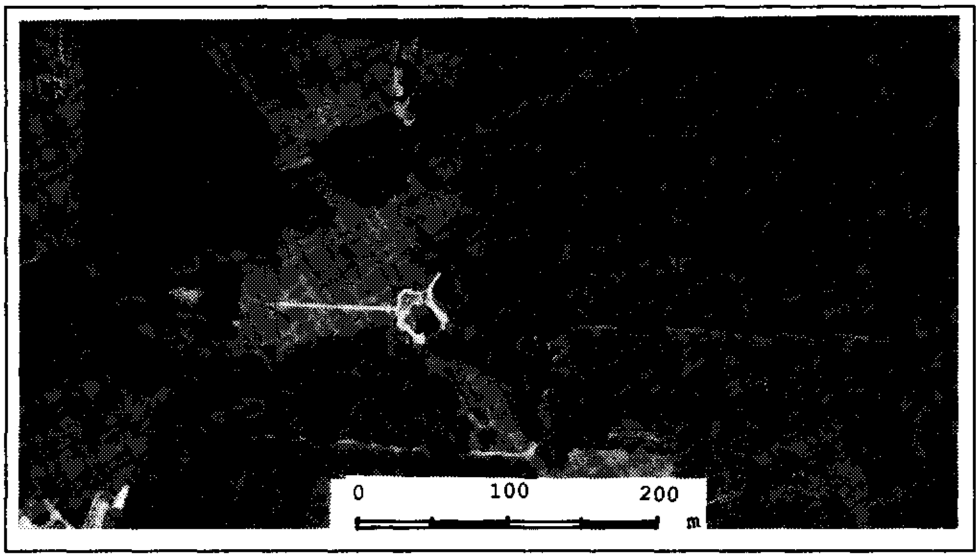

Figure 2.22. *Walking facilities on an airphoto.*
On the terrain of the mansion in the centre, walking is allowed on roads and paths, but only few of them can be detected on the airphoto.

Visitor attractions.
Of the objects that are attractions for a visit, this attractiveness may not be deduced by airphoto interpretation, neither whether visitors are allowed. But when the objects themselves are quite well identifiable, their recreational attractiveness and use then have to be determined by a field visit. Airphoto interpretation in this respect then can reduce the amount of fieldwork necessary for an inventory. But, it has to be admitted that many of these objects are also indicated on the topographical map, as well as on all kinds of touristical maps, for example that by Karssen (1986).
In the Netherlands, windmills are among the objects that are often worth a visit, either just to look at them as an element in the landscape or to actually enter them and have a guided tour in them. In most cases it is not difficult to identify a windmill as such in airphotos. In the central Ameland case one was identified in 1:18000 scale airphotos. (Van der Zee, 1973).
And also in the Enschede area there is a clear example. However, from airphotos it can not be deduced whether the windmill is worth a visit and/or whether it allows or even invites visitors. But this can also not be deduced from the maps mentioned.
Towers and churches are other objects for sight-seeing that can be identified without too much difficulty on airphotos. Whether they are really worth a visit can not be deduced either, however.
In the Mae Sa area in Northern Thailand special places such as orchid nurseries and fish farms are objects of visit for tourists that can be easily detected on the airphotos. However, other places with similar characteristics can be found that do not attract visitors. For the elephant camp, a major tourist attraction in the area, no indications can be found on the photos for its exact location and extent. (Van der Zee, 1988e).

Allotment gardens.
Allotment gardens are also included under the heading of facilities for informal pursuits.
An allotment garden is a piece of land that serves the user and his family as an ornamental garden or for vegetable and/or flower production, but is not a part of the house lot. They generally can be found in the rural urban fringe. Exact data on the area of allotment gardens in each municipality are hard to get and often only estimates can be obtained. (IJkelenstam, 1988). For example, for the municipality of Enschede for 1985 one source gave 33 hectares of allotment gardens, another one only 10 hectares. A survey in 1989 also found 33 hectares. (IJkelenstam, 1990).

On airphotos they can be relatively easily identified, however, because of their characteristic pattern of very small fields, which they have in common with nurseries, associated with a large number of small structures: toolsheds, which make them distinct from nurseries. In the Enschede study area 21 allotment garden complexes with in total 25.8 hectares were interpreted on the base of these criteria and correctly so. Only two areas (0.8 ha) had changed function since the time of photography, and one area of 0.3 ha was not interpreted. A mis-interpretation of only 1% of the total area of this category. That not 33 hectares were found can be caused by the fact that not the whole municipality was included in the photo coverage.

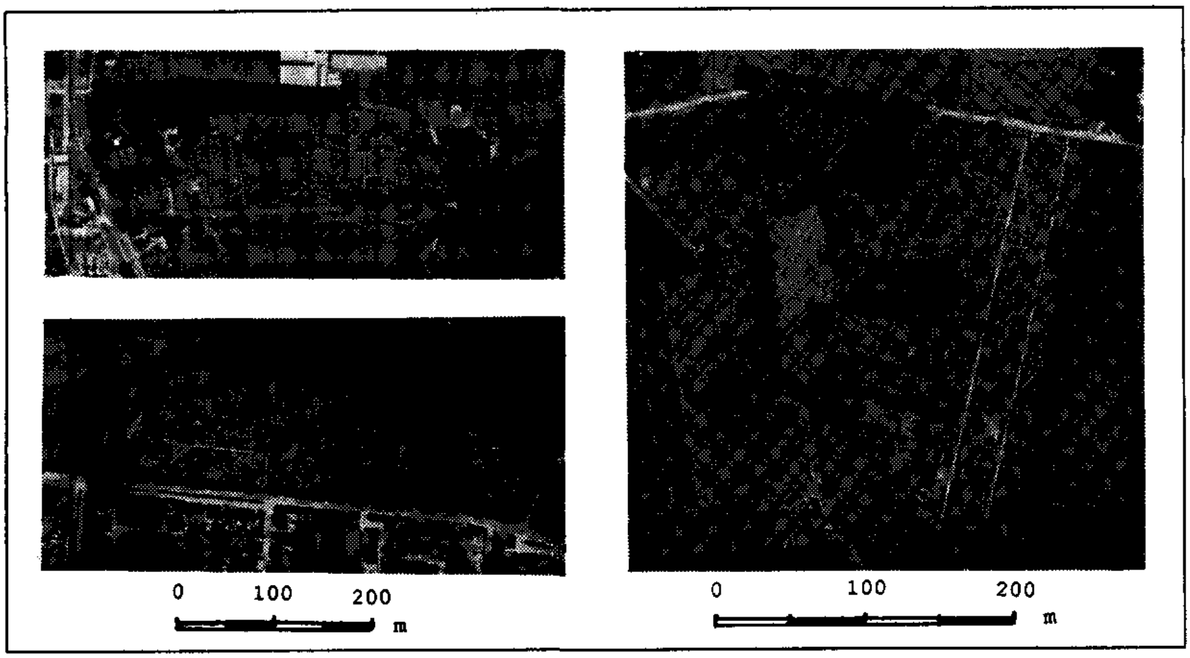

Figure 2.23. *Allotment gardens on airphotos of the Enschede area.*
To the left, the original scale of the airphotos; to the right, 1.5 x enlarged.

Only in one allotment garden complex in the Enschede case study area a number of caravans was identified, that could be used for overnight accommodation. Whether they were indeed used as such could not been verified. For the rest no overnight accommodation was encountered in any of the complexes around Enschede. This confirms the observation by IJkelenstam that overnight staying on the allotment garden is hardly of any importance outside the Randstad area and is concentrated there in Amsterdam and Rotterdam. (IJkelenstam, 1988).

Thus, also on the interpretability of informal facilities no general conclusion can be drawn. The comments given at the end of the section on sports facilities, including those with respect to the objectives, also apply here.

Entertainment facilities.
Many entertainment facilities such as bars, discos, etc. often coincide with restaurants or hotels, but also if they occur on their own they may be housed in a structure of any kind and can not be detected as such. (Van der Zee, 1973).
On a pair of 1:6000 airphotos from the United Kingdom in the corner of a sports centre a children's playground can be identified by the slide that appears clearly in stereo. Other play structures are present and visible, but can not exactly be identified as to what they really are. (Van der Zee, 1973).

In the Enschede case study area in between a hotel-restaurant and a camping-ground a recreation park with a small lake with boats, a big slide, and a number of cylindrical objects - merry go-rounds and such things- was interpreted. May be not all individual objects could be

identified, but the complex as a whole was definitely identified as recreational. See figure 2.9, top right.
Another camping area , see figure 2.24. right, was found associated with a swimming pool (S) with water slide and a big playing lawn with some playground equipment (P), all identifiable on the airphoto. And another hotel-restaurant (R), see figure 2.24. left, is associated with clearly identifiable mini-golf (M) and playground areas (P). The (G) in this figure are the greenhouses of the neighbour.

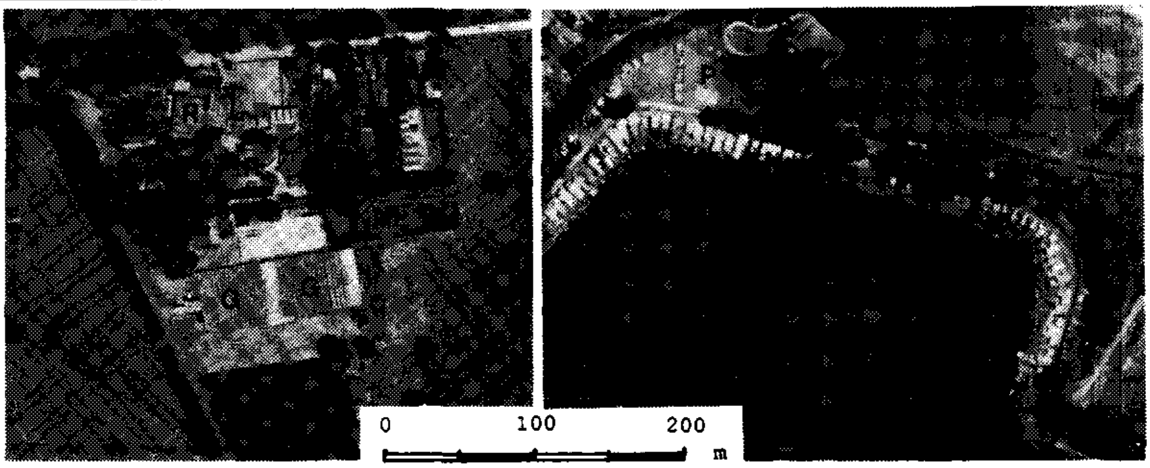

Figure 2.24. *Examples of entertainment facilities on airphotos.*

In these cases the entertainment facilities can be identified on airphotos, but these are exceptions rather than the rule. For this category other means of inventory than airphoto interpretation have to be used.

The interpretation of the accessibility infrastructure.

Examples of Ameland and Loosdrecht.

In the case of Ameland two ferry-dams represent the infrastructure that link the the island with the outside world. See figure 2.25. The smallest one is not functioning any more as ferry-dam, because it is only reachable at high tide. It now serves as yachting harbour. The large dam extends to the deep water also at low tide. This is clearly visible on the airphotos, that were taken around low tide. Three boats are lying at the dam, two of which can be easily identified

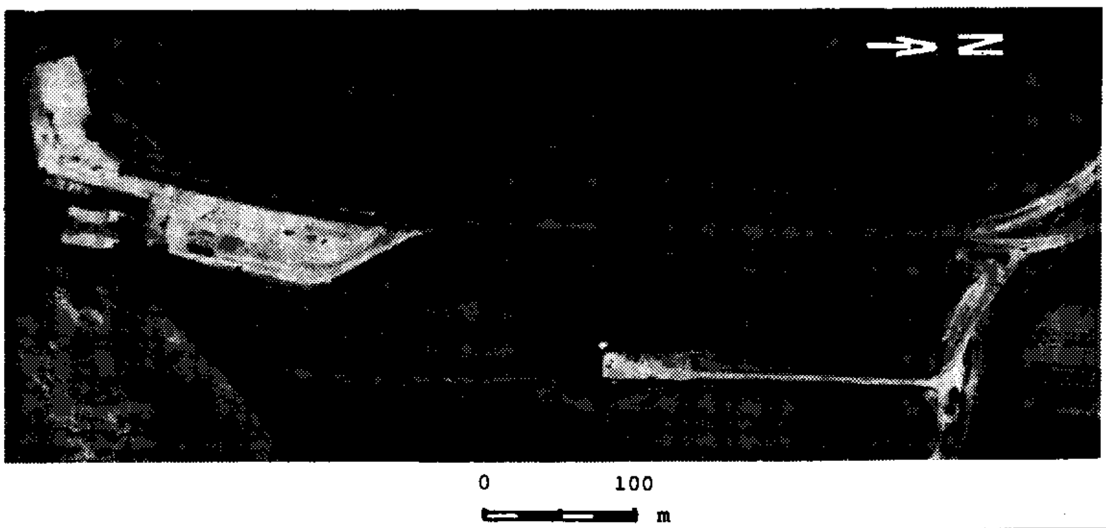

Figure 2.25. *The ferry-dams of Ameland.*

as car ferries by their large open decks. This indicates that the tourist may bring his car to the island. The presence of a large number of cars is also demonstrated by the extent of the paved road system, the numerous parking places, and the fact that the beaches are most crowded at places where they can be approached closest by car. (Van der Zee, 1973).
In the Loosdrecht area the ample parking space, that can be observed on the airphotos near the hotels/restaurants and the marinas, see for example figure 2.7., are an indication that many visitors come by car (Van der Zee, 1973).

The roads of Mae Sa valley.
In the Mae Sa area study (Van der Zee, 1988e) also the aspect of accessibility has been considered. The roads could be rather easily identified and classified with the help of airphotos. The classification was based on the width and the curviness of the roads. Whether a road was paved or not could not consistently be interpreted. Distances were measured on the interpretation map in order to arrive at an accessibility map. The quality of the road was included as a weight factor. The steepness of the road should have been included too -it can be easily assessed by airphoto interpretation- but has not been done because of lack of time. The distribution of the various recreation places can then be analyzed in relation to the accessibility.
Some resorts are located along the road, but some also along (improved) minor roads. The same applies for the special places. They all are easily accessible, and within the study area differences in distance hardly seem to matter. The individual restaurants all cling to the main road and are not found beyond the distance of Erewan resort. For this facility accessibility thus appears to be more crucial than for the resorts. For the second homes accessibility appears to be less essential. They occur along the main road as well as at large distances from it along unpaved, but still motorable, roads. The assessment of accessibility can also be easily expanded to areas not yet developed for recreation in order to establish which zones in this respect would be more or less attractive.

Interpretation of roads on SPOT images.
The use of SPOT images was found to be not very useful for this type of analysis. Both spectral and spatial resolution are insufficient for this purpose. This corresponds to the conclusions about the possibilities of SPOT for the identification of settlement and infrastructure in south-eastern Sri Lanka (Van der Zee and Cox, 1988). It does not mean that the SPOT image is without any use at all. It provides a comprehensive overview in which the main roads and the main relief features appear clearly. Only minor roads cannot be consistently traced because of the lack of resolution. The SPOT image may therefore serve as a base map easier than a topographic map. (Van der Zee, 1988e). See also figure 2.11.

The interpretation accuracy of roads in the Enschede case study.
In the Enschede case study also the road network was analyzed by airphoto interpretation. The categories distinguished and the interpretation criteria used are presented in table 2.1.

When checking the interpretation in the field, the categories highway, rail road and main road and path were maintained, of the other roads the type of pavement was recorded: asphalt, bricks, concrete, rubble or sand. Gravel roads were included under the rubble roads. Sand roads included also roads which contained a lot of grass. The difference between a pure sand road and a real rubble-paved road is a gradual one, various stages between the two extremes were found. The classification could have included also the width of the road and the condition of the pavement, but it was decided to keep it simple.
The results of both airphoto interpretation and field check are presented in table 2.2. See also figure 2.26.

Table 2.1. *Categories of roads and interpretation criteria.*

Categories	Photo Interpretation Criteria
Highway	Separate traffic lanes, split-level crossings, intricate junctions
Rail road	Straight, gentle curve, no junctions with other roads, light linear feature with dark linear centre
Main road	Wide roads with intricate crossings and bifurcations, often white demarcation lines and symbols visible (triangles, arrows)
Other paved road	Varying widths and grey-tones, but in general thought to be darker than tracks
Track or non-paved road	Lighter grey-tones than paved roads, edges less regular, sometimes two narrow light lines suggesting a grass-covered centre,
Path	Also lighter grey-tones but much narrower than tracks
Tree-covered road	The presence of the road is suggested by the linear arrangement of the trees, but the type of road or path can not be assessed, this category therefore asks for more elaborate field checking

Table 2.2. *Categories of roads interpreted and field-checked (in kilometres).*

air photo interpretation			field check		
category	total length km	%	category	total length km	%
highway	5.1	1.7	highway	5.1	1.6
rail road	4.6	1.6	rail road	4.6	1.4
main road	16.5	5.6	main road	14.6	4.5
paved road	174.7	59.6	asphalted road	160.9	49.9
tree covered road	38.5	13.2	brick-paved road	8.6	2.7
track	40.4	13.8	rubble-paved road	25.6	7.9
path	13.5	4.6	concrete road	0.4	0.1
			sand road	61.2	19.0
			path	41.7	12.9
TOTAL	293.3	100	TOTAL	322.7	100

Highway and rail road have been interpreted correctly. In the main roads a small difference is found, due to reclassification rather than misinterpretation. It is in the other road categories that the major differences occur. The total length of roads interpreted and recorded in the field is different, a 9% under-representation. Some roads have disappeared because of town expansion, other new roads have been constructed since the date of the aerial photography, but the main cause of the difference is that roads have not been interpreted at all. This can for a large part be attributed to the category paths. If these are left out of consideration, the total length of roads interpreted is 280 kilometre, and the total lenght of roads found in the field 281 kilometre, which is not a bad result at all.

To analyze and quantify the misinterpretations, the two road networks have to be superimposed and compared. This was done by digitizing them into computerized maps and then making a cross-table that expresses the coincidence of interpreted categories with field categories in numbers of grid-cells (of 25 x 25 m). Because in the process of transforming the maps into grid-cell maps a certain amount of generalization takes place, the combinations can not be expressed in units of length any more. Instead the results are presented in percentages of grid-cells in table 2.3. for two approaches: how the field roads had been interpreted and what the interpreted roads were in reality.

For example, with respect to the main roads identified in the field it can be stated that 99.4% were also interpreted as main road. A very high accuracy therefore. That it is not 100% can be attributed to the fact that in the computer mapping sometimes at road crossings the grid-cell has been attributed by the programme to the other road category. When considering the roads that have been interpreted as main road, however, it appears that only 87.3% were really main road and 12.7% not. Even though in this case it was more a question of reconsideration of the classification after the field visit than a real misinterpretation, the accuracy factor becomes quite different. And so also the other categories can be viewed from both points of view.

Table 2.3. *Comparison of interpretation and field observation of the road network. (in percentages of grid-cells)*

Interpretation Categories	Road Categories Found in the Field								
How the "field" roads had been interpreted	Main road	Asphalt road	Brick road	Sand road	Path	Rubble road	Concrete road	No road	
Main road	99.4	1.2	-	-	-	0.3	-	-	
Paved road	0.4	81.8	62.2	42.9	-	33.1	-	26.1	
Tree covered	-	11.3	8.8	19.0	10.6	19.1	7.1	5.0	
Track	0.2	1.9	6.1	32.5	15.9	29.2	85.7	68.9	
Path	-	0.1	2.0	-	31.0	2.6	-	-	
No road	-	3.7	20.7	5.5	42.5	15.7	7.1	-	
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
What the interpreted roads were in reality	Main road	Asphalt road	Brick road	Sand road	Path	Rubble road	Concrete road	No road	TOTAL
Main road	87.3	12.2	-	-	-	0.5	-	-	100
Paved road	0.0	75.0	3.0	15.6	-	5.4	-	1.0	100
Tree covered	-	43.9	1.8	29.3	10.9	13.2	0.1	0.8	100
Track	0.1	7.0	1.2	46.9	15.3	18.8	0.8	10.0	100
Path	-	1.0	1.2	-	92.5	5.3	0.0	-	100
No road	-	17.5	5.2	10.4	53.6	13.2	0.1	-	100

Of the asphalted roads identified in the field 82% had been interpreted as paved road, thus correctly, and 11% was obscured by trees on the photos. About 4% could not be interpreted because they were constructed after the date of the aerial photography. Of the brick-paved roads 62% was interpreted as paved road, nearly 9% was obscured by trees, and about 33% had been interpreted as track. The rather high percentage that was not interpreted at all is not a real misinterpretation, but is due to the incorporation of the drive ways on the large parking lots of a recreation area into the inventory after the field survey. Still, this category has a much lower accuracy score than the asphalted roads. But, in absolute sense this category is only relatively small.

Of the roads interpreted as paved roads, 75% appeared to be asphalted, 3% brick-paved, 5% rubble-paved, and 16% were sand roads. Only 1% was not found in the field any more because they had been removed in the course of town expansion activities. When taking asphalted roads and brick-paved roads together as paved roads, then 81% had been interpreted as such correctly, the major source of error being the tree cover. But still, of all the roads interpreted as paved, only 78% was so in reality. Especially with respect to the smaller roads it has been difficult to interpret whether they are really paved or not. Also the sand roads or rubble-paved roads in this area are quite straight, neat and wide.
Of the sand roads 43% had been interpreted as paved roads, almost 20% were obscured by trees. Of the rubble-paved roads 33% had been interpreted as paved road, 30% as track and 19% were obscured by trees. Taking both categories together as tracks, then 40% was interpreted as paved road and only 32% as track. Not a high accuracy thus. Also from the other point of view the accuracy is not really high. Of what was interpreted as tracks 47% appeared to be sand roads and 19% rubble-paved roads, together 66%. In addition 8% appeared to be paved road and 15% was classified in the field as path.
Of the paths 31% was interpreted as such, 11% was obscured by trees, and 16% was interpreted as track, rather a classification error than an interpretation error. But 43% of the

Of the paths 31% was interpreted as such, 11% was obscured by trees, and 16% was interpreted as track, rather a classification error than an interpretation error. But 43% of the paths was not interpreted at all, either because they were not visible in the airphotos, or because during the interpretation they were not included as such, being considered an integral part of a park. After field work it was then decided to include such paths too. If the non-interpreted paths are left out of consideration, then 54% of the paths have been identified as such. Still not a very high score. But, when looking at it from the other side, what had been interpreted as path in 93% of the cases was found to be path in reality too.

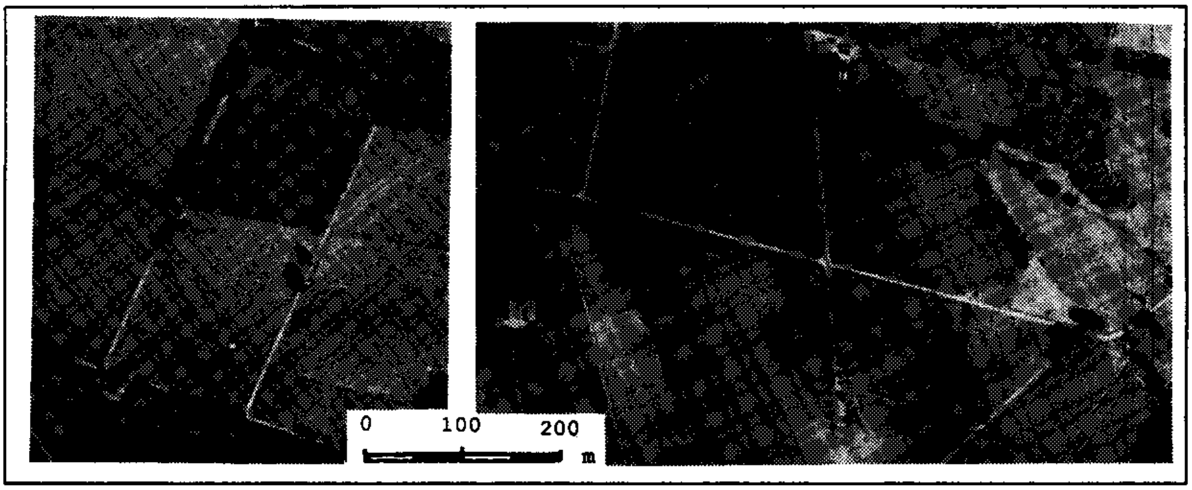

Figure 2.26. *Some examples of the difficulty to distinguish different road categories on airphotos. (A) are asphalted roads, (S) are sand roads.*

Resuming, it can be stated that the total length of the road network, excluding paths, has been accurately interpreted, but that the subdivision into different categories cannot be made with sufficient reliability and consistency. Paths, at least in this part of the country, cannot be interpreted with sufficient accuracy, mainly because they are hidden under the trees and too narrow and/or winding to be revealed by alignment of trees.

But, why should the road network be interpreted from airphotos in the first place? Is not sufficient information already available on topographical maps? The maps available for the Enschede case study were published in 1977, based on a revision in 1974. The road classification for the sake of comparison has been regrouped into: main roads, secondary roads, other paved roads and non-paved roads. Paths are also indicated on the topographical map, but have not been included in the comparison. These roads also have been digitized and compared with the interpretation results as well as with the field observations.

Of all roads interpreted 19% did not appear in the map, and of the roads found in the field 24% was not in the map, of which 36% main roads.

Also with respect to the classification differences can be observed.

Of the main roads and also the secondary roads the interpretation corresponds reasonably to the classification on the map: 97% and 82% respectively (or 93% if tree covered roads can be included as correct interpretation). At the lower orders of roads the discrepancies are larger, but it cannot be established whether this is because of misinterpretation or because of road improvement since the time of mapping. But it is of course more interesting to compare the map with the field observations, see table 2.4.

The main roads in the map did correspond to those in the field. The small differences indicated in the table have to be attributed to the grid-cell allocation problem that was already mentioned. Of the secondary roads 93% corresponds to paved roads. Of the other paved roads of the map 59% was asphalted or brick paved, 25% rubble-paved and 16% sand road or path. Of the non-paved roads in the map 19% in reality was (now) paved, 14% rubble-paved and 67% sand road or path.

Table 2.4. *The road network on the topographical map compared with field observations (in percentages of grid-cells).*

Roads on the topographical map	Roads found in the field				
What the roads in the field are on the map	**Main road**	**Paved road**	**non-paved road**	**Path**	
Main road	62.4	0.1	0.2	-	
Secondary road	25.8	64.7	3.9	1.2	
Other paved road	0.8	9.3	11.0	2.3	
Non-paved road	1.9	9.6	61.7	34.2	
No road	9.1	16.1	23.3	62.3	
TOTAL	100.0	100.0	100.0	100.0	
What the roads on the map are in the field	**Main road**	**Paved road**	**non-paved road**	**Path**	**TOTAL**
Main road	95.9	2.2	2.0	-	100
Secondary road	3.1	93.4	3.1	0.4	100
Other paved road	0.4	58.7	37.3	3.6	100
Non-paved road	0.3	18.7	64.8	16.2	100
No road	1.7	36.0	28.2	34.0	100

Of the main roads in the field 62% was indeed indicated as main road, 26% as secondary road and 9% did not appear. Of the paved roads (asphalt or brick) 65% was indicated as secondary road, 9% as other paved road, 10% as non-paved road and 16% did not appear. Of the rubble-paved and sand roads 62% was indicated as non-paved, 11% as other paved and only 4% as secondary road. But 23% was not indicated on the map at all.

Therefore, although the map may not be up-to-date with respect to the actual condition of the roads, it is not really less accurate in this respect than the results of the airphoto interpretation. But with respect to the completeness of the road network, irrespective of subdivision into categories, the map is far from complete. This difference will become much larger if the available topographic map is of a very old date and/or of a small scale, a situation not uncommon in many developing countries
Therefore one conclusion is that airphoto interpretation can be very useful for a rapid up-dating of the map for the road network.
Another conclusion from the Enschede case study is, that not too much accuracy can be expected with respect to a classification of roads into different categories in this case. However, the accuracy with which a classification of roads can be made by airphoto interpretation strongly depends on the types of road available, the criteria that can be applied, as well as the character of the area, and therefore will differ from one area to the other. In many developing countries a rather simple classification, for which airphoto interpretation criteria can be established easily, will suffice, as was the case for example in the Mae Sa area. The resulting interpretation accuracy can then be expected to be relatively high.
In the Enschede case study the high incidence of roads obscured by trees contributed to the inaccuracy. This may be a factor of importance in many tropical countries too. In an open polder or prairie landscape this factor will be of much less importance.
Moreover, it may go without saying that airphotos can only reveal the presence of roads, which most of the times have a multiple use function. The amount of (recreational) use has to be established by other means.
Also about the juridical, social and economic aspects of accessibility airphotos cannot give any information.

2.3. THE INTERPRETABILITY OF THE RELATION OF FACILITIES TO THEIR RESOURCES.

It has already been suggested and in several cases the previous sections could confirm it, that airphotos can be a valuable tool for the analysis of the spatial pattern of the recreational facilities and of their environmental setting, that is, the relation between the facilities and their resources. Thus partly responding to the question of objective 3. But a few cases may be further discussed especially with respect to this topic.
Whether the facilities have been identified by airphoto interpretation or by other means is not important for this analysis, that may help to find out to what characteristics of which original resources they are related.
Often recreational resources are associated with the natural environment, with the rural landscape, and their dominant characteristic is thought to be their outstanding physical qualities. But the original recreational resources may also comprise man-made resources. (Van der Zee, 1988e).
Some relationships are rather obvious. For example, water-based recreation is found along lakes and streams. But closer analysis will reveal that not all water in the same degree attracts concentrations of users. The same is true with respect to forests, mountains, beaches and other *self-evident* recreational resources.

Some observations on the Loosdrecht and Ameland areas.
In the Loosdrecht area it can be concluded from the orientation of second homes and hotels/restaurants, especially from that of their marinas and jetties, that certain areas of water apparently are less attractive or less suitable than other areas. Comparison of the different water bodies reveals that the non-used one is smaller, but in all other aspects does not show any difference in character. Water depth can not be assessed from these photographs. But additional information reveals that the non-used lake is a nature reserve. (Van der Zee, 1973).
Although the depth of water cannot often be interpreted from airphotos, in some cases the presence of specific water-plants can be an indication of the depth, or, when the water is clear enough, shallows can be visible.
In the central Ameland area most of the camping-sites and second homes are located at the inner side of the coastal dune belt. The conclusion is, that the North Sea coast is the main attraction factor for the recreationists and that they want to settle as close to it as possible. But an additional explanation is, that this part of the island consists of land that is only marginally suitable for agricultural use and that farmers were willing to sell their share in this land, rather than let any of their better land be occupied by recreational facilities. (Van der Zee, 1973).

Analysis of the landscape setting of the Mae Sa recreation sites.
Not everywhere though the relations and explanations are that simple and clear. In the Mae Sa area therefore an attempt was made to analyze more specifically the characteristics of the recreation sites in order to elaborate some parameters with which other parts of the area then can be evaluated for their suitability or attractiveness for recreation. (Van der Zee, 1987; 1988e). Assuming that the pattern of recreational facilities can be considered to reflect the apparent actual preference of the visitors of the Mae Sa valley, the impression exists that for the Thai the created resources in the form of garden-parks are the most essential and that the quality of the surrounding scenery is but secondary. Except for visiting accessible waterfall sites, other activities in the sphere of *nature directed recreation* are rare. Four variables have been used to roughly characterize the natural environment. Altitude as main indicator for the aspect of climate, terrain form and vegetation cover as expression of the scenic character and water source for its general scenery aspect as well as its special attraction as such.
Altitude is much easier derived from the existing topographical maps than established by airphoto interpretation. A real dominance in a specific altitude zone and thus a clear relation of recreation to an optimal climatic setting was not found. (Van der Zee, 1987; 1988e).
The *terrain form* of the sites themselves as well as of the area surrounding them can be easily determined by airphoto interpretation. With respect to terrain form the attraction factors for

establishing resorts in this area appear to be the presence of sloping zones in the surroundings, but flat to gentle slopes for the actual site of the resort. It is not easy however to identify some clear parameters that consistently apply to all resort sites. The waterfall-sites, because of their nature, *all occur in narrow steep sloped valleys that are easy to detect in the airphotos when* viewed stereoscopically.

Also the *vegetation cover* can be rather easily interpreted from the airphotos. Almost all of the resorts are found to be surrounded by forests or shrubs and located in sloping zones. The presence of forest and other natural vegetation therefore apparently is one of the factors *attracting recreationists. But this natural vegetation should not occur on the site itself.* (Suwan & Nurbaya, 1986; Van der Zee, 1988e).

Water resources are very important for a recreation site. Water is used for consumption, for watering the plants in the decorative gardens, but above all is a main attraction factor for visitors. Of the recreation places in the area five are located at a waterfall-site. The famous Mae Sa falls *recreation area even has a series of nine falls in line.* (Van der Zee, 1988e).

Six places may not be sited at a waterfall, but at least along the Mae Sa stream with its rapids. Two resorts are located on a tributary of the Mae Sa. (Van der Zee, 1987). Water in the form of reservoirs, ponds and streams can be easily detected on the airphotos. Of the waterfall-sites many are suggested in the stereo-view by a sharp drop along the course of a stream, but only *in a few cases it can be detected that there is actually water falling down. In many cases* trees obscure the scene. (Van der Zee, 1988e).

The results of this attempt to analyze the characteristics of the natural environment of the recreation sites in the Mae Sa area only give a general impression. The number of recreation places considered is still too small and their character too diverse and therefore such an analysis cannot be expected to arrive at general conclusions. Thus, no clear definition of what exactly are the recreational resources in this area can be given. This makes it difficult to enter the next step of the procedure: the inventory of these resources in areas where there is no actual recreational use yet, in order to establish the potential that may be developed and the factors that obstructed development so far.

An exception may be the waterfall-sites. The preference of the Thai for recreation at waterfall-sites has been observed (Midaglia et al., 1987; Van der Zee, 1988b). The various sites, with and without recreation, that have been inventoried all can be easily identified in the stereo-view of the airphotos. An inventory of sites that are likely to have a waterfall therefore does not seem to be too difficult. But whether they actually have water and whether they are used for recreation has to be identified in the field. Also, waterfall-sites can be very different in quality and attractiveness. But a more detailed analysis of waterfall-sites for these aspects had to be based on parameters that for the largest part could not be determined with the help of the airphotos (Van der Zee, 1988b), see also figure 1.16. The present accessibility of the potential waterfall-sites again can be rather easily identified by airphoto interpretation (Van der Zee, 1988e).

However, despite the limitations that are inherent to airphoto interpretation, it still offers better and more comprehensive opportunities to analyze the relation of recreation facilities to their resources than many other approaches. This also applies to the possibility to objectively assess the incorporation of a camping terrain in the surrounding landscape. Possible impacts on the landscape are rapidly visible. (Dodt and Van der Zee, 1984).

Analysis of the aspect of location in the Enschede area.

One aspect that was analyzed for a number of categories of recreational facilities in the Enschede study area is the location with respect to the built-up area. The distance zones were generated in the computerized map in which also the areas of the categories concerned had been digitized. Only simple distance zones were used, no correction for the degree of (in)accessibility of the terrain was applied. See figure 2.27.

The cycle-cross terrain and the two skating rinks are all within one kilometre from the edge of the built-up area, (figure 2.27.A). Of the sportfields 95% is within this one kilometre zone (Figure 2.28.A). This indicates that these are typically user-oriented facilities.

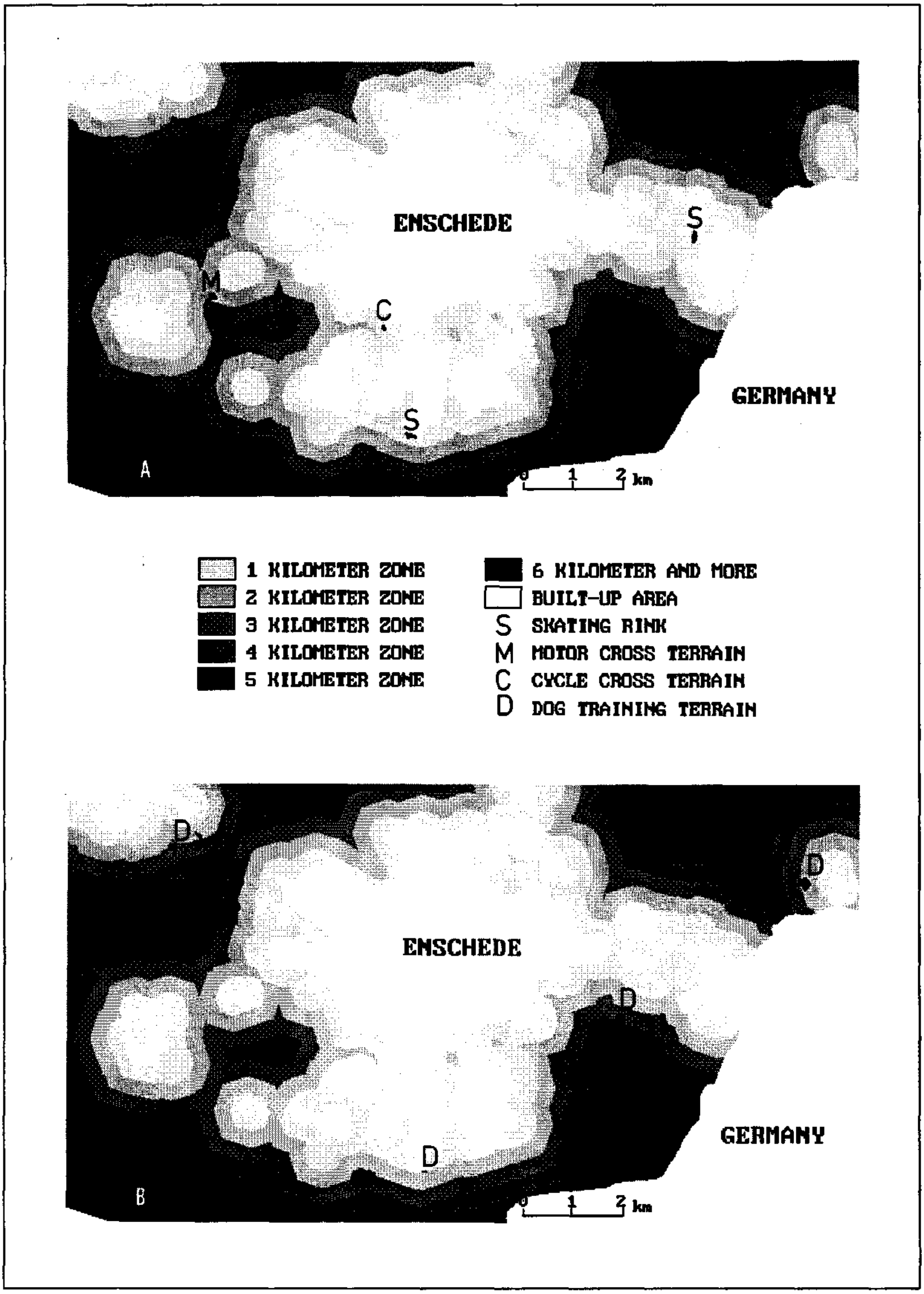

Figure 2.27. *Location of several categories of recreational facilities with respect to distance zones. Skating rinks, motor and cycle cross and dog training.*

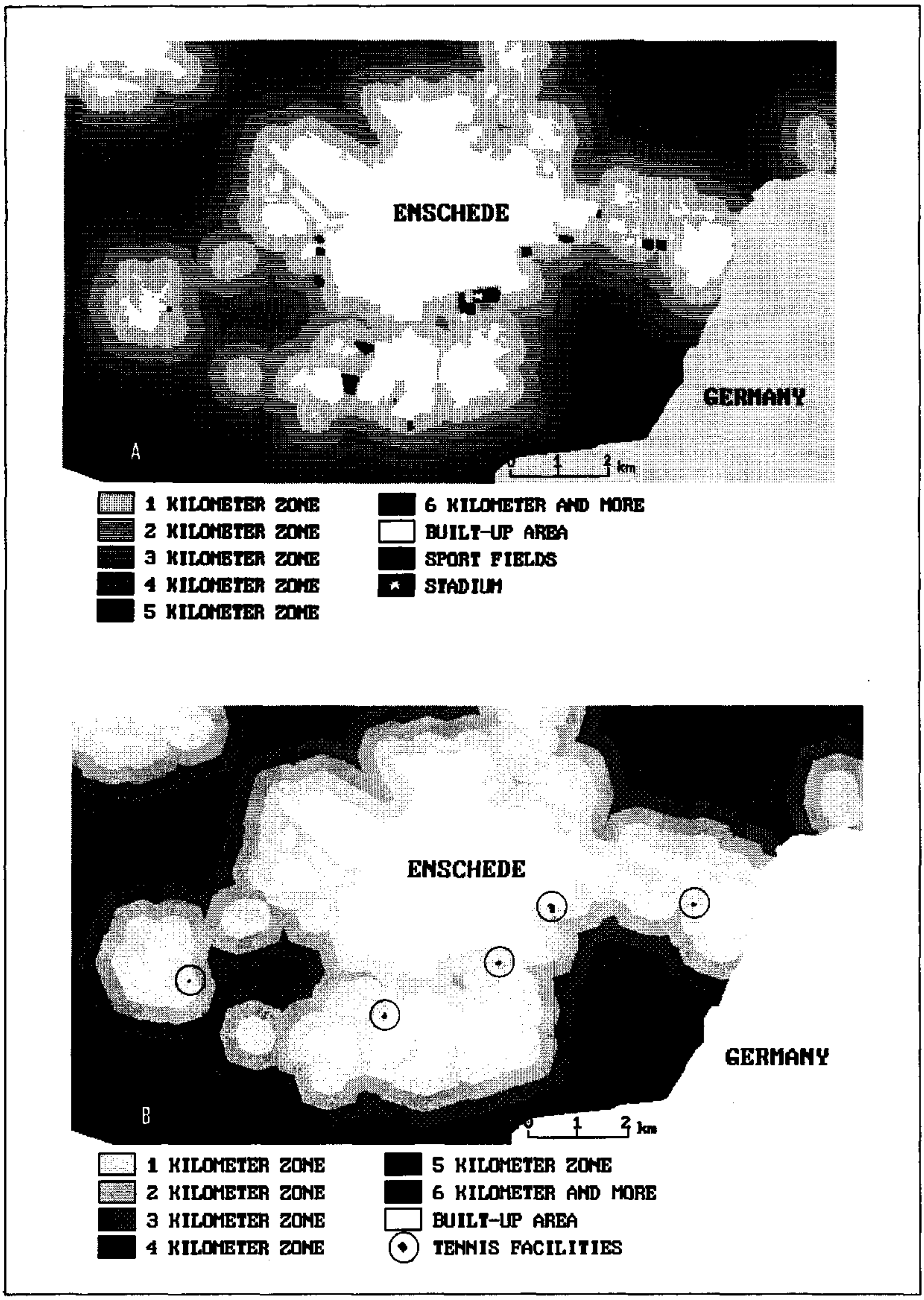

Figure 2.28. *Location of several categories of sports facilities with respect to distance zones.*

Of the tennis courts 82% is located within one kilometre and 15% in the 1-2 kilometre zone. Only one tennis court is *far out* (3-4 km) near a mansion house. See figure 2.28.B.
With respect to the six dog training areas, one is found within 1 kilometre of the built-up area, two are found 1 and 2 kilometre, two between 2 and 3 kilometre and one beyond 6 kilometre. This facility therefore appears to be less user-oriented and more resource-based. In this case the resource apparently is a more or less natural terrain, that is located at reasonable distance of inhabited area. See figure 2.27.B.
Of the motor cross terrain also a location away from the inhabited world could be expected, and indeed, it is separated from the town by the highway. With respect to straight distance, however, it is located between 1 and 2 kilometre from the edge of the built-up area. See figure 2.27.A.
Of the allotment gardens more than half (51%) is located within one kilometre of the built-up area, 11% lies in the zone of 1-2 km, 29% from 2-3 km and only 9 % from 3-4 kilometre. See figure 2.29. This corresponds to the observation of Ukelenstam (1988), that more than half of the allotment gardens is located within 1 kilometre of the built-up area.
It is obvious that such an analysis of the distribution of facilities over distance zones only makes sense when the inventory of facilities can be made more or less comprehensive and their location accurately identified. For delineating the distance zones themselves in this case no airphoto interpretation is used.
Thus, in most cases the question of objective 3 can be answered positively. However, objective 4 in many cases can not be achieved, either because no parameters can be defined or because these can not be consistently identified by remote sensing.

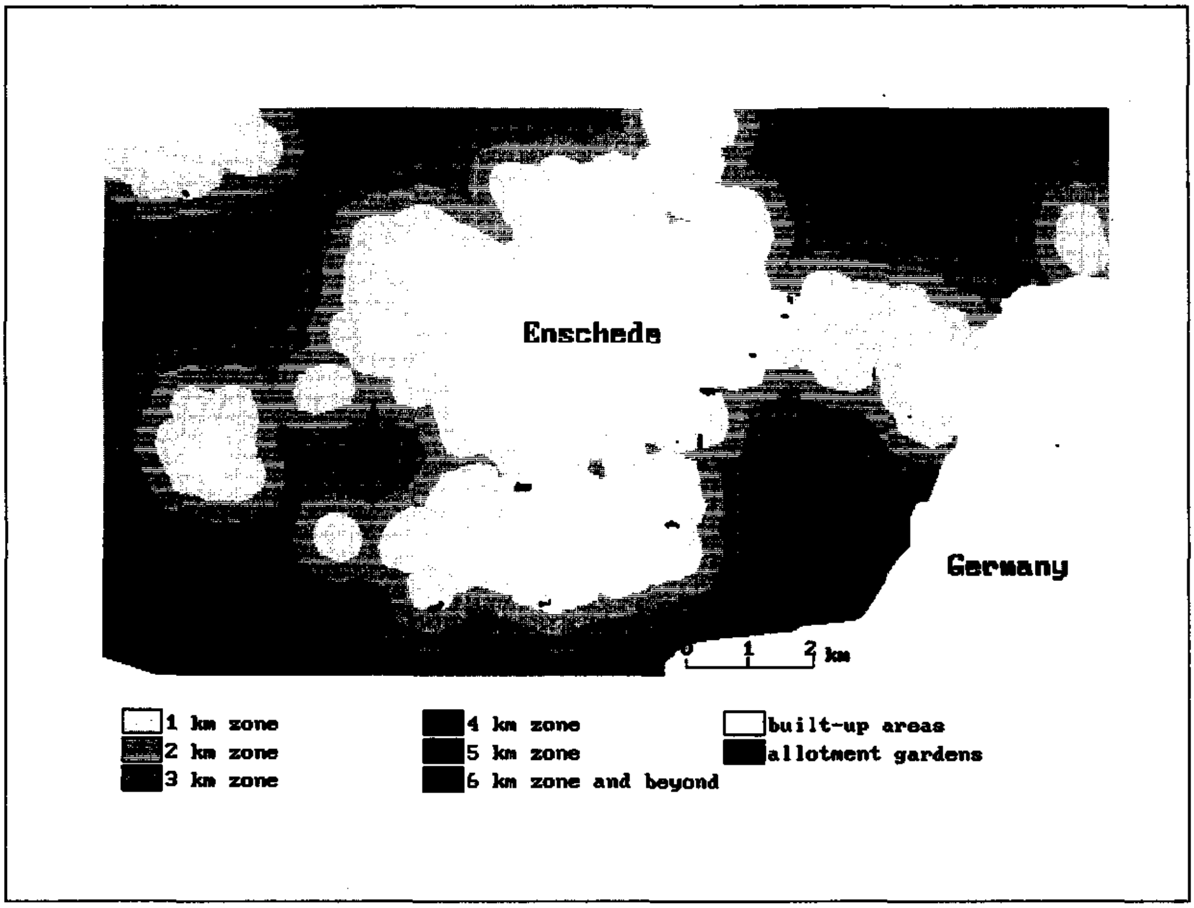

Figure 2.29. *Location of allotment gardens with respect to distance zones.*

3. Analysis of development processes.

3.1. INTERPRETATION OF SEQUENCES OF AIRPHOTOS.

Monitoring, watching to warn.

One advantage, not yet mentioned in chapter 1.3, that often is attributed to observations from air and space is, that they can be repeated regularly. Thus the disadvantage that only one moment is registered, and that no observations on changes through time can be made can be overcome (Stroband, 1971; Van der Voet and Dijkstra, 1971; Driebergen, 1981a; Bakker and Thewessen, 1986; Schrauwen and Terpstra, 1986; Thewessen and Bakker, 1987). Especially of the electronic images from satellites it is stated that they are very suitable for such a repeated *coverage* (observation) with sequential analysis via geo-information-systems (Kannegieter, 1987).

Above all natural resources that are highly dynamic rather than static in character, especially the vegetation cover, both natural and cultural, for their proper management require new inventories periodically (Colwell, 1975). These sequences of inventories can be used for *watching in order to warn* when large deviations threaten to occur in the situation that we want to achieve with our planning and management. (I.Zonneveld, 1987). *Monitoring* is the fashionable term used for this activity or process (I.Zonneveld, 1987; Kannegieter, 1987; Colwell, 1975). Through monitoring, it is feasible to identify land use changes, the type of land that is being used most rapidly and the amount of land committed to specific uses (Killmayer and Epp, 1983).

The applicability of satellite images to monitoring in the field of recreation so far is limited however, because of the restrictions put by the spatial resolution. And the costs of regularly having a new set of airphotos made often is inhibitive. Real monitoring cases therefore, in which several sequences of airphotos during a day or on different days in a season are used, are very few and related to very specific purposes and small areas. (Stroband, 1971; Van der Voet and Dijkstra, 1971; Driebergen, 1981a; Bakker and Thewessen, 1986; Schrauwen and Terpstra, 1986; Thewessen and Bakker, 1987). Some examples will be discussed in chapter 4.

Retrospective monitoring.

More common is the use of older, existing sets of airphotos in addition to the most recent one to compare the present pattern of recreational land use of an area with one or more situations in the past. This procedure also is *sequential analysis*, but instead of real *monitoring* it might be better referred to as *retrospective monitoring*.

In such a procedure the images provide historical documentation, and comparative studies of sequentially obtained images can reveal important information on trends in both physical and cultural processes (Estes and Simonett, 1975).

When studying topographical maps for comparing landscape changes it remains always a question how many of the differences may be real ones and what depends upon the draughtsman (Rasmussen, 1962). A number of elements may have been generalized out of the map. Maps of different dates may have been compiled with different levels of generalization. The more recent maps are all based on airphotos, but the earlier maps are based on field observations only.

These problems do not exist when comparing airphotos. Because all elements in the terrain are recorded without any subjective choice, airphotos are most suitable for comparative studies of changes in the landscape. (Rasmussen, 1962). This also applies to the analysis of recreational development processes (Dodt and Van der Zee, 1984).

Methods of monitoring.

Neither in real monitoring nor in retrospective monitoring comprehensive mapping of all images or photo coverages is necessary. One situation, usually the present or most recent situation,

is mapped as a basis and only with respect to the topics of interest and some additional features that help in orientation.
In real monitoring then all following images or airphotos are screened for changes as compared to this base map or *bench-mark map*. Such changes are then indicated or annotated on a copy of the base map in order to keep that up-to-date. From these annotated maps also the amount, extent and type of changes can be measured and analyzed. The accuracy of these measurements and analysis is strongly related to the accuracy with which the categories involved can be interpreted. And this again is depending on whether it is possible to have all sequences of more or less the same date in the season. The results of this analysis may be comprised in a (cross)table and/or in special *change* maps. If the repetitive coverages are done frequently the use of an electronic geographic information system is very easy, if not imperative.
When the base map is of sufficient geometric accuracy, the successive sequences of airphotos need not be of the highest photogrammetric accuracy. Priority can then be given to low cost and rapid availability of data and the use of small format vertical or even oblique airphotos can be considered. (Killmayer and Epp, 1983). But whatever the type of images used in monitoring, they are usually of a similar scale and type, which makes the comparison easier.
In retrospective monitoring the most recent image is compared with situations in the past. This type of analysis is dependent on whatever material happens to be available. If there is a lot of material a selection can be made of the most suitable scales and seasons, but very often there is no scope for such selectivity. The amount of change that can be detected then will depend on the comparability of similar features on different scales and in different seasons. It may not always be possible to do it as detailed as wanted. Also in this type of study normally the changes are annotated on a copy of the base map, after which they can be measured and analyzed.

The problems with respect to the interpretability of different categories of recreational facilities and land use will be the same as those that have been discussed in chapter 2.2. Differences in scale and season of successive sequences may create additional problems. But then, it is not crucial that for the base map the inventory of recreational facilities and land use is carried out exclusively by interpretation. A considerable amount of field observations can be used as input too. The information contained in the base map then will serve as an aid for the interpretation of the following or previous sequences.
In monitoring it may be observed that certain features have disappeared and it will be of interest to identify what came instead. If this can not be established by interpretation the sites should be earmarked for field inspection. The same applies for the occurrence of new features that can not be identified. The number of unidentifiable changes will often be limited however.
In retrospective analysis it is rather simple to observe which features are not yet present in a previous situation. The identification of the character of the site before the change in most cases will not present a problem either. But in cases where a physical feature remained present but changed its function in the course of time, for example a farmhouse changed into a second home or a restaurant, it will be very difficult to assess whether on a certain image the change had already taken place or not.

Types of changes observed with respect to recreation.
With respect to recreation the most obvious changes in the landscape are caused by the physical facilities, whether permanent, semi-permanent or temporary. The aspect of a landscape can change drastically if it is occupied by summer cottages, a caravan-site or camping-ground, a large parking place, etcetera. Sometimes changes such as construction of hotels or bungalow-complexes, touristic roads or cable-lifts, occur in rather short time and are consciously planned. Other planning processes are of a more gradual nature. But very often the development occurs as a spontaneous gradual process that is hard to recognize. (Van der Zee, 1982). Such processes are not reflected in official permits or licenses nor in visitor statistics. They are difficult to represent, because each individual observation seems so insignificant. But all insignificant changes together may suddenly be experienced as a threat to the resources that still remain. Because gradual changes are often recognized late, it is

difficult to get them under control. (Thalen, 1977). In such cases the interpretation of sequential aerial photographs may make the process clear and may also reveal a certain pattern in it. This knowledge may be of use if one wants to control the process. It has to be kept in mind, however, that measuring the amount of change is one thing, deciding how much change can still be tolerated is another, a *political* issue (Thalen, 1977).

The increase in space taken through the years can be easily assessed by the study of sequences of airphotos (BM&RIN, 1984). The factors determining the suitability and/or attractiveness of recreational resources may become more apparent by such a sequential analysis than when only one situation can be studied. It can be deduced where recreational development started, which parts of the area were first occupied by recreational uses and which parts were incorporated in later phases. (Van der Zee, 1986; 1987). Also the character of the area at the time before the recreational development took place can be analyzed (Van der Zee, 1986; 1987; BM&RIN, 1984). Thus the analysis of sequences of airphotos can contribute to answering the question of objective 3.
From such a comparative study also information can be abstracted about which types of recreation were apparently more favourite in the earlier period and which types of recreation are more recently in the focus of interest, thus about changes in preference or fashion. It may reveal too in which period the bulk of recreational development has occurred and thus whether the area is a rather established, traditional recreation area, or whether it is a new emerging recreation area. Both types of area may require their own approach in land evaluation for recreation. (Van der Zee, 1986).
Thus, such a study may give a clear indication of which type of resources or resource elements have (or had) the highest preference and which parts are more of a second or third choice. And in this way the requirements of the recreational Land Utilization Types may be more narrowly defined. (Van der Zee, 1986; 1987). Thus, possibly an answer may be given on the question of objective 4 in a number of cases.

The idea is not new. Examples of such sequential airphoto interpretation applied to recreation studies from the 1960's are that on the Skanör peninsula in south Sweden (Rasmussen, 1962) and the Connecticut River Valley (MacConnel and Stoll, 1969). More recent examples of such studies are that in the Proserpina Lake area in south-western Spain (Van der Zee, 1982), the Mae Sa area in northern Thailand (Suwan and Nurbaya, 1986; Suwan 1987; Van der Zee, 1987; 1988e), and a specific study on the influence of recreation on the *protected* villages of the Dutch Wadden Sea islands (Van der Zee and Van der Zwiep, 1977).

3.2. Analysis of development patterns.

In the previous part of this chapter the procedures of sequential analysis have been explained and suggestions have been made as to what information can be gained with it. Now it is time to demonstrate how in some real case studies the development pattern could be analysed, what type of information could be obtained and in what respect there are still limitations.
That some of the examples are rather old does not decrease their value from the methodological point of view.

Sequential airphoto interpretation for recreation studies. Some examples.

The Skanör peninsula.
In the example presented by Rasmussen (1962) for the Skanör peninsula in south Sweden near Malmö, airphoto's of 1938 (1:20000), 1955 (1:10000), 1959, 1960 and 1962 (all 1:30000) could be used for an analysis of changes in the landscape. For changes that started earlier - the building of summer cottages started at the end of the 19th century - four editions of the topographical map, from 1860 to 1958, were used. The difference in information accuracy between map and airphoto has already been mentioned. Also the effect of the scale of the

airphotos on the interpretation accuracy has been discussed in the previous chapter. The age of the airphotos does not necessarily imply a significant difference in quality, at least not significant for interpretation purposes.
The analysis revealed that the area under forest increased, the area under heath decreased and the number of buildings increased with two thousand since 1913, and only a few of them are not built for recreational purposes. With the material available it was possible to analyse the amount and type of change period by period, and Rasmussen does so for forest, buildings and heathland, but places emphasis on the elaboration of the last category.
The heath area on Skanör peninsula decreased from 600 ha in 1938 to 425 ha in 1955 and 275 in 1960. Thus 325 ha of heath vegetation have dissappeared from 1938 to 1960. Forests occupy more than one third or 120 ha of this. One quarter or 85 ha are built-up, though to a high degree still forest covered. The rest of the lost heath is used as military training field (45 ha), camping ground (40 ha) and golfcourse (35 ha). Other purposes for which the former heath is used are roads, speedway, dumping place and pipeline for water. Even though not all of the landuses that replaced the heath are recreational land uses, the impact of recreation is considerable. If the peninsula as a whole is considered, the impact of recreation on the landscape is dominant.

The Connecticut River Valley.
In the USA a sequential study was carried out for the Connecticut River Valley by MacConnel and Stoll (1969). For this study airphotos 1:12000 were taken in the spring of 1965 covering a tract of about 150 meters on each side of the river. Earlier coverages at scale 1:20000 were available, all taken in summer, but in different years (1951, 1952, 1953 and 1955) for different parts of the valley.
For this inventory agricultural or open lands were classified into 9 types, forest lands into 40 types, wetlands into 9 types, mining, exposed rock or waste disposal into 6 types, urban into 12 types, outdoor recreational facilities into 14 types and riverbank and edge of riverbed into 26 types. It is stated that four photo-interpreters developed the skills necessary to consistently and accurately apply the classifications developed. But no information is provided on the criteria by which each of the categories can be distinguished, except that the larger scale and springtime airphotos permit easier interpretation than the smaller scale and summer airphotos, and that only the identification of vegetation types could be done better on the summer photographs, where all the trees have their leaves.
The analysis of the 10 to 13 year time lapse proved that not much change has occurred on the river in that period.

The villages of the Dutch Wadden Sea islands.
A lot of recreational facilities find a location in built-up areas, the villages. The gradual increase of facilities has its effect on the settlement as well as on nature and landscape. On peak days the villages on the Dutch Wadden Sea islands are as crowded as an inner city of a big town on the main land. The increase in number of recreationists makes that more and more facilities are necessary, more shops and entertainment facilities, directly *derived* from recreation. The original residential function of many buildings is lost in this way. (Van der Zee and Van der Zwiep, 1977).
Because it was thought worthwhile to preserve their original character and cultural and historical values, some of the villages have been designated as *protected village*. This does not mean that no changes will occur, neither that no changes are allowed any more.
Since the change of function of buildings in the villages is also a gradual process,it can only be determined in its real dimensions by observations over a long period. Airphotos can be used to indicate how much structures have appeared or disappeared and give a quantification of change. (Van der Zee and Van der Zwiep, 1977).
Inventories of changes have been made with the help of airphotos of the protected village centres. Airphotos of two years, 1969/70 and 1975/76 were compared with each other and with the base map that goes with the designation as protected village. It became clear that, although a valuable tool, the airphoto has its limitations for this type of application. First of all, only external changes can be observed, that is, whether structures have been added,

removed or expanded. Whether a building with just minor external changes has changed function in most cases can not be determined. Neither can it be determined whether a change has been against or within the law and planning regulations. Secondly, the small scale of the available airphotos used does not allow to detect much detail. Small changes thus may escape the attention. Moreover, some buildings are obscured from view by the crowns of trees. (Van der Zee, 1977; Van der Zee and Van der Zwiep, 1977).

In addition, the changes observed with respect to the base map belonging to the designation as protected village need not be real changes. The cadastral plan that serves as a base map need not represent the situation at the time of designation, and moreover only indicates main buildings and represents only a limited number of additional buildings, depending on their size and type and material of construction. Therefore, although the differences between the map and the situation at the time of designation as represented on the airphotos are large, they need not all imply real changes.

Documentation from the municipality of Schiermonnikoog indicated that of the 77 small buildings missed on the map and present on the airphotos of 1969, the major part was already existing before 1965, and that only 14 of these had a function related to recreation. The number of large changes since the designation as protected village, that can be deduced from airphoto interpretation, is limited. The airphotos can not give any information about the type of changes, neither about the legality of them. (Van der Zee, 1978).

Lake Proserpina.

A good example of a sequential airphoto interpretation is the case study on the developments around Lake Proserpina, near Mérida in south-western Spain (Van der Zee, 1982). For location, see the Annex. The lake is in origin a Roman reservoir and the Roman dam has been repaired or reconstructed in this century. The landscape around the lake is a gently rolling area with granite boulders and almost treeless. This is somewhat peculiar because in the wider surroundings the areas not turned into permanent arable fields are dominated by savanna-like vegetation of scattered oak trees with a herb layer.

In the interpretation of aerial photographs of 1956 (1:32000), 1969 (1:25000), 1974 and 1975 (1:10000) and 1978 (1:20000), see figure 3.1., the obvious changes brought about by the physical facilities -houses and cottages, camping-grounds, roads and parking lots- are immediately apparent, and show that the recreational development started and still has its largest extent and intensity on the southeastern shore and that developments on the western shore are much more recent and so far less intensive, whereas along the northern part of the lake almost no buildings are found. The very few old buildings around the lake correspond with the buildings that appear on the topographical map of 1941 and originally had agricultural functions. Some are still used as such, for example the farm complex near the Roman dam. Other buildings -former labourers' houses or herdsmens' cabins- have been converted into summer homes or bars. These buildings can also be identified on the 1956 airphotos. It seems most likely that all of them still have an agricultural function, although this cannot be deduced from the airphotos with certainty. In the same photos the road along the western side of the lake is present but probably not asphalted. Also a number of tracks can be seen. There are no trees except those associated with the complex of farm buildings. An area with a very light tone at the southern shore of the lake may indicate new construction activities. Although the qualityof the airphotos of 1956 was less than that of the coverages of the later years, this did not influence the interpretation accuracy.

The 1969 photos show on this site a trap-shooting range and clubhouse building and it could be confirmed that the construction of this complex started in 1956. Between 1956 and 1969 many more changes occurred. Many trees were planted in a small rim, almost all around the lake, and in some larger extensions along the eastern side. On the photograph the tree cover looks denser on first sight, but stereoscopic analysis reveals that many are shrubs rather then trees. The trees are Eucalyptus and have been planted in 1961 by the authority that controls the reservoir as such. Many buildings have been constructed, some along the western shore, but the majority concentrated along the southeastern shores. This corner shows the most dramatic landscape changes, from grassy undulating plain into a spaciously laid out summer home settlement with many trees, a cluster of tennis courts and numerous indications of

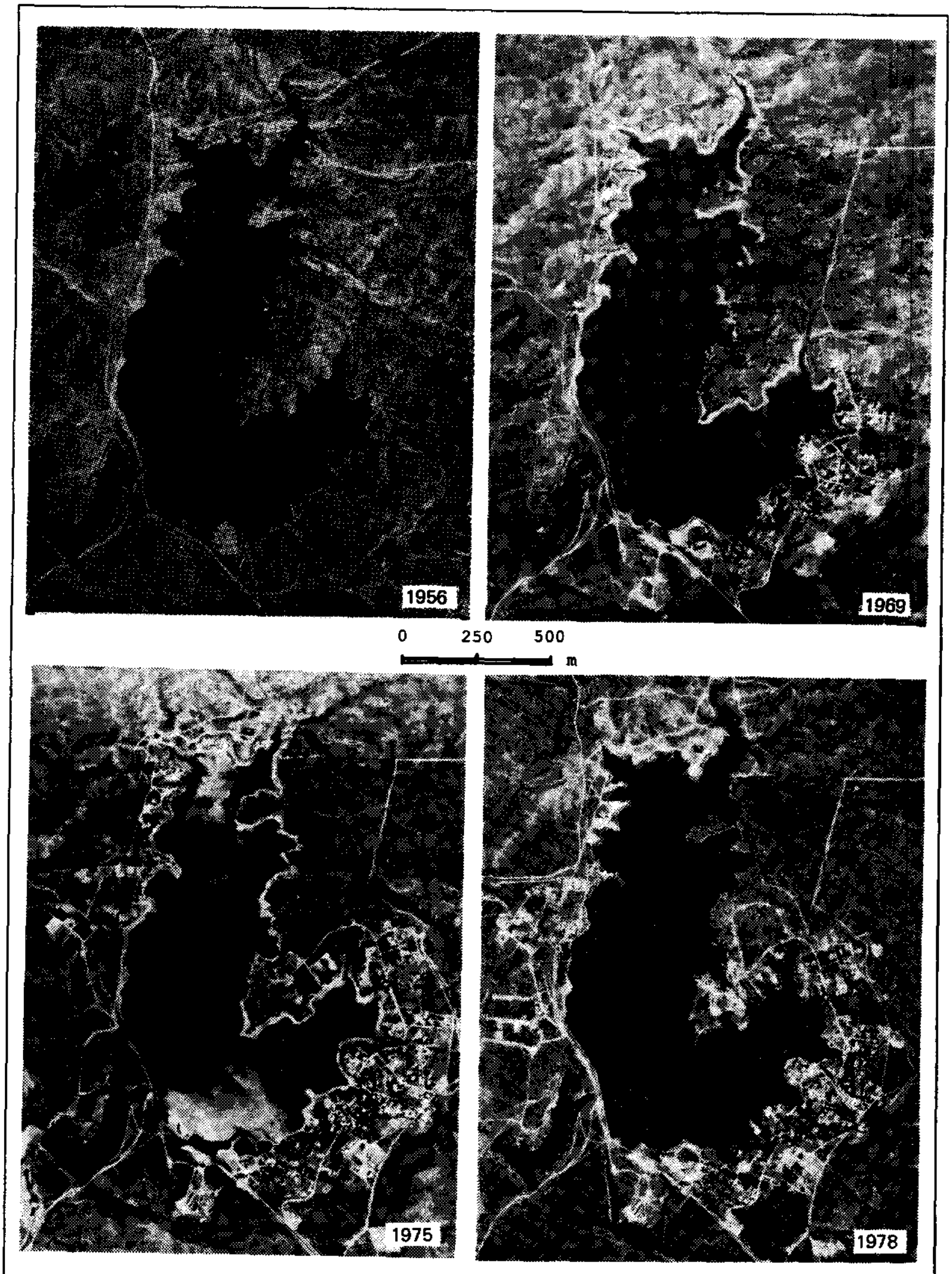

Figure 3.1. *The expansion of recreational settlement around Lake Proserpina as seen on airphotos of four different dates.*

construction work in progress. South of the lake the wide new tracks and some small buildings indicate that the camping ground had been established also. The main road along the western side of the lake obviously had been asphalted. On the photos of 1974 some further expansion could be noticed. Another trap shoot and a number of tennis courts were added to the complex at the southern shore. See also figure 2.8. Some new structures have been added to the camping site, and some new tracks and buildings are found at the western side of the lake shore. In the north the chapel of San Isidro has been built. Most of the expansion, however, concentrated in the southeastern settlement.

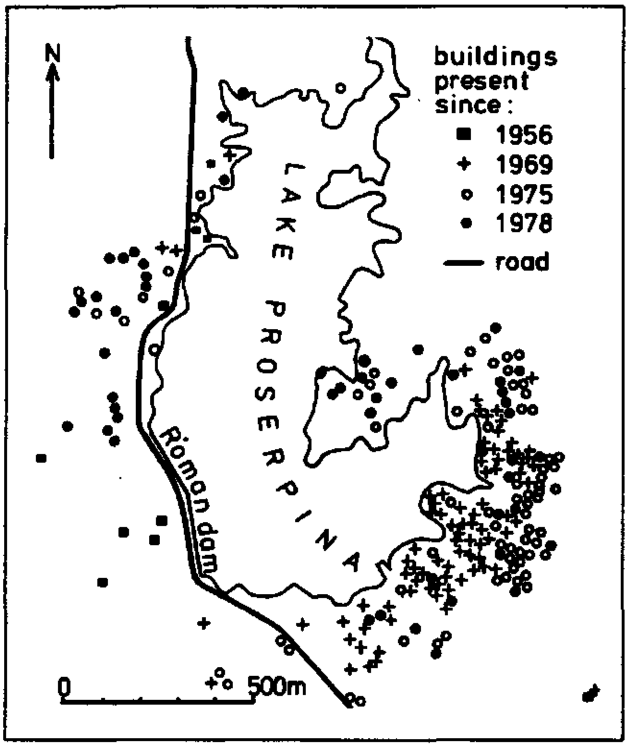

Figure 3.2. *The pattern of expansion of recreational settlement around Lake Proserpina as interpreted from airphotos.*

The changes between 1974 and 1975 are but small, but illustrative of the rate of growth of this settlement. Some more new buildings appear both in the western and southeastern settlement. The cluster of tennis courts in the southeastern settlement expanded and the swimming pool has been added to the complex. See also figure 2.18. The photos of 1978 show that there has been a steady expansion of the southeastern settlement. Empty spaces were filled with new buildings and the eastern peninsula has been definitely incorporated in the settlement. New tracks opened up the eastern lake shore area and the western shore area shows a remarkable increase in the number of buildings and tracks. Field observations in 1980 revealed that the expansion did not stop. Construction activities continued and many lots or completed *chalets* were being offered for sale.
Reviewing the whole series of photos, see figure 3.2., it can be concluded that what originally appeared to be a random development pattern has become somewhat better ordered in the later phases. The municipality of Mérida has legalized the present settlement, but has *zoned* future development areas, which will result in preservation of existing open lake front areas and further expansion of residential areas inward, away from the shore.

The Mae Sa valley.
The Mae Sa Valley is located in the province of Chiang Mai, in Northern Thailand, see also the Annex. The valley lies more or less East-West, has narrow parts with steep forested slopes as well as wide parts with paddy fields and villages, and contains a number of waterfalls.

In the last decennia a rapid expansion of the area under cultivation and a decrease of the area under natural vegetation (forest) occurred, as well as a rapid increase in the number of recreational facilities. The valley has experienced a real *recreation boom*. (Van der Zee, 1987; 1988e).

Although it has been stated that airphoto interpretation can be used to easily carry out an inventory of recreational facilities (see for example MacConnel and Stoll, 1969; Van der Zee, 1982), in this case study it appeared to be less easy. Of the four main types of recreation facilities that were distinguished in the Mae Sa valley: resorts, restaurants, second homes and special places (Van der Zee, 1987), none could be identified consistently by airphoto interpretation, and the inventory of recreational places in this region had to rely on field observations. See also chapter 2.2. and figure 2.10. The airphotos were only used for the delineation and mapping. Of course, it is pointless to try and identify by means of photo-criteria sites that are already known, if the technique of airphoto interpretation is meant to be used mainly for its efficiency in the inventory. But for monitoring future developments and expanding the analysis to other regions the possibility to identify recreation sites on airphotos would have been very useful. (Van der Zee, 1988e).

Still, for retrospective monitoring the airphotos are valuable documents, even if the present recreation sites could not be inventoried by photo interpretation but by other means. See also figure 3.3.

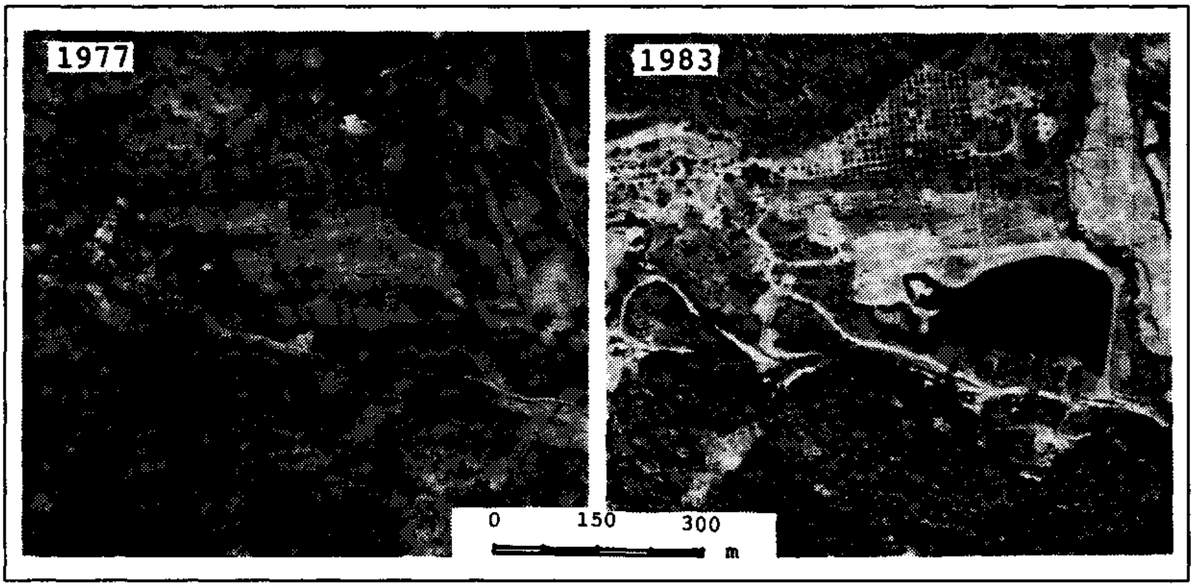

Figure 3.3. *The site of Erawan resort on airphotos of 1977 and 1983.*

In total 20 recreation places have been considered, resorts as well as special places, and all except three do appear on the airphotos of 1983. But only four of the places could be identified as recreational on the airphotos of 1976, though less developed yet. And only the site of the Mae Sa falls shows some indications of recreational visit on the airphotos of 1969 and possibly also on those of 1954/55. But because of the small scale this is not very clear.

This analysis of airphotos of different years therefore gives clear evidence that the bulk of the recreational development took place in the last decade. More precise starting dates obtained from interviews confirm this. Up to 1980 only one-third of the places existed. In 1980-1981 came the point of acceleration with another one-third of the places being established. The last third only was developed since 1983 and new places are still in development. See also figure 3.4.

But no clear pattern emerges with respect to the type of development that is established first and the types that follow later. Neither does a clear relation between spatial distribution and time of development appear. But one thing is clear. On the 1983 airphotos the main road from Mae Rim to Samoeng shows white and wide. It is apparently under reconstruction and improvement and parts may be finished already. On the 1976 airphotos the wide curves climbing the slopes near the Mae Sa falls are already present. In the 1969 photos the road still goes more straight up this slope. In the 1976 photos the main road is wide at least up to the site of the elephant camp, be it less wide and white than on the 1983 photos, but for the rest no signs of improvement can be detected yet. The highest parts of the road in the westernmost part of the Mae Sa valley were completed only in 1984. Comparison of this development of the road improvement with the development of the recreational places may lead to the conclusion that the recreational development, with may be few exceptions only, has followed the improvement of accessibility of the valley. (Van der Zee, 1988e).

By the analysis of airphotos of different years also the impact of the recreational development on the landscape can be assessed. The Mae Sa valley as a whole has experienced a tremendous development. On the airphotos of 1954/55 most of it is still forest, with some paddy fields in the valleys and a few upland fields on the slopes only.

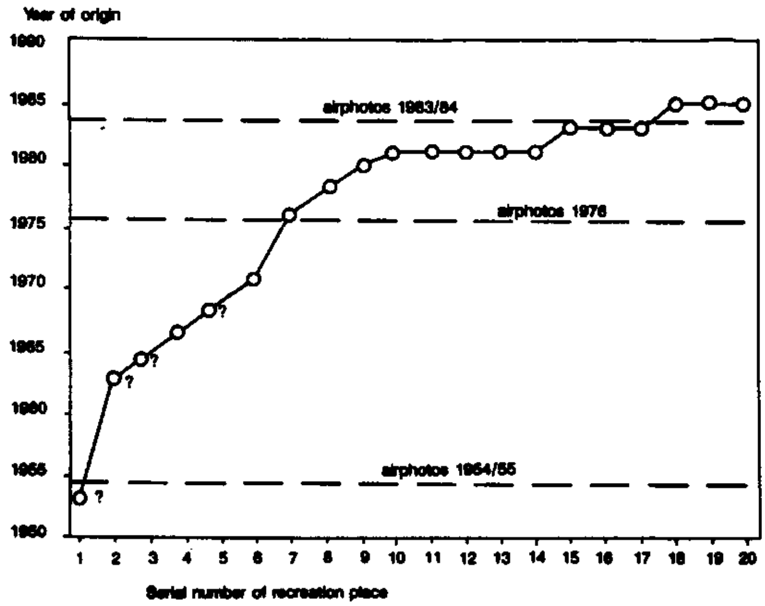

Figure 3.4. The recreational development of the Mae Sa valley in time. (derived from: Suwan and Nurbaya, 1986; ? = date of origin not exactly known)

The obvious thought that recreation has caused the forest to decrease in extent appears to be not true. The interpretation of the photos of 1969/70, 1976/77 and 1983/84 reveals that successively in an increasing degree large areas of forest are degraded or completely disappeared under the pressure of expanding agriculture. The amount of forest that disappeared because of the recreational development in that context is almost negligible. It could be observed, when comparing the photos, that recreation often is not the land use that directly replaces the forest. Many of the recreation places are established on former paddy fields, in fruit-tree plantations or abandoned tea gardens (Suwan, 1987; Van der Zee, 1988e). See also table 3.1. Especially with respect to land that is only marginably suitable for agriculture, farmers have been willing to sell for prices that exceeded those normally paid for farm land. In some cases wealthy city dwellers started with establishing a second home with a decorative garden in combination with a fruit tree plantation to make it still a bit productive. When they discovered that so many people liked to visit such a garden they further developed it into a resort. Other people, seeing the success of such development, directly invested into the creation of a resort as an economic enterprise.
Thus, also in this analysis of the past situation airphoto interpretation has given very useful information.

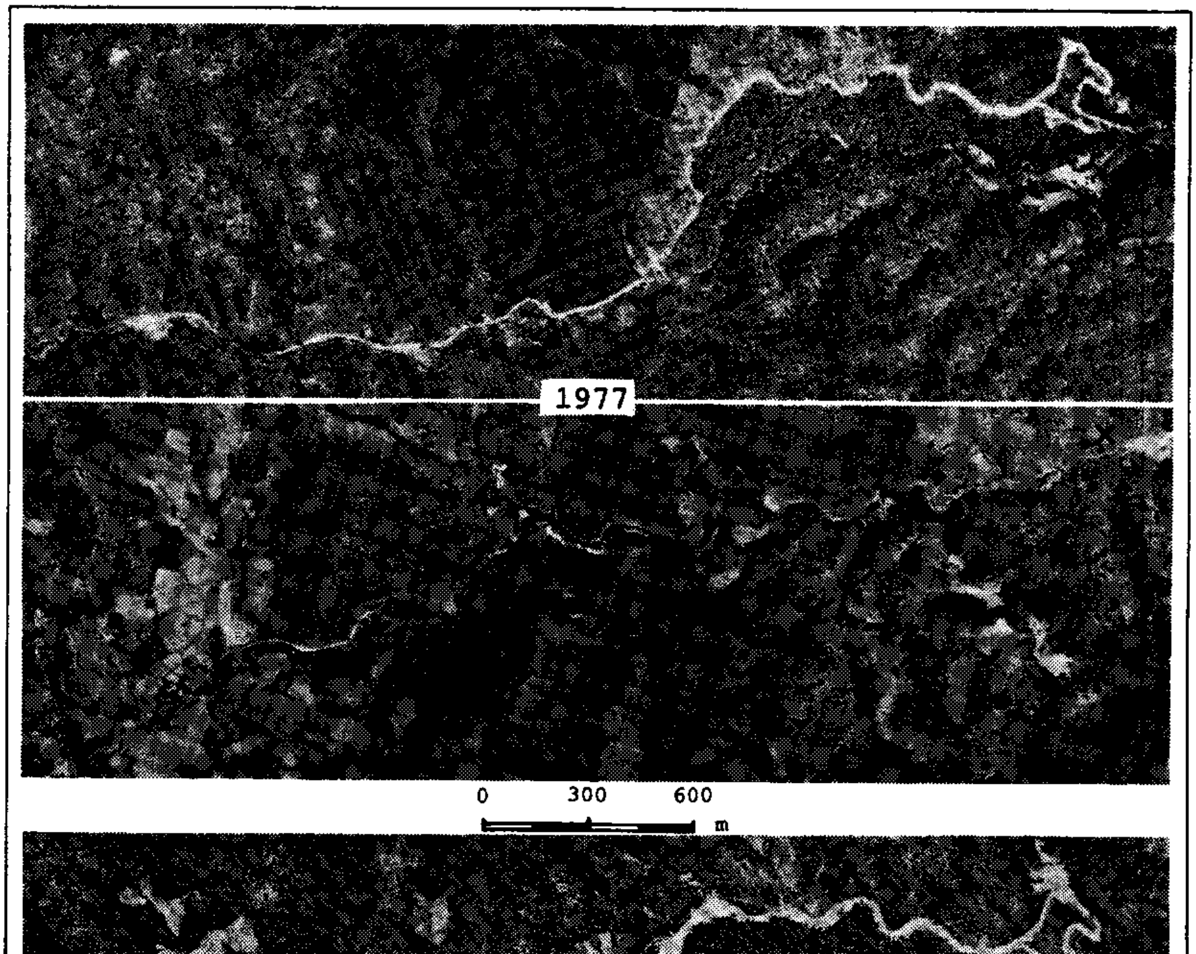

Figure 3.5. The development of the main road in the Mae Sa valley as seen on the airphotos. Above, 1977, the road improvement has proceeded until (X); below, 1983, the road improvement has been completed, but the road verges are still bare.

Table 3.1. *Land uses replaced by the recreation places in the Mae Sa Valley.*

Recreational place or resort	as interpreted from 1954-55 AP	as interpreted from 1976 AP	as interpreted from 1983-84 AP	as observed in field in 1986
Adisara Farm	Rice fields	A complex of blocks of rice fields	Fish ponds	Fish ponds
Tungha Farm	Homestead garden	Homestead garden	Fish ponds	Fish ponds
Sainamphung Orchid Farm	Woodland	Existed, some open spaces	Orchid farm with two nursery houses	Orchid farm with two nursery houses
Mountain Orchid	Woodland	Tree plantation, partly cleared	Orchid farm with one large nursery	Orchid farm with one large nursery
Mae Sa Resort	Woodland	Woodland	Few buildings in woody area	More buildings, land opened for golf and sport complex
Wang Kulab	Terraced rice fields	Terraced rice fields	Rose garden with few buildings	Rose garden with few buildings
Asian Antiques	Rice fields	Rice fields	Open space	Existed, antique shop
Mae Sa Waterfall	Existed, few buildings	Existed, more buildings	Existed, area expanded	Existed, area expanded
Tont Tong	Primary forest	Shrubland	Open space, buildings under construction	Few buildings completed, two ponds present
Rintr Garden	Open land	Open land	Existed with a row of cabins	Existed with a row of cabins
Elephant camp	Primary forest	Woody shrubland	Existed in woody shrubland	Existed in woody shrubland
Botanical Garden	Primary Forest	Existed, open forest	Existed in open forest	Existed in open forest
Mae Sa Valley	Primary forest	Man-made terraces for rice and tea	Existed with many buildings	Existed with many buildings
Hmong Mae Sa Mai	Existed, settlement of few houses	Existed, more houses	Existed, more houses	More houses, building of extension workers and demonstration farm
Erawan resort	Terraced rice fields	Tree plantation, terraced fields	Existed, buildings and pond	Existed, more buildings and pond
Mae Yim Waterfall	Shrubland, partly opened	Existed in shrub land	Existed in shrub-land	Existed in shrubland, tree plantation, flower
Chiangmai Resort	Primary forest	Shrubland on hill top	Buildings of road workers	Existed, few cabins and a restaurant
Kangsadal Lodge	Primary forest	Woodland, partly open	Existed with few buildings	Existed with more buildings
Hmong Pang Tong Daeng	Existed, settlement of few houses	Existed	Existed	Existed

from: Suwan and Nurbaya, 1986.

The potential of SPOT for analyzing recreational development.

Although in the Mae Sa Valley case study no consistent criteria could be established to identify all recreation places by airphoto interpretation, enough indications could be found that will make it possible to keep an eye on further developments such as the expansion and improvement of existing places, the establishment of new places, and above all changes in the road network. Since new coverages with airphotos are not expected to be made frequently, because of the costs, two alternatives can be thought of. One is the reconnaissance survey by light aircraft with occasional small format oblique photographs or slides. The other is the use of SPOT images.

As already mentioned in chapter 2.2., of the recreation places considered the (known) location could be pinpointed on the SPOT image without problem in most cases. But the image does not permit an identification of the site as being a recreation place or at least as a special kind of place. See also figure 2.11. It does not mean that the SPOT image is without any use at all. It provides a comprehensive overview that reveals the setting of the individual recreation places in their spatial and environmental context, much easier than a laid-out photo mosaic would. The major landuses, or rather cover types, such as forest and paddy fields, can be easily identified. Also the main roads and the main relief features appear clearly. Only minor roads cannot be consistently traced because of the lack of resolution. The SPOT image may therefore serve as a basemap easier than a topographic map. The image will also allow to locate major changes in cover type, that may indicate new developments. See also figure 3.6. Whether such developments are related to recreation has to be established in the field.

As such, the contribution of SPOT still can be valuable. But it is doubtful whether this will justify the purchase of an image for that purpose alone. (Van der Zee, 1988e).

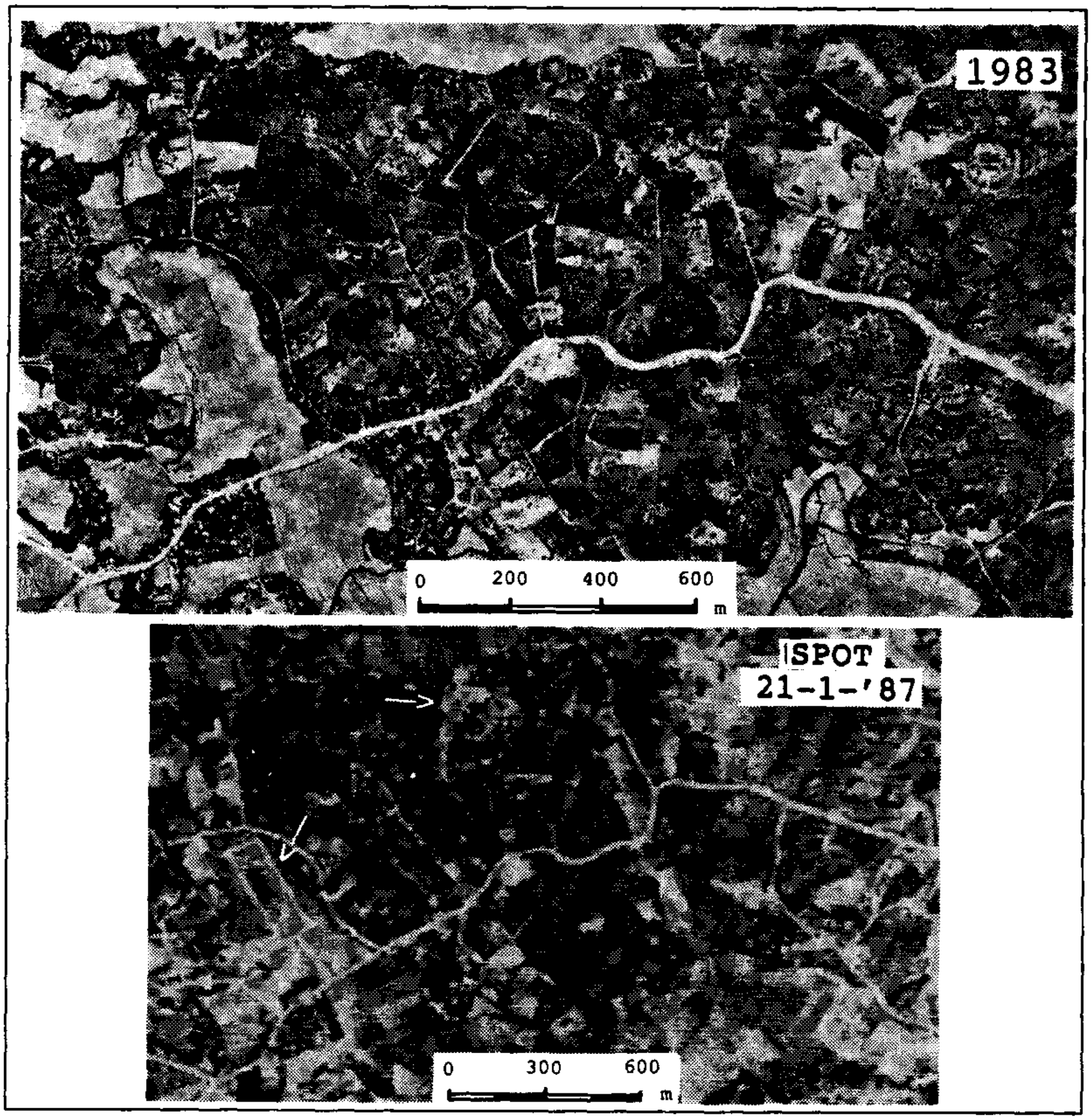

Figure 3.6. *Changes with respect to recreational land use observed on a SPOT image as compared to the airphoto of the previous situation. At one place a rectangular road system has been laid out in the plain, start of a new (recreational?) settlement. At another place the whitish spots in the forest point at construction activities, in this case the construction of a golf course, tennis courts, swimming pool, etcetera, for a recently established resort.*

3.3. INDICATIONS OF RELATIONS TO RESOURCES.

In the study by Rasmussen (1962) on the Skanör peninsula, it appeared that the earlier houses were placed in the forest, but later on many are also built in open, formerly cultivated, fields and close to the fences around the remaining heath. An explanation was not given. Was it a change in preference, or was it simply that at a certain moment the available forest sites were all occupied so that newcomers had to be satisfied with second and third choices? Airphoto interpretation can only reveal the trends, for the explanations other methods of investigation have to be applied.

The publication on the results of the study for the Connecticut River Valley does not give clear information on relations between recreational land use and the resources.
In the case study on the developments around Lake Proserpina, one of the interesting aspects is the concentration of houses and facilities on the southeastern shore. Because the physical characteristics of the shoreline are similar almost all around the lake, proximity to the main road from Mérida must have been quite influential. A further consideration is the presence of trees and wooded areas. Trees planted between 1956 and 1969 obviously enhanced this area, but trees were also planted in the northeastern section. The planting pattern, of course, may have reflected existing preferences. A third, and perhaps more important, element may have been the willingness of landowners to sell various parcels of land for recreational use.
Although nearness to the lake may have been an important location factor for summer homes, planning regulations require a distance of at least one meter between the shore and fences around private lots. Direct private access to the lake is thus eliminated. (Van der Zee, 1982).
One observation can be made with respect to the trap-shooting range with clubhouse that seems to have triggered off the whole development. Location at the lake shore means that no large terrains on land have to be secured because of falling shot and target disk fragments. Location at the southern shore then is preferred because for shooting in northerly directions the sun angle is favourable during the largest part of the day.
The possible strong correlation between recreational development and road construction or road improvement in the Mae Sa valley has already been mentioned in chapter 3.2.

It can be concluded that, when analyzing sequences of airphotos, the relation between recreational facilities and their resources may become more clear than when only single situations can be analyzed, and thus can help in answering the question of objective 3. It may be even possible in some cases to say something more specific about the parameters than when using a single coverage of airphotos, thus contributing to an answer on the question of objective 4. But, it is also clear that, even when using sequences, airphoto interpretation can only give part of the answers. The rest of the answer has to be obtained by other means. Still, the interpretation of sequences of airphotos may help to point out which other ways best to explore.

4. ANALYSIS OF SPATIAL BEHAVIOUR.

4.1. DIFFERENT WAYS OF ANALYZING SPATIAL BEHAVIOUR WITH AIRPHOTOS.

The need for knowledge on spatial behaviour.

By an inventory of recreational facilities, as in the potentialities approach, a fair impression can be gained of the spatial distribution of recreational landuse that is the result of the interplay of physical suitability, accessibility and scenic quality of the landscape. It appears that although recreation can occur everywhere it still tends to be highly localized. (Coppock, 1966; Patmore, 1983; Van der Zee, 1990).

What applies to the distribution of recreational land use at a regional level, also applies to the distribution of recreational activities at a local level, for example, over an individual recreation area. It has been observed in many instances that within a single recreation area perhaps as much as 95 per cent or more of total use occurs on as little as 5 per cent or less of the total area (Clawson, 1963; Clawson and Knetsch, 1966; Joint Schools Survey, 1970; Maas, 1971; Van der Zee, 1990). Recreationists often do not perceive and use a recreation area as an entity, but as a combination of separate locations: a certain panoramic view point, some recreational routes, some facilities, some sites to relax, the stay accommodation, all together not forming a spatial entity in the sense of *bounded space* (Mulder, 1982).

This is not unique for recreation areas. The same pattern of imbalance in space use has been observed in city areas, for example by Whyte (1980). *Demand is not blanket in its expression, but rather confined to narrow corridors of movement and to nodes in the network of routes, to recreational gathering points, or honeypots* (Patmore, 1973).

The overcrowding of such popular sites or *honey pots* raises the problem of how access and development can be allowed and managed with a view on long-term conservation (Cosgrove and Jackson, 1972). It also means that, even though in the most isolated areas always some plants will be trampled and animals disturbed, the largest part of the area can be managed with minor measures only (Van der Zee, 1990). However, when the planning and management of recreation areas enhance this spatial segregation too much, this may lead to isolated recreation facilities or so-called *recreational flowerpots* (Van der Voet, 1989; Van der Voet and Haak, 1989; Dietvorst, 1989a; 1989b; 1989c). Such a spatial segregation of functions is perpendicular to present social processes such as individualisation, differentiation in life-styles and changing time-space behaviour (Dietvorst, 1989a; 1989b; 1989c). This rather asks for more integration, for example into *touristic-recreational complexes* (Dietvorst, 1989a; 1989b; 1989c), that serve *activity clusters* (Ashworth, 1985).

In addition it has to be realized that recreationists not only use specially designed facilities of often large scale, but also all kinds of recreational possibilities in areas with a dominant non-recreational function in the context of *multiple use* (Dietvorst, 1989a; 1989b; 1989c).

Average visitor densities as expressed in total numbers of visitors divided by the total area of the recreation terrain in this context are absolutely irrelevant. With low overall average densities certain sites and roads may be used on occasion almost at, if not already beyond, their capacity.

In order to be able to plan for proper management of recreational resources detailed information on the spatial behaviour of recreationists within a single landscape or landscape element is required. How do people walk in the forest, where do they sit down? Where do people sit down at the beach or the lake shore, what parts of the lake are more frequented by boats and what parts hardly visited? (Van der Zee, 1990). And not only what people do where is of interest, but also at what moment and in what order. Such information pertains to the time-space pattern of activities, that in turn can indicate how different facilities are interrelated. In addition, such information can help in (further) specifying the physical requirements of a recreation type and in determining how the different aspects of suitability are interrelated in specific situations (Van der Zee, 1990). Although the presence of facilities certainly influences the spatial behaviour pattern, inventory of facilities as discussed in the previous chapters does not contribute very much to this type of information. Other approaches are needed.

Analysis of spatial behaviour of recreationists.

The analysis of the way in which the structure of space in a landscape influences the spatial behaviour of recreationists and their distribution over a recreation area can be done by field observations, marking on a map the places where groups or individuals settle down and counting numbers of persons and groups met in the various types of areas, at specific times of the day or in the season (De Jonge, 1968). Of course, such observations only relate to the actual demand, to what people do, not to what people would prefer to do of no restrictions whatsoever would be present. Interviews with recreationists can add to the information (De Jonge, 1968), and may be also reveal something of the latent demand. See also chapter 2.1. for the discussion of the demand aspect and the possibilities and restrictions of recreation behaviour surveys in general.

De Jonge (1968) states, that by comparing observations on spatial behaviour of different areas and periods it may be possible to draw conclusions about some general trends in the choice of places and about the way in which these trends are manifest under changing circumstances. However, as Van der Ploeg (1990) states, such observed recreation patterns are the result of *specific* combinations of visitor characteristics and physical characteristics for *different* recreational use forms. They are thus aggregates that cannot be traced back to simple explanatory variables. Such aggregated recreation pattern information is descriptive but not explanatory and its value for multiple use management can be questioned. Still, he does not see a good alternative, as frequent interviews with visitors at many different sites seem virtually impossible because of costs and because they would also be a nuisance to the visitors.

For recording numbers of visitors to a certain area mechanical and or visual traffic counts can be carried out at the entrance(s). Visual counts can not be carried out continuously, therefore samples have to be taken. For interviews sampling is even more unavoidable. (Van Hoorn et al., 1988a; 1988b). Still, in a way, such inventories are relatively simple. To record the way in which visitors distribute themselves over the area is much more complex. Even without interviews the approach suggested by De Jonge (1968) is very labour intensive and thus expensive and hardly suitable to cover large areas or be frequently repeated (Van der Zee, 1990). More cost-effective methods, for example with the use of aerial photographs, would be welcome also in this case. This possibility has been suggested already by Dodt and Van der Zee (1984). Two main approaches can be distinguished in this respect.

One is to study the spatial behaviour of recreationists by analyzing the visible impacts that it has on the environment. Sometimes this can be done by interpreting a single coverage of aerial photographs, but more information can be obtained by analyzing sequences of airphotos. Because the spatial behaviour of recreationists is not analyzed directly but only indirectly by studying or monitoring the impact of recreation on the landscape this approach can be called *indirect monitoring* of the spatial behaviour pattern. Such analysis may say something about the spatial behaviour pattern, but does not reveal anything about the time dimension of the behaviour pattern. (Van der Zee, 1990). This approach will be discussed to give an answer on the question of objective 6.

If on airphotos the recreationists themselves and/or their vehicles can be identified, their spatial distribution in the terrain can be studied directly. If then several sequences of airphotos taken during the same day, on successive days or on different days throughout the season can be interpreted, not only certain regularities in the pattern may be observed, but also the time dimension in this distribution pattern can be studied and may give information on the dynamics in the spatial behaviour pattern. This approach can be called *direct monitoring* of the spatial behaviour pattern (Van der Zee, 1990), and will be discussed to provide an answer on the question of objective 7. In addition, both approaches relate to the question of objective 8. They will be further discussed in the following two sections of this chapter.

4.2. INDIRECT MONITORING BY ANALYSIS OF THE IMPACT OF RECREATION.

The analysis of the impact of recreation on the environment can not only give an impression of the spatial behaviour of recreationists, but is also relevant for its own sake in the context of land evaluation for recreation. It reveals which parts of the landscape are more damaged by recreation and which less, and under certain conditions also which elements apparently are more sensitive and which more resilient. This is very important information especially when trying to balance recreational developments with the conservation of nature and landscape in planning and management. For these reasons objective 6 has been included in the study.

Different types of impact.

What type of impact recreation will have on the landscape and how strong will depend on the type of recreational activity on the one hand and the type of landscape on the other hand. The impact of recreation can be and has been distinguished into various categories or types, both from the point of view of causes and of effects, as well as with respect to size of area affected and intensity. Examples are given by: Marsz, 1972; Usher, 1973; Liddle and Scorgie, 1980; Rambousková, 1981a; 1982a; 1982b; 1982c; Van Oort and Jeekel, 1982; Patmore, 1983; Van Berkel, 1983; Van der Ploeg, 1984a; RMNO, 1983b; 1984; 1985a; 1988; 1989; De Vlas, 1985; Goderie, 1986. Not all of these categories lend themselves easily, if at all, for analysis by airphoto interpretation. In addition to that, not many impacts can be exclusively attributed to recreation, and it will be difficult to assess recreation's share in them (Rambousková, 1981a; 1982b; Van Berkel, 1983; Van der Ploeg, 1984a), while another problem may be presented by the spatial and temporal discontinuities between cause and effect (Rambousková, 1982b). Therefore no attempt is made here to give a comprehensive classification or overview of all types of impact of recreation, but instead only a focus on those that can be analyzed with the aid of airphotos. Three main groups of impacts will be discussed. The most conspicuous of course is the impact by physical facilities. The impact on vegetation may only become visible when it is severe enough. For the impact on the animal world airphotos might only indirectly be of use.

Impact by physical facilities.

All recreational facilities occupy a certain amount of space, even though in its direct claims on space, recreation is remarkably modest, and also comparatively little of the land used for recreation, especially in rural areas, is devoted exclusively to that purpose (Patmore, 1983).
It is not only the recreational residence and related facilities that create an impact on the landscape. The transportation network providing the internal and external accessibility of recreation areas can put a heavy claim on the environment too. Also facilities created for directly serving the recreational activities may occupy considerable space and severely influence the landscape. For example, in Austria alone between 1964 and 1975 more than 10 000 ha of forest was cut for ski pistes (Lansink, 1983; Van der Zee, 1990)
But, in addition, the impact on the environment can not always exclusively be attributed to recreation. Some of the facilities are under multiple use, and in many cases the contribution of recreation to the impact is only marginal. Still, locally it can be of considerable influence. How well different types of recreational facilities and infrastructure can be interpreted has been discussed in chapter 2-2, and how analysis of sequences of airphotos can show the pattern of development in space and time and thus reveal something about preferences and spatial behaviour at that level has been discussed in chapter 3. For this type of impact the answer on the question of objective 6 therefore has been given already and needs no further elaboration.

Impact on vegetation.

The impact of recreation, however, is not necessarily restricted to the space it directly occupies with physical facilities as a landuse. That a natural landscape is without any *official* landuse does not imply that it is not used at all and thus uninfluenced by man. Whenever recreationists visit the natural landscape, they walk in it, sit in it, play in it, throw litter around in it, in short:

display a behaviour that normally is not destructive in intention but is damaging in effect because changes in vegetation, often resulting in degradation and even erosion, are the results. (Van der Zee, 1983; 1991). *People, if there are enough of them, can do as much damage to young vegetation as a bulldozer* (Clawson and Knetsch, 1966).
The vegetation may be influenced in several ways by recreation. Littering by durable substances that are practically not subject to decomposition, such as glass, tins, plastics and rubber, may locally obstruct plant growth or affect some animals. But more important is that it may make an area less attractive for recreationists, who try to avoid it and shift their activities to areas that are not yet degraded, thus spreading the impact more and more. (Marsz, 1972). Littering by organic substances, subject to a relatively quick decomposition, can have serious consequences in spite of relatively fast self cleaning capacities of the terrain, because during a short time the conditions of habitat are changed, mainly by over-fertilization of the soil. (Marsz, 1972). Such littering may turn oligo- or mesotrophic environments into eutrophic ones and thus change the species composition. (Van Ittersum and Kwakernaak, 1977; Rambousková, 1982c; Weber, 1982; RMNO, 1985a; Van der Zee, 1990).
Recreationists may pick flowers, or take fruits or parts of the vegetation or even dig out complete plants. If this is done frequently and continuously some species may disappear. Planting of non-endemic vegetation elements is another way of (unwanted) influence on the vegetation of an area. (RMNO, 1985a; Van der Zee, 1990). Excessive withdrawal of water from the groundwater layers to meet peaks in water consumption caused by peaks in recreational visit may result in the lowering of the groundwater table to such an extent that the vegetation is seriously influenced (Van der Zee, 1990). On the Dutch Wadden Sea Islands the groundwater extraction in summer largely exceeds natural accretion of the volume. This has induced a remarkable change in the vegetation in many areas, wet dune slack vegetation being replaced by bushes and by flora that is less specific for the dunes. (Van der Ploeg, 1990).
Changes in vegetation that are the result of these impacts, if not too subtle, may be detected through interpretation of sequences of airphotos by a specialist in airphoto vegetation survey. But so many conditions have to be met, that no guarantee for success can be given for this method in all cases.

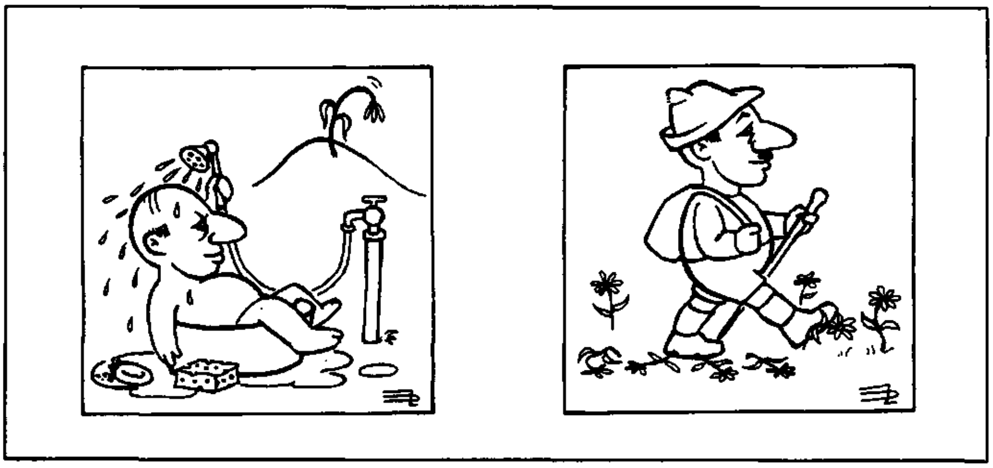

Figure 4.1. *Vegetation can be influenced by excessive withdrawal of water and by trampling.*

However, the effects of recreation are most pronounced when the feet of repeatedly passing recreationists create a network of tracks and paths and even areas of bare soil. This is the ultimate stage of a process called *trampling*, that starts with a change in the vegetation composition and a general degeneration of the vegetation. (Frederiksen, 1977; Hylgård, 1977; Van der Zee, 1983; 1991; Goderie, 1986). Trampling not only is considered detrimental to plant communities because it tends to result in death or injury to individual plants, but also because it can adversely modify their growing environment (Bayfield, 1979).
Of all impacts on vegetation the effects of trampling have been studied most frequently (Van Berkel, 1983; Cole, 1989), probably because it can be easily observed at the hand of changes

in soil and vegetation (Van Berkel, 1983). Therefore, and because in many cases airphotos can be very well used in the analysis of these effects some more attention will be given to them in a separate paragraph.

Impact on animals.

The impact of recreation on the animal world occurs in various ways, directly or indirectly. Indirectly through reducing the extent of the habitats by the construction of all kinds of physical facilities, or by changing the character of habitats by the impact on the vegetation or the water quality. (RMNO, 1985a; Van der Zee, 1990). Animals are often strongly dependent on plants for food, shelter, breeding sites, or simply for somewhere to sit, therefore they may suffer indirectly if plants themselves are affected (Liddle and Scorgie, 1980; Bayfield, 1979). Very direct impact on the animal world is by taking or killing of fauna (RMNO, 1985a). This may range from fishing and hunting to small animals being crushed by trampling (Bayfield, 1979). But also the mere presence of recreationists has to be considered as a direct impact. Persons, boats, vehicles, planes and the like radiate a certain influence in the terrain. (RMNO, 1985a). Most important aspects are noise, vibrations and visual disturbance (RMNO, 1985a; Liddle and Scorgie, 1980). Especially larger mammals, birds of prey, small singing birds and birds that nest on the ground are susceptible for it (Goderie, 1986). And even in the most isolated areas animals are disturbed, if not by a noisy school-class then by an enthusiastic botanist, photographer or bird-watcher (Maas, 1980), or by a hang-glider or parasailer (Pavlicek, 1991). When the disturbance is frequent and continuous this may result in a disappearance of certain species or in a reduction of animal life in total.
But recreation does not only lead to the expulsion of animals. There is stocking for recreational purposes, for example with fish or pheasants. Scavenging species are attracted to areas where there is litter accumulation, as in car parks and on or around campsites. (Usher, 1973).
Direct feeding of animals -so nice for the children- may lead to local overpopulation of pigeons, squirrels or ducks.

Case studies of recreation impact on animals are numerous, but results are often contradictory and highly site- and species-specific. Studying animals' reactions to recreational use is difficult because undisturbed populations are hard to locate and mobile animals are usually difficult to monitor.
The impacts of recreationists on wildlife may be most severe in winter when animals are weak and stressed. (Cole, 1989).
The impact of recreation on the animal world is therefore less easy to determine and inventory than that on vegetation. But, although the possibility to inventory this impact by remote sensing as such is negligible, it does not mean that the technique can not be applied in this context at all. Airphoto interpretation can be used for the analysis of the types of habitats available in an area and the changes in types and extent of those habitats. Thus, for the Nieuwkoopse Plassen area in the Netherlands, for example, a map of the vegetation structure was made by interpretation of vertical colour airphotos of 1:2500 (BM&RIN, 1984; Van der Hoeve, 1985). The map, produced on 1:1900 was used to characterize the habitats of birds (BM&RIN, 1984) and served as a base to design a programme of field observations to analyze the influence of recreation on breeding birds (Van der Hoeve, 1985).
An example of a habitat map of a much larger area, that is based for a large part on the interpretation of aerial photographs, is that of the Wadden Sea (Dijkema, 1990a; 1990b). From this map ecological maps have been derived, from which possible consequences or impacts of actions, including recreational activities, on various elements of the ecosystem can be assessed (Veld and Dijkema, 1989; 1990). A study of the consequenses of a reduction of the habitat of chamois was carried out by Pavlicek (1991). Other examples of the study of wildlife habitats, especially with respect to developing countries, are the studies of the habitat of the Javan rhinoceros by Hommel (1990), of the Sri Lankan elephant by Cox (1985, 1988), and the study of the Kora National Reserve in Kenya by Loth (1988).
In these cases, in which it concerns areas which often are very inaccessible and for which data, and especially maps, are non-existent, application of remote sensing is the only solution.

Another application that can be used in the context of studies on impact on the animal world is the inventory of numbers of animals by remote sensing. Not only in the case of large animals counting from the air, directly or from (oblique) airphotos is practised, such as for example, for the seal in the Dutch Wadden Sea (Reijnders, 1976; Van Haaften, 1976; 1980; Reijnders et al., 1981) and for wildlife, and cattle, in African Nature Parks or Game Reserves (for example, Norton-Griffiths et al., 1983). But also seabirds and sea ducks are counted from the air (Laursen et al., 1989). The techniques and methods used are more or less similar to those used in the direct monitoring of the spatial behaviour of recreationists, that will be discussed in part 3 of this chapter.

The impact of trampling on vegetation.

Trampling comprises walking, sitting, lying, camping, horse riding and driving with (motor) vehicles (Van Berkel, 1983), and also jogging and informal (ball) playing. It is an inherent part of almost every recreational activity. Trampling affects plants directly and indirectly (Rambousková, 1982b).

The effects of trampling.

Most plants, of various species, are not killed by incidental trampling, but rather their stems and/or leaves are damaged, after which a plant may be partly or wholly recover. Repeated trampling will cause lasting effects, however. Such damage is most obvious when looking at plant height as a parameter. (Van der Ploeg, 1990). Trampling can reduce plant height, as well as the vigour, reproductive capacity, and abundance of plants. (Liddle and Greig-Smith, 1975; Cole, 1989; Coleman; 1981; Van Ittersum and Kwakernaak, 1977). In cases of very high trampling intensities plants have no opportunity to recover any more and will die (Van der Ploeg, 1990). Thus, where recreation use is heavy, all ground cover vegetation, except that in protected places, may be eliminated (Cole, 1989; Van Berkel, 1983).
In addition to this direct impact of trampling to plants, the environment will change as a combined result of changes in soil structure -for example, soil compaction- and changes in micro-climate -the vegetation becomes more *open* by the change in height- and plant growth will be different in due time in reaction to this. (Liddle, 1975a; Van der Ploeg, 1990; Van Berkel, 1983; Pavlicek, 1991). For some species the environment becomes unfavourable and they will be out-competed by other species that are more tolerant. Thus the vegetation structure and composition will change (Van der Ploeg, 1990), a loss of natural variety (Van der Zee, 1977) or biological variation (ten Houten de Lange, 1978).
The effects of trampling can be distinguished into different phases. First, trampling leads to marked changes in plant growth and in the reproductive performance of plants. Changes in species composition are quick to follow, with a competitive advantage given to the small number of species that are resilient to the effects of trampling. (Van der Werf, 1972; Liddle and Greig-Smith, 1975; Van Ittersum and Kwakernaak, 1977; ten Houten de Lange, 1978; Rambousková, 1982b; Patmore, 1983; Cole, 1989). Certain (groups of) plant species show strong correlation with high recreation intensity (Van der Werf, 1972; Rambousková, 1981b; 1982a; 1982b; Van der Ploeg, 1984a; Saris et al., 1984a; Van Lier, 1988), sometimes even are called *trampling flora* (Liddle and Greig-Smith, 1975), and thus plant communities can be classified according to both their resistance to trampling and their power of regeneration (Piotrowska, 1979; Van Dorp and Van Dijk, 1982). Some vegetation types are moderately resistant to trampling, others are considerably less resilient and still others can scarcely bear trampling at all (Frederiksen, 1977; Van Ittersum and Kwakernaak, 1977; Kontturi and Lyytikainen, 1985; MacConnel and Stoll, 1969; Rambousková, 1981b; Coleman, 1981). However, such a definition of resistance to mechanical destruction is of relative value only (Piotrowska, 1979). With continued pressure, the percentage of bare ground increases, when the intensity of trampling is sufficient to inhibit the growth of even the most resistant species (Hylgård, 1977; Frederiksen, 1977; Kingo Jacobsen, 1977; Van der Zee, 1977; Patmore, 1983; Van Berkel, 1983; Cole, 1989). Such bare areas, that mostly appear in the form of paths, as result of concentration of use, can represent recreational impact in its most acute form. Many areas bear the scars of popularity (Patmore, 1983).

Aspects influencing the effects of trampling.

Two main groups of aspects determine the impact of trampling. One concerns the intensity of trampling, related to the number and type of users, the other relates to the sensitivity of the environment. (Coleman, 1981; Rambousková, 1982b; Van Berkel, 1983). A third group of factors may be added: the seasonal fluctuations of the weather, which modify the effect of the first two groups. The weather fluctuations may be considered to be the same within a relatively small area. (Coleman, 1981).

The *intensity of trampling* is a function of the number of passages by users and by the type and the weight of these users. (Rambousková, 1982b; Van Berkel, 1983). Users vary greatly in their potential to cause impact. Impact potential generally increases from walkers or hikers to horsemen or pack animals to motorized vehicles. An experiment on a sloping mountain grassland in Montana (USA) revealed that 200 motorcycle passes removed twice as much vegetation as the same number of passes by a horse and nine times as much as 200 passes by hikers. (Cole, 1989). In addition to the weight of the walker, the type of footwear, and even the gait of the individual will influence the detailed force distribution on the ground. The exact force exerted by trampling on any part of a terrain can not be calculated, for practical reasons, except under controlled experimental conditions. In absence of such control it has been assumed that these factors can be considered in total and represented by a simple count of the number of passages. (Coleman, 1981).

Other user characteristics that are likely to influence impact include party size, length of stay, and knowledge and commitment to minimizing impacts (Cole, 1989). The frequency of use may be as important in assessing recreation pressure as total numbers, but little data exist to confirm or deny this (Coleman, 1981).

Impact is also a function of *site durability* or *sensitivity*, which is again related to soil characteristics, vegetation types, land forms and design or terrain management features (Van Ittersum and Kwakernaak, 1977; Patmore, 1983; Cole, 1989). With respect to slopes, they are extra sensitive (Van Berkel, 1983), the steeper the slope of a terrain, the smaller its resistance to trampling (Marsz, 1972). Walking downhill has been found to be more damaging than walking uphill and the maximum force exerted upon the ground was found to increase with slope. A steep cross-slope has an inhibiting effect on path width. (Coleman, 1981).

The making of maps of soil, terrain form, vegetation cover and land use with the use of airphotos or satellite images has become more or less routine already. Therefore in cases in which such maps are not already existing, this part of the study of recreational impact can be easily based on airphoto interpretation, provided that properly trained specialists can be engaged.

Also the attractiveness and accessibility of the terrain play a role. Around features that are attractive for recreationists: a small lake, flowering heath land, bramble bushes, look-out points and of course the shore, higher concentrations of visitors will occur. For walkers and cyclists a landscape with high variation in vegetation and relief will be most attractive. The accessibility of the terrain is determined by the vegetation structure, soil condition and groundwater level. In addition to that the location with respect to recreational facilities is important. (Van Ittersum and Kwakernaak, 1977).

Some landscape elements, are more vulnerable than others. Coastal sand dunes are particularly vulnerable. (Patmore, 1983). They have a low resistance to mechanical destruction resulting from their excessive recreational use (Piotrowska, 1979), because of the loose sandy soils and the thin vegetation cover (Edington and Edington, 1977; Van der Meulen et al., 1985). Heavy pressure on the dune landscape, mainly by pedestrian visitors, has been reported from several areas along the Dutch coast, including the Wadden Sea islands. The main problem is caused by people walking randomly through the dunes in great numbers, creating paths, erosion spots and gullies, destroying vegetation and disturbing animals. On the Wadden Sea islands an increase in illegal paths of 15 to 60 % within a period of six years has been reported. (Van der Ploeg, 1990).

The alpine or mountain ecosystems are very sensitive too, because the soils are very thin, the slopes make them less stable, and regeneration processes go slow or are absent at all (Lansink, 1983), because of short growing seasons (Cole, 1989) and severe climatic conditions

(Coleman, 1981; Rambousková, 1982b). Also in deserts, where moisture is the limitation, recovery rates are slower than deterioration rates. (Cole, 1989).
It is especially the herb layer of the vegetation that is affected most by trampling. This is the layer that is most important in keeping the top-soil together. If it is damaged or removed the soil is exposed to erosion by water and wind.

The length of the growing season has been mentioned already as a factor influencing the sensitivity of the vegetation to trampling. This relates to the third group of factors, that might be comprised in the term *seasonality*. Does trampling occur concentrated in particular periods of the year, and if so, how does this relate to the life cycle of the vegetation? If peaks in trampling intensity occur in seasons of the highest sensitivity of the vegetation, then the damage will be most severe. Trampling in other seasons might be far less destructive, and if plants are left in peace during crucial periods in their life cycle, their regeneration power may be left unharmed. Or, does trampling occur throughout the seasons? If so, does the vegetation get any opportunity to recover of the damage incurred or not? A low but continuous recreational pressure may in the end be more devastating than short periods of high pressure. The trampling pressure in a dry year may have more severe effects than the same amount of trampling in a relatively wet year. That is not only because plants may be more resistant when not being under a drought stress too, but also because the spatial behaviour of the recreationists is different under different weather conditions. It therefore may vary from one season to the other and even from one year to the other, and in addition may show an evolution through the years.
This all does not make it easier to analyze the effects of trampling, leave alone to venture into predictions for the future. Moreover, not all changes in the vegetation need to be considered negatively. A certain amount of pressure may lead to a larger diversity in the vegetation that could be valued positively. But, without engaging in this discussion, how can the impact of trampling be determined?

Approaches to determine the impact of trampling.
There are two main problems in the determination of the impact of trampling. One is the collection and quantification of data that can be used to express the impact (Rambousková, 1981b), the other is to relate that to a quantified recreation pressure.
Usually three ways of observing the recreational impact are distinguished:
1. Monitoring a change through time; this requires a time series of observations of both recreational use and condition of vegetation. (Rambousková, 1982b). A study into the influence of recreation on the natural conditions in a certain area should preferably be done in this way, the so-called longitudinal research (BM&RIN, 1984). It not necessarily means continuous observations, but just at certain (regular) intervals.
2. Simulation, that is, direct observation in time of an impact being induced and measured under controlled experimental conditions (Rambousková, 1982b).
3. *After-the-fact analysis*: comparing an affected and adjacent unaffected site with respect to the differences that can be attributed solely to the effects of outdoor recreation (Rambousková, 1982a; 1982b; BM&RIN, 1984).
   This is commonly expressed in the differences in vegetation structure and species composition and the occurrence of anthropophytes (Rambousková, 1981b). Such research is called *transversal* (BM&RIN, 1984), and often has to be resorted to when time and budget are lacking for longitudinal research. It will be very difficult however to find areas that only differ in recreational pressure and not in any other respect (Rambousková, 1982b).

The changes in vegetation composition and a general degeneration of the vegetation, that are the result of the first phase or intensity level of trampling impact, are difficult to measure and to express in figures (Van der Zee, 1977; 1983). Such changes lead to a gradual disappearance of plant species and/or animal species. A lot is still left, but it is difficult to see what is no longer there (Thalen, 1977), and, moreover, the disappearance of some species may hardly appeal to most people (Van der Zee, 1977).

When it is known from earlier studies which species are sensitive and which more resistant, then the absence or presence of certain species can be used as an indicator for the intensity of trampling (Usher, 1973; see also: Van der Ploeg, 1984a; Saris et al., 1984a). In stead of mere absence or presence registration it has also been attempted to define the degree of complexity and multiformity of the vegetation by numerical indices (Kostrowicki, 1970). On this base the resistance of plant cover to trampling has been expressed in a formula, that includes the percentages of the area covered by species resistant to trampling, species moderately resistant to trampling, species not resistant to trampling and bare soil (Marsz, 1972). The data on which such an approach has to be based can only come from field observations, because airphoto interpretation can not, or only in an incidental way, reveal anything about the floristic composition of the vegetation.

Not only floristic composition but also vegetation structure has been found to be clearly related to measured recreation intensity (Van der Ploeg, 1984a; Saris et al., 1984a). Such differences in structure in some cases are identifiable on airphotos, but not in all.
It is rather difficult to assess the effects on vegetation of relatively low trampling intensities, but disappearance of all plants is both more striking to people as well as measurable and quantifiable. When trampling becomes so intensive that even the most resilient plants can not recover, the vegetation disappears completely and a bare path appears. Narrow paths become wide paths and paths may grow together into big bare areas. (Van der Zee, 1977; Van der Ploeg, 1990). A distinction between clearly visible paths and the rest of the stands (*non-path*) has proven to be important (Van der Ploeg, 1990). Such paths are referred to as *wild, spontaneous* or *illegal* paths in contrast to the officially designed and thus *legal* paths. Also the terms *worn-out* paths or *beaten* paths (Van Ittersum and Kwakernaak, 1977) have been used, referring to their erosive origin. Man behaves as a herd-animal and follows the tracks someone else made earlier (Van Ittersum and Kwakernaak, 1977). But also because compacted soils and short vegetation are easier to pass over than the undisturbed adjacent soils and vegetation a once formed path easily leads to repeated use. This is enhanced by greater number of visitors. (Van Berkel, 1983). Thus small tracks become wider and wider and become quite distinct and visible paths, one more reason to follow them (Van Ittersum and Kwakernaak, 1977).
More intensive trampling may lead to denser beaten path patterns, but also to widening of the already existing beaten paths. Especially where they join or cross, large areas without vegetation may result, which by the action of the wind may become rapidly extended. (Van Ittersum and Kwakernaak, 1977; Van der Zee, 1977).

Path density and percentage of bare soil can be used as a reasonably objective measure of impact (Van der Ploeg, 1984a; Saris et al., 1984a; L.Zonneveld, 1987), even though it is not always easy to relate these parameters to recreation pressure, because spontaneous paths do not appear everywhere, bare areas may have occurred also before the recreation era and the original vegetation is different everywhere (Van Dorp and Van Dijk, 1982). It has been observed, that at places where visitors frequently leave the *legal* paths, most illegal paths are found, but a causal relation between the total number of recreationists beyond paths and the estimated length of illegal path could not be established (Van Berkel, 1983; Van der Ploeg, 1990).
But because the network of spontaneous paths as well as the total area of bare spots both are clearly identifiable on airphotos, the length of the paths, the density of the path-network and the extent of area of bare soil can easily be measured and expressed in figures (Van Ittersum and Kwakernaak, 1977; Van der Zee, 1977; 1983).
And because this *recreational erosion* is a gradual process there are numerous small, often almost imperceptible changes, that are not seen in their interrelation and are not reflected in official permits or licenses or in visitor statistics. They are difficult to represent because each individual observation seems so insignificant. (Thalen, 1977). Imperceptible changes may, however, be cumulative and become perceptible after numerous repetitions of the action (Zube, 1987), and then they may suddenly be experienced as a threat to what still remains (Thalen, 1977).

Often the extent of such changes can only be really judged by comparing sequences of aerial photographs. Such monitoring of paths can give an indication of the changes in recreational pressure through the years. (Van der Zee, 1977; Van Berkel, 1983; BM&RIN, 1984; L.Zonneveld, 1987; Van der Ploeg, 1990).

An analysis of the pattern of paths caused by trampling will make clear what are the points of interest for the recreationists. For example, in the Dartmoor National Park survey it was observed that visitors had worn a network of paths linking car parks, rocks and a granite quarry. (Joint Schools Survey, 1970). Thus, the patterns revealed by an inventory and analysis of the effects of trampling may give a further detailed indication about the relation between certain recreation types and specific landscape elements, and can also reveal something about the spatial behaviour of the recreationists.

Airphoto interpretation of recreational erosion.

When trying to apply airphoto interpretation to analyse the impact of recreation on the vegetation, the *wild* paths and bare areas resulting from recreational erosion are the most obvious objects to focus on. This has been done in several studies, more or less systematically. Some approaches are merely qualitative and descriptive, other studies attempt a qualification, but the way in which the amount of impact or the degree of increase is expressed is not always the same.

Some examples.

In the study on *tourist wear* on the Skallingen peninsula, Denmark, it was stated that it could be observed on airphotos that the vegetation was trampled to pieces. When comparing airphotos of 1945, 1954, 1961, 1975 and 1976, in the first three coverages only one track was observed and only in the airphotos of 1975 and 1976 a whole network of tracks and paths was found. (Frederiksen, 1977). But nothing is mentioned about a systematic analysis of the airphotos in order to analyse the path pattern or try and quantify this impact. Instead only field measurements on sample areas and transects, as well as enquiry surveys and traffic counts were carried out. It can be assumed that may be the selection of the sample sites and transects was based on the information obtained from the airphotos, but that has not been specifically stated. (Frederiksen, 1977; Hylgård, 1977; Thiesen, 1977).

In a study into the effects of trampling and vehicles in the Aberffraw sand dune system on Anglesey, North Wales, the increase in paths observed in a comparison of airphotos of 1960 and 1970 was expressed in the length of paths. In 1960 3.2 km of track and 2.2 km of footpaths were measured, in 1970 11.7 km of track and 16.5 km of footpaths even though the smaller footpaths have been omitted. (Liddle and Greig-Smith, 1975).

The nature reserve *Westruper Heide*, located to the North of the big German population agglomeration *Ruhrgebiet*, is a heath and dune area of 62.5 hectare on which in the 1970's at certain days already 1000 persons at the same time have been counted. Comparison of airphotos of 1954 and 1979 reveals that the road and path network not only increased in density but also in width. In this case not the length of paths was used as an indicator, but the width, or rather the area covered by paths and bare spots. In 1954 only 3% of the area was covered by paths and bare spots, in 1979 already 7% (Wittig, 1979; Weber, 1982). The width of paths was also used as a parameter in a study in Brabant, the Netherlands, where spontaneous paths were mapped from airphotos (Voskens-Drijver, 1987).

For a dune area near Wassenaar, the Netherlands, where spontaneous paths were mapped from airphotos of different years, the increase was expressed in *path density*, that is, length of path per unit of area. Thus an increase from 770 m path/ha in 1967 to 1070 m path/ha in 1971 was observed. In an adjoining area, near a parking place, a density of 1660 m path/ha was observed already in 1966. (Van der Werf, 1972).

For a study of the Berkheide, a dune area along the western coast of the Netherlands, false colour airphotos of 1:2500 were used and interpretation maps as well as maps with field observation data were drawn on 1:2500 too (Van Dorp and Van Dijk, 1982). This has to be considered as a *luxury* study, which is possible only for small areas. When comparative analysis of larger areas is required special purpose aerial photography most likely is out of the question and already available material originally made for other purposes has to be used. Usually this implies smaller scale panchromatic airphotos. This has been the case in the study of the Wadden Sea islands.

The Wadden Sea islands study.

When using the length of paths or the width, a quantitative comparison is only possible for the same area over time, but different areas can not be mutually compared. Path density in this respect is a more convenient parameter. It has been applied in the study on the recreational erosion on the Dutch Wadden Sea islands (Van Ittersum and Kwakernaak, 1977), which can be used to illustrate the approach of a comparative study of a large area carried out still within a reasonable time with limited manpower. For this study airphotos of 1969/70 and 1975/76, predominantly on scales of approximately 1:20000 were used. For details see the Annex.

The advantages to use airphotos for such a study are clear, if not self- evident. Topographic maps do not present the *spontaneous* paths and can not be used therefore. (BM&RIN, 1984; Voskens-Drijver, 1987). The Skallingen study and other studies make clear that with field measurements only small sample areas can be covered and therefore are not suitable for a comparative study of large areas. Moreover, time series are hard to get in this way.

In the study of the Dutch Wadden Sea islands first the airphotos were interpreted in order to arrive at a general classification of the dune areas of all islands into landscape units, such as high dunes, low dunes and valleys. Other parts of the island were not considered because recreational erosion does not occur there. For each landscape unit, wherever necessary sub-divided into sub-units by natural or man-made demarcation lines, a preliminary assessment of trampling intensity (= path density) was made based on visual impression. The reconnaissance map resulting from this interpretation phase served as a base to select one or more representative test or sample areas on each island. This selection was done based on the variation in landscape units and difference in trampling intensity. For the islands Vlieland, Terschelling and Ameland the photographs covering these sample areas were then enlarged to 1:10000. For Schiermonnikoog instead existing airphotos of 1:6000 (1970) and 1:5000 (1976) were used.

In these test areas of each landscape unit, that were demarcated on the photograph, the length of the paths that did not appear on the 1:25000 topographical map was measured with a curvimeter for both survey years. Then the area size of each unit was measured with a planimeter. Thus the path density could be expressed in meters of path per hectare.

Field observations and measurements carried out in samples of the sample areas revealed that the values for path density and area of wind-blown sand obtained by photo measurement were correct or even a bit low.

Confusion with paths created by rabbits can be excluded. Such paths are much narrower and therefore can be seen in the terrain but not in the airphoto. Moreover, their pattern does not relate to the clear pattern of the *spontaneous paths* created by the recreationists.

The measured path densities were then compared to the visually assessed densities of the first interpretation phase, and based on this comparison values were extrapolated for those areas that had not been measured in order to arrive at a map of path densities for the whole dune area of each of the islands. Also separate small maps were made presenting an indication of the rate of increase of the path densities.

In order to make the comparison easier the path densities were classified into five classes. After systematic comparison of these classes with the measured path densities in the sample areas it appeared to be justified to attach a quantitative value to these classes.

For each island the extent of each class was measured and multiplied by the median value of that class, then by adding these values of all classes an approximation of the total path length and average path density per island was obtained. (Van Ittersum and Kwakernaak, 1977; Kwakernaak and Van Ittersum, 1978), see table 4.1.

Table 4.1. Increasing path density in the dune area of the Dutch Wadden Sea islands (1969/70 - 1975/76/77)

Island	size of dune area in ha	average path density in m/ha 1969/70	1975/76/77	increase in %
Schiermonnikoog	735	525	605	15
Ameland	1460	395	630	60
Terschelling	2400	345	480	40
Vlieland	950	305	415	35
Texel	2255	345	(375)	10

(Van Ittersum and Kwakernaak, 1977).

It has to be emphasized that the most important aspect in this approach is the comparison of different situations in space and/or time with respect to the difference in path density. For that the use of airphotos is excellently suited. For determining absolute measures of impact, leave alone mapping beaten paths and eroded areas in their precise location and extent, the accuracy of the method can be questioned. The example of Schiermonnikoog may serve as an example.

It also may have become clear from the examples, that airphoto interpretation of erosional paths is especially successful in open terrain. In wooded or forested areas it will be much more difficult if not impossible.

Schiermonnikoog studies.

For the island Schiermonnikoog some further sequences have been studied. First, when new airphotos of the island became available of 1979 (for details, see the Annex), an attempt was made to compare the situation of 1976 with that in 1979 by ITC student's work (Sombat, 1980). The same landscape unit sub-divisions were used as in the previous study, and also the basic interpretation sheets of that study could be used for comparison. A representative selection of sub-divisions was made for which sections of the 1979 airphotos were enlarged to approximately the same scale as the 1976 photos. Both the 1976 and 1979 airphotos were interpreted. The interpretation of the 1976 photos was compared with that by Van Ittersum and Kwakernaak, that of the 1979 photos could be checked by a very short fieldwork in the autumn of 1980. The bare sand areas were interpreted for the 1976 situation larger than by Van Ittersum and Kwakernaak, and for the 1979 situation larger than they appeared to be in reality. The lighter grey tones that were included on field inspection appeared to be no bare sand but (sparse) vegetation. Especially in the dry summer of 1976 of course the difference between sparse parched vegetation and bare sand is but subtle. But the main difference between the interpretation of Sombat and that by Van Ittersum and Kwakernaak is that Sombat only indicates the clearly white paths and Van Ittersum and Kwakernaak all linear phenomena, probably closer to reality. The exercise made clear that a person without profound knowledge of the phenomenon nor of the area studied, although being a skilled photo interpreter, can come to large differences in observed path lengths and extent of bare sand areas.

Because of the large differences observed a re-interpretation was made of two small sample areas (Van der Zee, 1981). But even an interpreter with knowledge of both area and phenomenon, although agreeing with the largest part of their interpretation of the 1976 photos, still found paths that were omitted by Van Ittersum and Kwakernaak, and had doubts about some paths that they did delineate. Also on the extent of bare areas in some places differences in interpretation occur. This leads to the conclusion that however objective the criteria are described and applied, an element of subjectivity can not be excluded. There is a low degree of *inter-observer reliability* or *replicability* (see chapter 1.4). This is similar to the conclusions of the discussion on the accuracy of house counts by airphoto interpretation in chapter 2.2. Also a study into the accuracy or certainty of interpretation of land units reveals that despite common training, a prescribed legend and interpretation criteria and a given set of *ground truth* points, a certain amount of disagreement between individual interpreters remains (Middelkoop, 1990).

In order to establish how large the differences between different interpreters can be in absolute sense, one of the sample areas of the re-interpretation of the 1976 situation by Van der Zee (1981) and the corresponding interpretation of Van Ittersum and Kwakernaak have

been digitized onto a common topographic reference base. (For location see Annex, figure A.6.). Although agreement exists on the main path pattern and the location of bare sand areas, with respect to details differences occur.
First of all the total path length in kilometres and the total area of bare sand in hectares have been measured and compared, see table 4.2.
It appears that Van Ittersum and Kwakernaak interpreted about one third more paths as well as sand areas.

Table 4.2. *Comparison of two interpretations of paths and sand areas.*

	Interpretation I	Interpretation II	Difference in % of I
Total path length in km	55.1	35.1	- 36.3
Total sand area in ha	10.4	6.9	- 33.7

(Interpretation: I = Van Ittersum and Kwakernaak; II = Van der Zee)

But, when plotting the two interpretations of the sand areas side by side it is clear that the main pattern is the same, see figure 4.2., but in interpretation II the delineation of sand areas appears to have been done more strictly or cautiously, whereas in interpretation I more ample criteria may have been applied and boundaries have been more generalized.
On the other hand, in interpretation II more small isolated bare spots have been delineated. There is definitely a difference in personal style of interpretation, that not only affects the *replicability of identification*, but also the *replicability of delineation*.

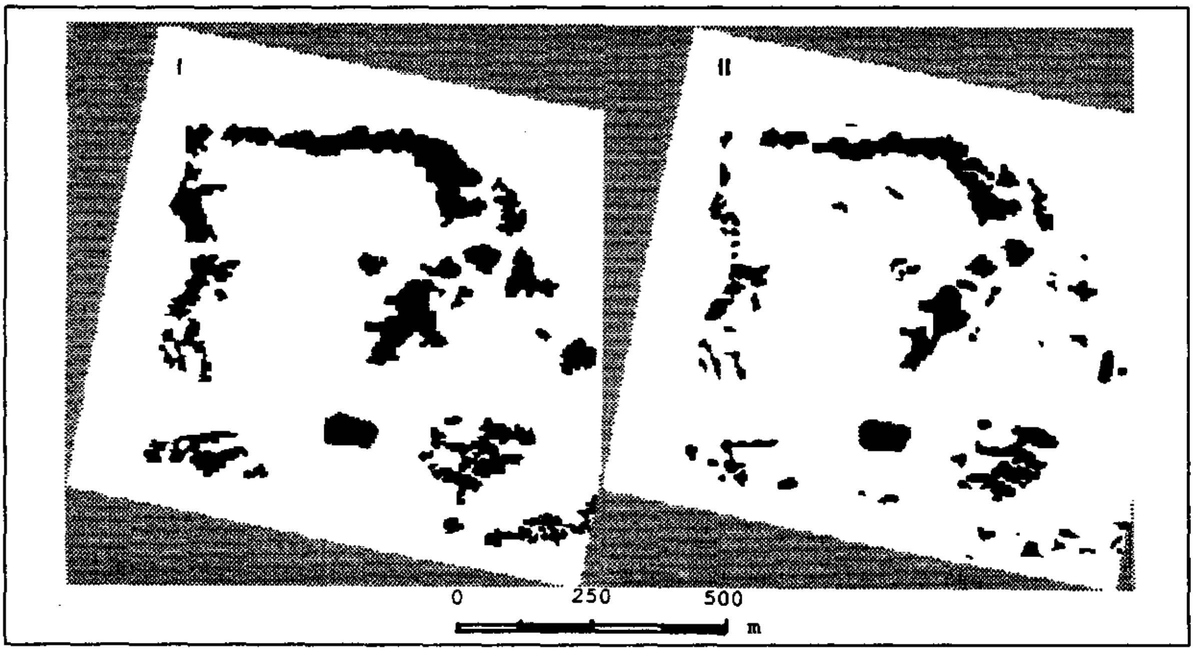

Figure 4.2. *Two interpretations of bare sand areas of the same airphoto of 1976.*

Compare also the interpretations with the airphoto in figure 4.5. When the two interpretations are superimposed on each other the differences appear more clearly, see figure 4.3.
Of the sand areas in interpretation II 78% correspond with sand areas in interpretation I, but 22% do not. This is partly because of the small isolated areas that are not included in I: *A* in figure 4.3. But for another part it is because, although the same areas have been outlined, they have been shifted to slightly different positions during the transfer to the topographic base: *B* in figure 4.3. If this dislocation could be corrected, more correspondence might be achieved. However, approaching it from the other side, of the sand areas in interpretation I only 53% correspond with sand area in II and 47% does not. Dislocation can not explain the overall difference in area of sand that has been interpreted (table 4.2).

The differences in interpretation may seem so dramatic because only a classification into two extreme categories was considered: *bare sand - vegetation cover.* If an interpretation would have been made allowing one or two transitional categories between bare sand and full vegetation cover, probably it would be found, that confusion between bare soil and full vegetation cover hardly occurs. Most of the mis-interpretations relate to the sparse vegetation cover areas, which as such may be as much an indication of recreational pressure as the bare sand areas. But even with such a more refined classification the problem of differences in delineation would not be solved. Compare the interpretation with the photo image of the area presented in figure 4.5.

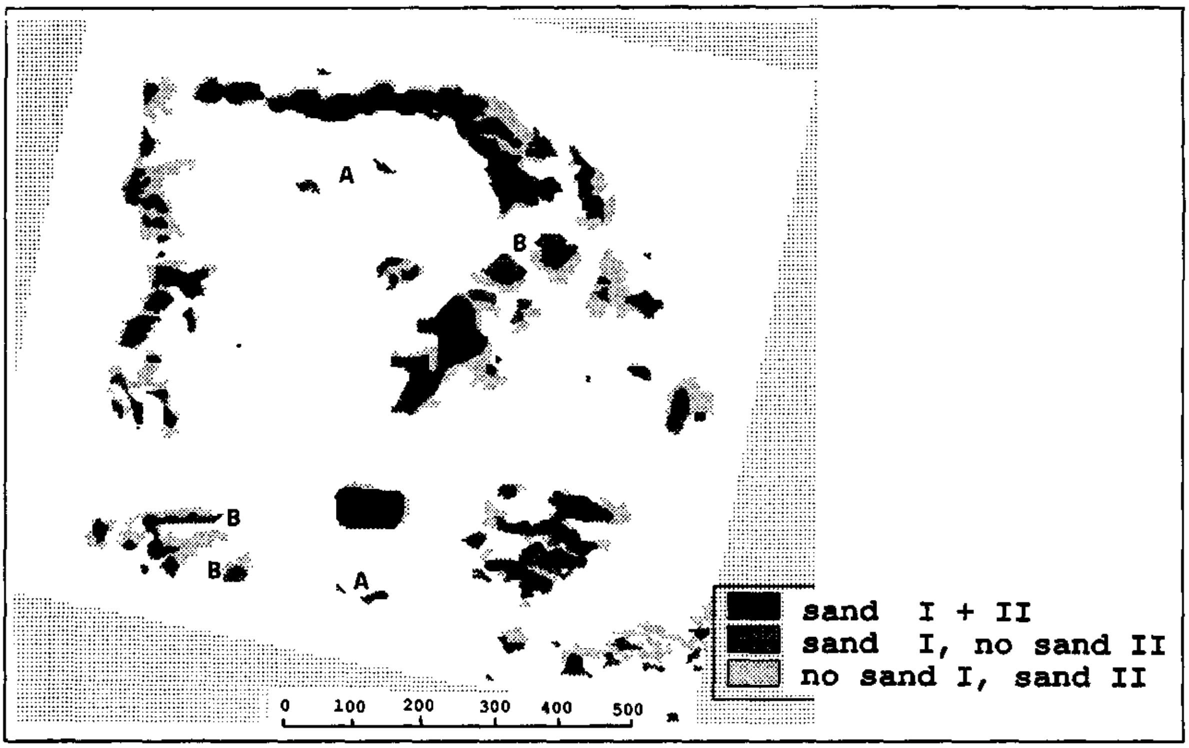

Figure 4.3. *The two interpretations of sand areas superimposed.*

Similar observations can be made with respect to the interpretation of spontaneous paths. Figure 4.4. shows the two interpretations side by side.
Interpretation I shows a larger overall density of paths than interpretation II. But where the highest densities occur in I, especially around a blockhouse from World War II, now one of the best look-out points of the island, they also have been registered in II. Also the main pattern of the paths is similar, although only incidentally paths have been registered in exactly the same position. Superimposing the two maps into one shows such shifts in location. A lot of more or less parallel systems can be seen. Only displaying the sections of paths that coincide, on a grid with cells of 2.5 metre, gives a rather diffuse pattern of dots and strips and only a few longer linear elements. There is not one specific section of the sample area, however, where the difference between the two interpretations is strikingly larger than in other sections.
In the photo image of figure 4.5 the path pattern is not or only hardly identifiable. For their detection the enlargement capacity of the stereoscope, the stereovision and above all the original print quality of the photograph are essential.
With such subtle elements in the landscape as these spontaneous paths, it is not surprising that there is not only the subjectivity in the interpretation, but also in the representation. Tracing the same very narrow, sinuous and may be faint line exactly in the same position is already difficult. Transferring it correctly to a topographic base will be another source of locational error. But, the objective is not to accurately map spontaeous paths, but rather to get an overall impression of the recreational pressure. And then the utmost precision in location and identification is not highly relevant.

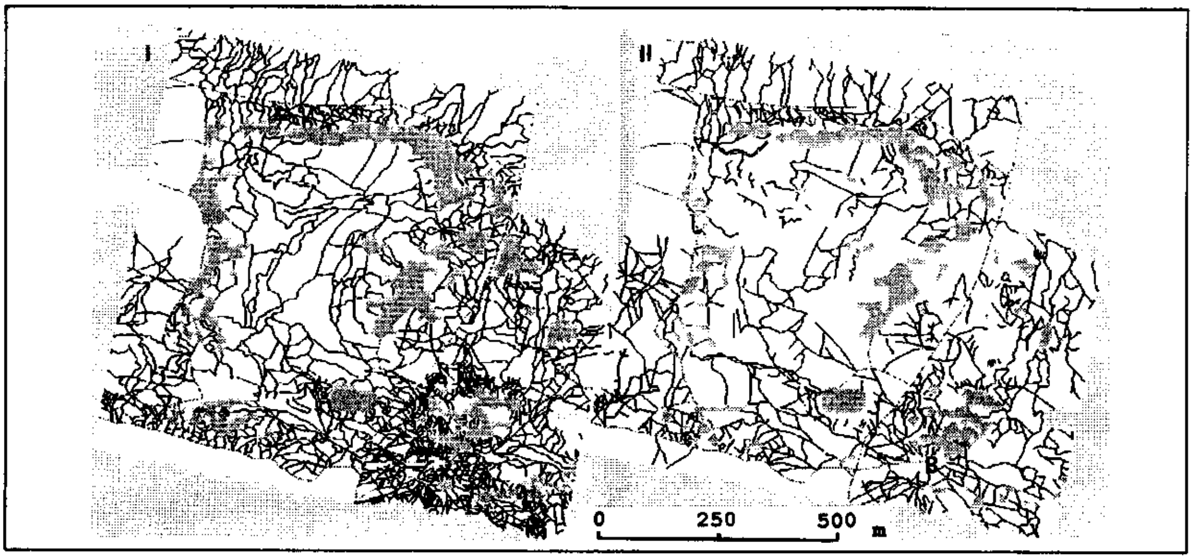

Figure 4.4. *Two interpretations of spontaneous paths of the same airphoto of 1976. At (B) the site of the blockhouse.*

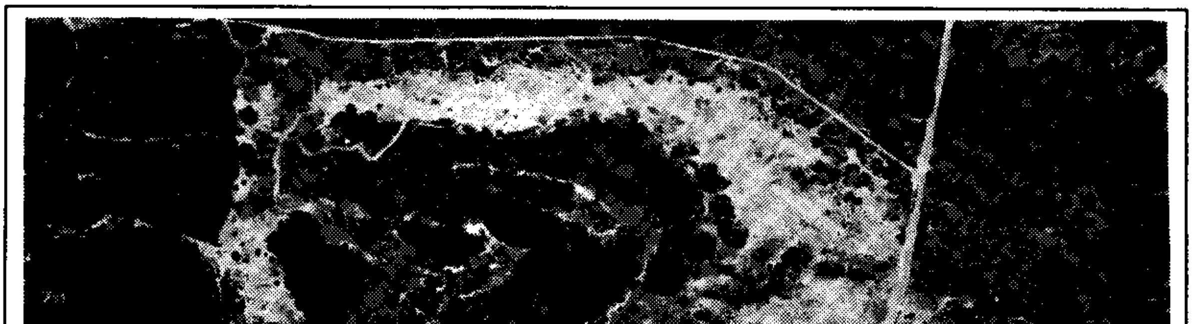

Figure 4.5. *The section of the airphoto of 1976 on which the interpretations of the previous figures have been based. At (B) the blockhouse, at (G) the garbage dump.*

The comparison of total length of paths, as done in table 4.2., if wanted expressed per unit of area, as in table 4.1, may suffice. The difference between the two interpretations thus observed, may be partly attributed to the over-simplification in the comparison: *path - no path*. If instead a sub-classification of paths would have been made, a higher correspondence might have been found with respect to certain categories, whereas the main difference then might be the ommittance of specific sub-categories in one of the interpretations. Such refinement, however, requires more effort and it would be even more difficult to define interpretation criteria and apply them consistently. And since for the overall impression of the recreational impact such sub-classifications are not needed, such additional effort is not necessary.

It has also been observed that the extent of paths in the field appears to be much larger than in the airphoto interpretation (Van der Ploeg, 1990). This implies that the results of the airphoto interpretation *certainly do not exaggerate the impact, as has been suggested sometimes.* The amount of difference found will depend again on the skill and experience of the interpreter.

Thus, not too high an accuracy value should be attached to the absolute values measured. But, if two areas, or the same area on two or more sequences of airphotos, are interpreted by the same person(s), thus with the same degree of subjectiveness, the differences observed between these two situations still are of high relative value. (See also L.Zonneveld, 1987).

Direct comparison of interpretations of different sequences of airphotos, in which each sequence is interpreted by a different person is bound to give difficulties. The person doing the interpretation of the most recent set of photos should also interpret at least a sample of the previous coverage and compare his results with that of his or her predecessor. Only when in this way the interpretation is calibrated a quantitative comparison is possible. For the 1976-1979 interval such calibration was not done.

In addition to the element of subjectiveness a difference in image quality between the original 1976 airphoto prints and the enlarged sections of the 1979 photos made accurate and quantitative comparison difficult.

Still, from the interpretations the overall impression was obtained that the bare areas had decreased in extent and that also the path density had decreased a bit. This may be attributed to management measures, such as fencing off of certain areas and covering the sand with branches, or to the natural recovery of the vegetation after the extremely dry summers of 1976 and 1975. (Sombat, 1980; Van der Zee, 1981).

Based on the experiences of this study, the comparison of the 1976 situation with that of 1982 was undertaken (L.Zonneveld, 1987). Again the same landscape unit boundaries were used as in the study by Van Ittersum and Kwakernaak (1977). Only part of the dune area north-west of the village was studied. Both the 1976 and the 1982 airphotos have been interpreted by the same person. The measurements have been carried out in the same way as in the 1977 survey. *Everything that on the airphotos looked like a path: relatively long, narrow objects,* was interpreted as a path. In dune areas the sandy, light-toned paths clearly stand out against the more dark toned surrounding vegetation and thus are easily recognizable as a path. Less clear are vegetated paths, that can only be distinguished by their '*deeper*' location (stereo-effect) relative to their surroundings. Some tussocky vegetation structure may give the impression of an area with a dense path network. In such cases only through-going paths, thus with a continuation outside such areas, have been interpreted as paths. The problems that occurred *in the interpretation with respect to identifying paths also occurred during the field observations.* The field check of the interpretation of the 1982 airphotos was done only in 1986. Because the yearly number of visitors to the island has remained the same from 1982 to 1986, the overall recreational pressure can be considered as having stayed at more or less the same level. Therefore this time gap was considered to probably not affect the results of the comparison seriously. In addition to paths also again bare sand areas were delineated, distinguished from vegetated areas on an airphoto by the lack of structure or texture and by a white to light grey tone. A very sparse short vegetation on sandy soil, however, gives the same impression. Moist bare areas also lack structure but are darker in tone and thus less easy to distinguish from their vegetated surroundings. Because of their higher humidity they are also less inclined to be wind blown.

Of the areas studied, in 1976 17.7% was bare, in 1982 only 6.3%, a decrease with 64% . The length of spontaneous paths increased all in all with 10%, but when the areas that have been closed to the public are excluded, an average increase of 25% is observed. The differences in increase between the different landscape units are large. The average increase in length of path per unit can not be related to the decrease in bare areas. The variation has to be seen as a reflection of the heterogeneous distribution of differences in land use and terrain management.

Although climate may have contributed to the differences between 1976 and 1982, the big variation in path densities is an indication for a predominant influence of man. Path density on a certain place is a resultant of trampling by recreationists and anti-erosion measures during a certain period. The large decrease in wind blown sand areas probably are also partly result of erosion control measures. The anti-erosion measures vary from completely closing off an area for the public, or only closing certain paths, to planting bare areas with bent-grass or covering paths and bare areas with straw and branches. The two landscape units that show a clear decrease in path density (with 18% and 39% respectively) have been closed to the public since a number of years.

It can be concluded that, despite some shortcomings, airphotos are a valuable tool for giving an overview of a relatively large area in a relatively short time and therefore are extremely suitable for the monitoring of certain parameters of recreational pressure. And although to the absolute value of the interpretations of path density not too high an accuracy can be attributed, their relative value for comparing changes is still unrivalled. (L.Zonneveld, 1987). The use of sequences of airphotos therefore is extremely valuable in the context of this type of analysis.

Analysis of spontaneous path patterns.

Some parts of the landscape are more attractive than others. Some parts are easier to walk in than others. This will be reflected in the path-pattern. Swampy areas and areas with thorny scrubs tend to be less frequented. A first impression can be gained by analysing path densities. On the Dutch Wadden Sea Islands it appeared that the way in which the dune areas are affected by recreationists depends on their location with respect to the concentrations of recreational facilities: parking-places and roads on one side and the points of recreational attraction on the other side. If an area is located in between, the pressure is high. If it is located at the periphery the intensity of recreational influence decreases with increasing distance from concentrations of recreational facilities. (Van der Zee, 1983). This was also clearly observed in Skallingen, Denmark (Frederiksen, 1977; Thiesen, 1977). How rapid this intensity decreases depends on the accessibility, that is, the roads along which and the vehicles with which the area can be reached, as well as on the *intervening opportunities*, areas located in between the recreational concentrations and the area considered, that can equally well satisfy the demands of recreationsts. Thus, analysis of path densities can tell something about the preferences and behavioural characteristics of the recreationists (Van der Zee, 1983), but even more information can be obtained when in addition to that also the path patterns as such are analyzed. And the only way to do so for large areas is by airphoto interpretation.

For the Dutch Wadden Sea Islands in this way three different path-patterns have been distinguished and correlated with the different behaviourial characteristics of the recreationists. In some other studies on recreational erosion in dune areas similar results were found.

1. *Parallel path-pattern*. The main source of attraction on almost all islands is the beach. The recreationists tend to go there along the shortest route possible, starting from their lodging-accommodation or from a parking-place. (Van Ittersum and Kwakernaak, 1977; Van der Zee, 1983, see also Hylgård, 1977). Thus, wherever a dune area is located in between the beach and a camping or cottage area, a parking area or parallel-road and is not properly fenced, a pattern of parallel paths through this dune area will be the result: scars in a zone of friction. Moreover the recreationists not only pass the dune zone on their way to the beach but they also tend to use the dunes nearest to the beach as sheltered lairs for sun-bathing (Van der Zee, 1983; see also: Thiesen, 1977, and Kingo Jacobsen, 1977).

See figure 4.7.

2. *Radial path-pattern.* Other points of attraction may be high dune tops offering a good view, an isolated restaurant or kiosk, a lighthouse, etcetera. The recreationists generally try to reach also such a point from wherever they are along the shortest way. A radial path-pattern will be the result. (Van Ittersum and Kwakernaak, 1977; Van der Zee, 1983; see also Frederiksen, 1977). See figure 4.5., the path pattern around (B).
3. *Fan-like path-pattern.* A fan-like path-pattern will occur where the natural landscape itself is the main object of interest for the recreationist that wants to explore the *free nature.* They want to walk, cycle or ride in it. Starting from a point -parking-place, restaurant, riding-school- or from a line -forest-edge, road or cycle track- paths fan out into the area, the lines of the fan often interconnected by shortcuts. (Van Ittersum and Kwakernaak, 1977; Van der Zee, 1983).

The characteristics of these path patterns clearly indicate that such paths are indeed related to recreational use, and that confusion with paths created by rabbits, too small to be identified on an airphoto anyway, can be excluded (Van der Zee, 1977a; Van Ittersum et al., 1978).

The analysis of the path patterns in this way is not only based on intuition and assumptions, but was supported by occasional though non-documented field observations during many years.

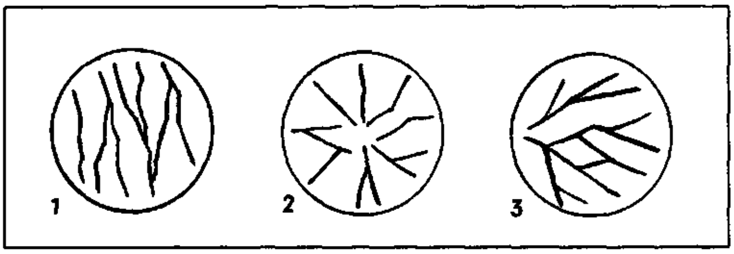

Figure 4.6. *The prototypes of path patterns.*
1: parallel; 2: radial; 3: fan-like.

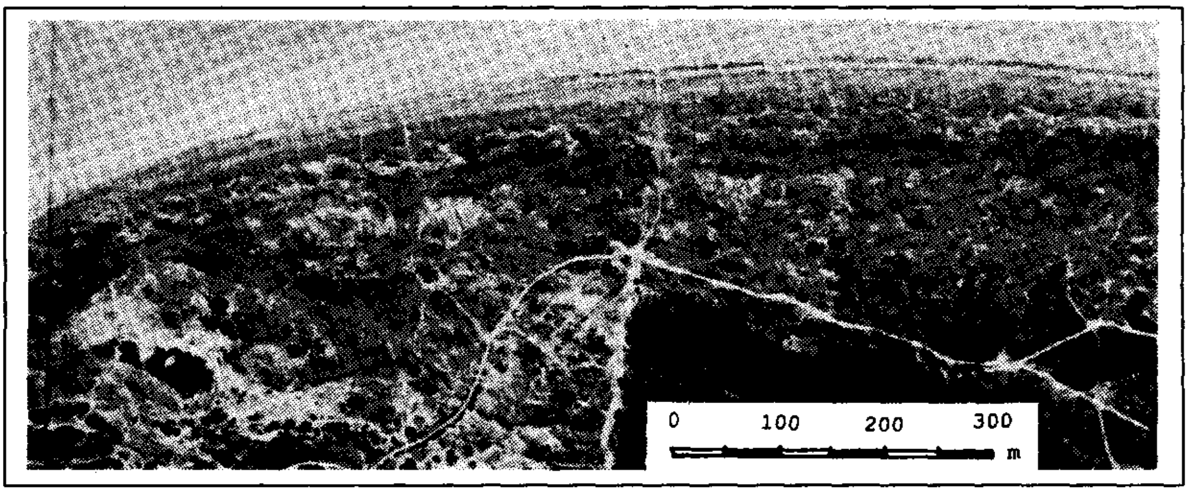

Figure 4.7. *The parallel path-pattern across the coastal dunes of Schiermonnikoog, 1976.*

Results of some more systematic field observation studies have also become available in recent years. For one area it has been found that the number of walkers going off the paths is more than 35% in the pre-season, and more than 25% in the peak season. (Voskens-Drijver, 1987). It should be realized however that a lower percentage in the peak season still may imply a much higher absolute number. Another observation has been that the number of people *going beyond the paths* appears to be proportionally larger in quiet (parts of) sites than in crowded ones. A possible explanation is that the visitors in the crowded sites are mostly *facility-based* recreationists, while the visitors in the quiet sites are *resource-based.* It is experienced

that people leave paths in particular if these paths are winding (in stead of straight) and if paths come near spots where one may expect interesting landscapes, etcetera. (Van der Ploeg, 1990).
The attitude of people with respect to the area they visit is of great importance too, and of course can not be analysed by airphoto interpretation but only by enquiry surveys, for example such as the one carried out for the Westruper Heide in Germany. There it was found that often the attitude of visitors to a nature area is very positive. But a high rate of agreement with the nature conservation aim does not correspond with the actual behaviour of the visitors. It is questionable therefore, whether the visitors define *nature conservation* in the same way as the terrain managers do. This is confirmed by the high rate of agreement with the statement that nature conservation and recreation can go very well together. There is a lot of appreciation of the fact that one can move around freely without sticking to roads and paths, despite signs indicating otherwise. The dense spontaneous path network and the many bare spots by most visitors are considered to typically belong to the area. (Weber, 1982).
It may be clear, that airphoto interpretation alone is not enough, but also the other surveys by themselves do not give a comprehensive impression. It is the combination that can provide valuable information for land evaluation for recreation.

Analysis of recreational impact on water and shoreline vegetation.

Not only terrestrial vegetation can be influenced by recreation, but also water and shoreline vegetations. Some of these impacts can be analyzed by airphoto interpretation and may give indications about the spatial behaviour pattern of the recreationists in that type of terrain.
To what extent that is possible will be illustrated by some examples. For the location of the case study areas see the Annex.

Reedbelt reduction in the Kagerplassen.

In the Kagerplassen area, a watersport area in the Netherlands, a decrease in extent of reedbelts was observed. Therefore a study of changes in the reedbelts was done with the help of airphotos of 1938, 1954, 1962 (partly), 1966, 1971, 1976 and 1981. (BM&RIN, 1984). On these photos the reedbelts were identified, including belts of rushes and similar vegetation. Reedbelts of less than two meters could not be identified however. Only the length of the reedbelts was used as a parameter for comparison. Whether belts had become narrower or thinner could not be considered. This, of course, is a limitation of the approach. The impact can only be partly identified.
After having made an inventory of the extent of reedbelts in the different years, the relation to recreation had to be analyzed. The decrease in extent of reedbelts can have several causes: eutrophication, recreation, damage by animals, the dumping of rubble and the drifting of ice. The contribution to eutrophication by recreation was considered to be relatively small, agriculture and waste water disposal playing a much larger role. No indications were found that damage by animals or drifting ice considerably influenced the length of reedbelts in the area. And also no clear relationship between the steady increase in number of boats and the fluctuating decrease in length of reedbelts could be found. On the airphotos of 1982 relatively few boats are found moored along the shores where a decrease of reedbelts has occurred before. On a peak-day in 1982 18% of the moored boats lies along the 30% of the shores that have a reedbelt and on these shores on those points where the reedbelt is interrupted. No boats are observed mooring in a closed reedbelt. Therefore, in this case study the analysis of changes in the shoreline vegetation only informs about impact in a limited way, can not be clearly related to recreation, and does not reveal much on the spatial behaviour of recreationists.

Disappearing rushes in the Zwarte Meer.

In the Zwarte Meer, one of the peripheral lakes in the IJsselmeer area in the Netherlands, the disappearance of fields of rushes was attributed to increasing recreational pressure and therefore in a watersport survey special attention was paid to that sector of the area where these fields occur. (Peltzer, 1977). Boats were counted lying at the edges of a field of rushes or anchored in a neighbouring sector. To establish a direct relation between these observations and the decrease in extent of the fields of rushes is difficult however. Moreover, the damaging effects of small rowing boats, airbeds, etcetera, could not be assessed because these objects could not or hardly be distinguished on the airphotos. Also this analysis therefore can not relate impact clearly to recreation nor reveal much on the spatial behaviour of the recreationists.

Recreation sites in the Biesbosch.

In the Biesbosch, a former tidal delta area in the Netherlands, the shorelines have been surveyed and classified according to a number of abiotic factors, vegetation structure and type, erosion, recreational facilities, hight of the shore, etcetera (Van der Ploeg, 1984a; Saris et al., 1984a). Because most of the boats visiting the Biesbosch land at one or more places during their visit, and although some use prepared, legal landing-stages, many visitors land where they, according to the regulations, should not, causing damage to the vegetation (Van der Ploeg, 1990). One overall mapping and a more detailed description of a hundred selected observation points were made. The overall 1:25000 landscape ecology based vegetation map of 1983 has been compiled in three steps. (Van der Ploeg, 1984a; Saris et al., 1984a). First an analysis and interpretation of available airphotos and maps was made. Then a field sampling of vegetation, the data of which were again fed back into a re-interpretation of airphotos.

Areas in which the vegetation does not show the expected structure and/or composition corresponding to the abiotic conditions because of recreational influence were indicated as *recreation sites* or *tourist spots*. The majority of these sites is located on shores of creeks that are accessible for all boat-types and where mooring and staying overnight are allowed. A tourist spot usually is composed of a landing spot directly at the creek, a *satellite* with fire place a bit away from the shore and a fuel-wood collecting spot further inland, all connected by paths. (Saris et al., 1984a; Van der Ploeg, 1990).

In the analysis of the relations between recreation and the natural environment of the shores three groups of *variables* have been analyzed in their interrelationship for each observation point (Van der Ploeg, 1984a; Saris et al., 1984a).

1. The abiotic environmental characteristics to which data on vegetation structure are added.
2. Individual plant species and their percentage of coverage.
3. Recreational characteristics:
   -average number of boats lying ashore per counting section,
   -average number of boats lying ashore or anchored per counting section.

The relations between these characteristics have been analyzed by correlation analysis methods. Certain characteristics of the vegetation structure appear to be clearly related with the measured recreation intensity. Open areas and percentage of bare soil are indicators of relatively intensive recreational pressure. A number of well-known indicator species is significantly correlated with the number of boats lying along the shore. Still, though the recorded impacts in the tourist spots are of importance, it is very difficult to draw any conclusions about the changes in the number and the quality of tourist spots as a consequence of changes in recreational use. (Van der Ploeg, 1990).

Thus, in this study airphotos where used to make the basic landscape ecological inventory, not an unimportant contribution at all, but the impact analysis was mainly done by (sample) field survey.

Analysis of the spatial pattern of the *recreation sites* might have given indications about the spatial behaviour of the recreationists, but was not done in this survey.

Where for recreation on land the effects of trampling can be very well studied by airphoto interpretation and can give good indications on the spatial behaviour of recreationists, for the recreation on water and along shores this indirect monitoring appears to be less successful. In this type of environment direct monitoring offers better opportunities.

4.3. DIRECT MONITORING OF SPATIAL BEHAVIOUR.

As opposed to the *indirect monitoring* of recreationists by analyzing their impact on the environment, *direct monitoring* implies the interpretation of the recreationists, or their vehicles or vessels, themselves on sequences of aerial photographs taken during one day and/or in the course of one season in order to study their spatial behaviour.
In the Netherlands considerable experience has been gained in several surveys of watersports in different watersports areas since 1969. In these surveys aerial photography as well as visual observations from the air are used. In the latter case the objects to be observed are directly counted. Of the aerial photography both vertical and (high and low) oblique photographs have been applied. Boats are identified and marked in their approximate or exact location on a map, distinguished in sailing boats and lying or moored boats and according to type : sailing-boat, motorboat. Boating densities are calculated per unit of (water) area and length of shore line. Some surveys rely on one photo coverage only to determine the spatial patterns, other surveys include several sequences of airphotos during one day or during the season to analyze the variations in the spatial pattern through time.
Similar studies have been carried out for beach or shoreline recreation, using large scale vertical airphotos or oblique airphotos to count persons, tents, motorcars, surfboards, rubber boats, etcetera, for separate sections of beach and for separate distance zones from the waterline. Distinct spatial patterns could easily be observed and analyzed.
Examples of direct monitoring of terrestrial recreation are far less abundant. Still, some examples from Britain can be used to discuss the possibilities and limitations in this field. Special studies on human spatial behaviour in relatively small open spaces with the help of a time-lapse camera are also worth mentioning.
In the following sections first the different approaches and techniques of the watersports surveys will be discussed, then the same will be done for the shoreline recreation and in the end attention will be given to the examples of direct monitoring of terrestrial recreation.

Watersport surveys from the air.

The need for information on watersports.

Among the recreational resources water is a very important one. Water-based recreation has boomed in popularity since the Second World War, in Europe and elsewhere. New types of recreation have emerged and existing types gained in numbers of participants. (Van der Ploeg, 1990). Even within the context of the general and rapid expansion of participation in outdoor recreation as a whole, the growth in water recreation is striking. (Rodgers et al., 1973).
Water recreation comprises those forms of outdoor recreation that are primarily focused on the use of water, and in which the open water is an indispensable element. *Watersport* comprises those forms of water-recreation in which use is made of a boat. (Van der Vegt et al., 1979a; BM&RIN, 1984).
The increase in importance of watersport can be expressed in the first place by the increase in numbers of recreational boats. See figure 4.8. for the example of the Netherlands. The strong increase in the 1960's and 1970's is apparent. Around 1975 the yearly increase was around 10%, but after 1977 this percentage has decreased strongly to about 2% at present (Droogers, 1990). This can be attributed to the economic recession, but it may also be an indication that a saturation point has been reached.
The increase in number of boats went hand in hand with a differentiation in boat types. For example, a large variety of boats has been developed that can be transported on trailers by car, and thus numerous new areas became accessible for watersport because of this new mobility. (Mulder, 1981a).
The composition of the Dutch recreation fleet in 1988 is also presented in figure 4.9. The yachts and motor cruisers, thus, the covered boat types, together comprise about 58% of the total. This does not comprise the windsurf boards. Since their introduction in the Netherlands in 1972 their number has increased to 400000 or 450000 and has now more or less stabilized (Droogers, 1990).

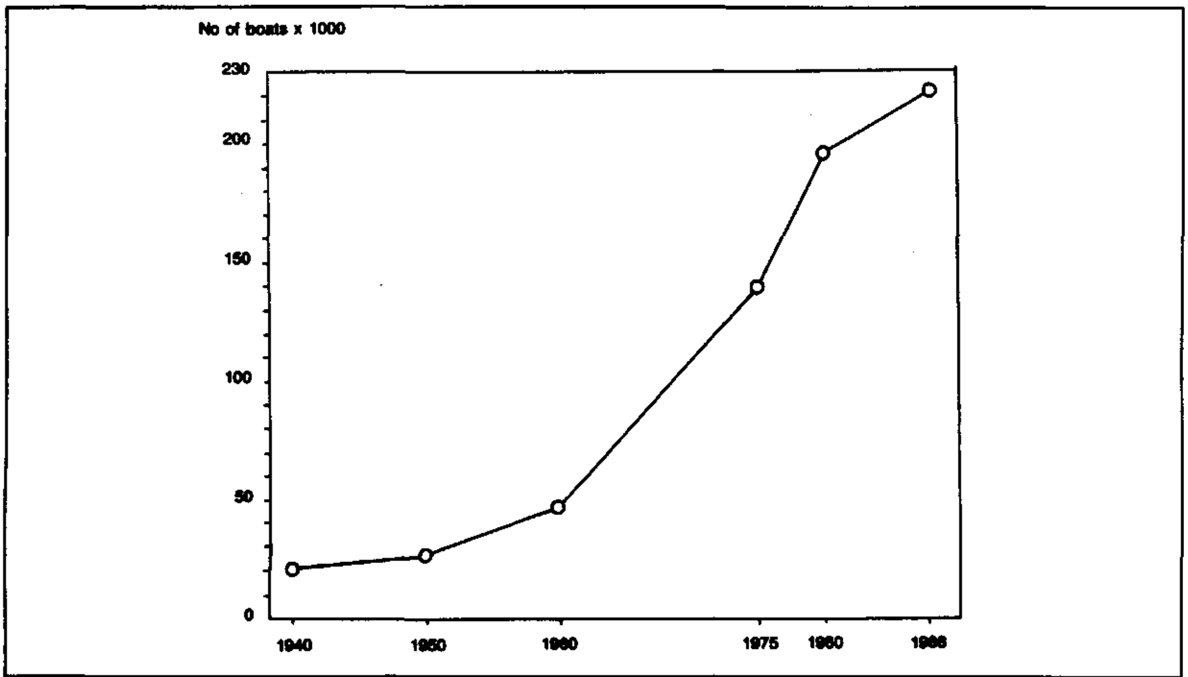

Figure 4.8. The increase in the number of recreational boats in the Netherlands (derived from Droogers, 1990).

These boats of course are used too. The average number of sailing days per recreational boat is estimated at 35 (Droogers, 1990), and the number of passages through a number of selected points on the Dutch waterways shows an increase comparable to that of the increase in number of boats (see for example De Ridder, 1987). All these developments lead to an increasing demand for different types of watersport environments by various categories of users, and this demand probably will continue to grow in the foreseeable future. The authorities managing the water areas thus are faced with problems of increasing demand for lying places and other facilities, and increasing pressure on shore zones and water bodies. (Dodt and Van der Zee, 1984).

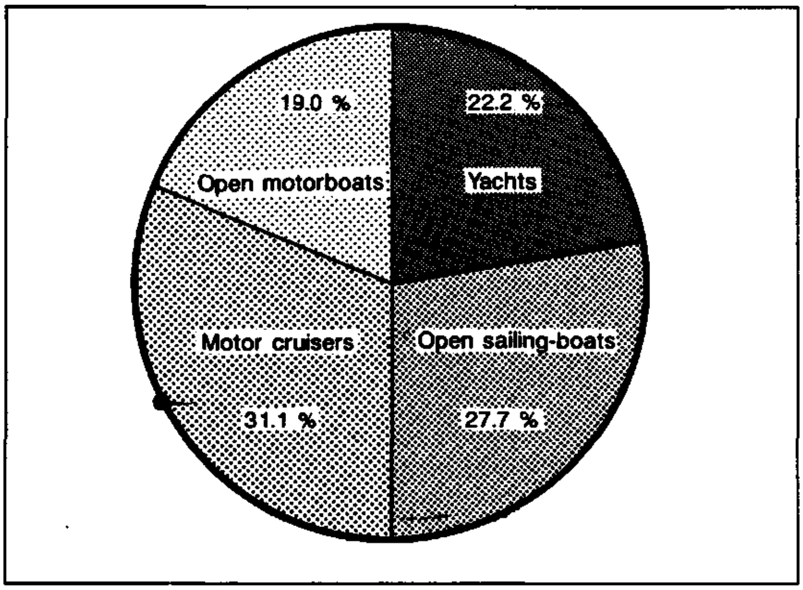

Figure 4.9. The composition of the recreation fleet in the Netherlands in 1988 (derived from Droogers, 1990).

This pressure not only damages the quality of the natural environment, but also influences aesthetic values and the quality of certain types of recreational experiences on some water bodies (Ashton and Chubb, 1971).

The type of information needed.

With respect to the information needed three aspects can be distinguished.

1. To give a first approximate and overall assessment of the pressure on the resources, that is, the size of the use, information is needed on the location and capacity of the marinas in the area and the total number of boats present in these marinas and/or entering the area as counted at entrance gates. Of this number the type and size of boats -especially the ratio sailing-boat: motorboat- and the number of persons per boat should be known. This information should not only be available for the present situation but also in projections for the future. (CD&PW, 1970; Hendriksen, 1971; BM&RIN, 1984).
2. But information on total numbers of boats present in the area alone is insufficient. Information should also be available on the participation rate, that is, how many boats sail out in the area concerned on a representative day. (BM&RIN, 1984).
3. Even with equal participation rates the size of the use varies from moment to moment (BM&RIN, 1984), therefore something should be known about the behaviour of the watersporters once they sailed out into the area.

The survey to provide such data and information has to relate to the area as a whole. Also it should be possible to repeat it several times. This means that the costs should not be too high. The time span of the survey should be short for reasons of comparability and to avoid double counts. (Hagoort, 1986a).

A number of questions can be answered by mere observations, for other answers enquiries will be needed. Counting of the occupation rate in marinas is relatively simple, as are counts of passing boats at bridges, locks or through canals. (CD&PW, 1970; Hendriksen, 1971; Kosters, 1985a). Such counts give some indication about numbers and movement of boats passing, but in a rather coarse way. For more detailed information on the areas preferred for certain activities and typical activity sequences of watersports, that is, the spatial and temporal behaviour pattern, counting of boats especially on large water surfaces is more problematic because the lines of movement do not form a fixed pattern. (PWF, 1977; Dodt and Van der Zee, 1984). To obtain such information by classical point counting methods is not possible, or only with large efforts in time and manpower (Dodt and Van der Zee, 1984). Using airphotos for counting recreational boats can solve this problem, and has been employed by several institutions now (CD&PW, 1970; Hendriksen, 1971; Dodt and Van der Zee, 1984).

For a study into the motives of recreationists that determine the behaviour pattern, only (sample) enquiry surveys can give the answers, but they may gain in value when supported by information from an aerial survey.

The aerial survey of watersport activities.

The aerial survey thus seems to be a logical solution. In the Netherlands considerable experience has been gained in several surveys of watersports in different watersports areas. In a survey on the use of aerial photographs among institutions and organisations in the Netherlands that carry out recreation research, of the 51 studies mentioned 56 % were concerned with water recreation (sailing, motor-boating, rowing and canoeing). (Bakker and Thewessen, 1986; Thewessen and Bakker, 1987; Schrauwen and Terpstra, 1986). The application to watersports almost always aims at counting of boats to determine their number and distribution in the study area (Schrauwen and Terpstra, 1986). The balance between aerial survey and field survey and/or enquiry survey is not the same for all studies. In some the emphasis is on the aerial survey, and field observations are only made in support. In other surveys the aerial survey is only auxiliary, giving a possibility to check on the field counts and to obtain complementary information on areas where in the field no counts were or could be done. Occasionally also a panorama photo survey from a high vantage point has been included. (Van der Vegt et al., 1979a; Loedeman and Van der Voet, 1979).

The experiences gained in these Dutch watersport surveys will be analyzed and compared in the following sections. The surveys included in this analysis are (in bold the names that will be used to refer to these studies, for their location see figure A.7 in the Annex): the study of the **Sneekermeer** area in Friesland in 1969 (CD&PW, 1970; Hendriksen, 1971), the study of the **Kagerplassen** and Braassemermeer in 1970 (Stroband, 1971; Van der Voet and Dijkstra, 1971), the study of the main lake district in **Friesland** in 1975 (PWF, 1977) and in 1977 (Van der Vegt et al., 1979), the study of the gravel pits in **Limburg** in 1977 (Loedeman and Van der Voet, 1979; Loedeman and Quaedflieg, 1979; Broekhuizen and De Wolf, 1979), the study of the **Zwarte Meer** area in 1977 (Peltzer, 1977), the study of the **IJsselmeer** area in 1976 (RWS, 1977; Meyboom and Hellinga, 1977) and in 1982, 1983, 1984 and 1986 (Hagoort, 1986a; 1986b), the study of the **Randmeren** in 1979 (RWS, 1979; Driebergen, 1981a), the study of the **Nieuwkoopsche Plassen** and the **Kagerplassen** in 1982, the study of the **Biesbosch** in 1983 (Van der Ploeg, 1984) and in the **Veerse Meer** in 1977 and 1987 (Bakker and Heil, 1988). For comparison also one report on a similar type of study in 1970 for some lakes in **Michigan**, the USA, could be used (Ashton and Chubb, 1971). There are some more Dutch studies that have been included in the review by Bakker and Thewessen, but not all reports could be obtained and be analyzed for this overview. No information is available on other foreign studies on watersport surveys from the air.

In many of the reports the results of the research are emphasised, of course. But this means unfortunately that not very often an elaborate description of the set-up and execution of the survey is given. Only reports from the 1970's may devote an extra paragraph to the then still new technique. If information is given at all it is piecemeal, incomplete or has to be read in between the lines. (Thewessen and Bakker, 1987). But, almost all of the studies start with arguments why airphotos were used as the principal method. What were the advantages and what were the disadvantages of this method. Most of these have been mentioned already in chapter 1.3., because they apply to the application of remote sensing in general. Still it may be useful to mention some that particularly apply to the application on watersport surveys.

Advantages are, that from the air a good overview of the situation in a relatively large area can be obtained in a relatively short time (Loedeman and Van der Voet, 1979; Bakker and Thewessen, 1986; Bakker and Heil, 1988). This applies especially to watersport areas, because these types of areas in general are open and do not conceal the objects to be counted (PWF, 1977, p 4). With aerial photography a record of that overview can be made (Loedeman and Van der Voet, 1979; Schrauwen and Terpstra, 1986), that represents the situation at one certain moment (Stroband, 1971). Aerial surveys can be carried out in very short time, and if necessary more than one time a day or even more than one time per hour (Loedeman and Van der Voet, 1979; Bakker and Thewessen, 1986; Schrauwen and Terpstra, 1986).
The advantage of airphotos over direct visual counts from the air is, that it can depict situations with objects, that are moving and/or difficult to directly identify, at one particular moment and thus make it possible to do the analysis afterwards, at ease in the office (Van der Voet and Dijkstra, 1971; PWF, 1977; Schrauwen and Terpstra, 1986). The information obtained in this way is accurate, reliable and detailed (Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). Application of aerial survey is a relatively cheap technique, if compared with the input of ground observation teams (Stroband, 1971; Driebergen, 1981a; Schrauwen and Terpstra, 1986; Bakker and Thewessen, 1986).
Disadvantages are that despite the overview not all objects may be visible from the air, because they are hidden behind other objects such as forest, trees and buildings, or they do not contrast against their background or surroundings. That in a short time with little manpower a large amount of data can be obtained has as disadvantage that only one moment is registered, and that no observations on changes through time can be made, unless more series of airphotos, several sequences during a day or on different days in a season are made. But it will be clear that costs then will increase considerably. (Stroband, 1971; Van der Voet and Dijkstra, 1971; Driebergen, 1981a; Bakker and Thewessen, 1986; Schrauwen and Terpstra, 1986; Thewessen and Bakker, 1987).

The elaboration and the analysis of the airphoto interpretation may take more time and effort than expected, and often is difficult and boring (Loedeman and Van der Voet, 1979; Bakker and Thewessen, 1986; Schrauwen and Terpstra, 1986; Thewessen and Bakker, 1987). Counting from photographs requires a lot of time and high concentration (Broekhuizen and De Wolf, 1979). *Aerial surveys can only be used for quantitative analyses, additional information on, for example, motives and attitudes of the recreationists has to be approached in a different way.* (Schrauwen and Terpstra, 1986; Bakker and Thewessen, 1986; Thewessen and Bakker, 1987). Therefore airphotos as the only tool will often not suffice. The high weather dependency often is mentioned as a disadvantage, but weather dependency will also apply to many other methods of recreation survey (Thewessen and Bakker, 1987).
And, last but not least, even though aerial photography may be *relatively* cheap, as compared to conventional surveys to obtain the same amount of data, in *absolute* terms it *still is rather expensive* (Loedeman and Quaedflieg, 1979).
Some of the disadvantages mentioned will also apply when only ground surveys are made (Bakker and Thewessen, 1986). All in all, by the organisations questioned, more advantages were recognized than disadvantages (Thewessen and Bakker, 1987). Of course, what is an advantage or a disadvantage heavily depends on the objectives. Some of the studies aimed at accurate counts for statistical inventories. In the context of land evaluation for recreation, however, such high accuracy counting seems to be less necessary. It is more important to get a good idea about the distribution patterns of boats in time and in space, and thereby of the spatial and temporal behaviour pattern of the recreationists. But for this it does not really matter whether indeed all boats are counted or whether some are missed. And, relative positions are sufficient, no high precision in location is required.
Still, also for this objective the view from the air seems a logical solution for watersport surveys, especially because of the overview over a large area, and the advantages on first sight seem to outweigh the disadvantages. The first basic choice then is between mere visual observations from the air and the use of aerial photography. When the decision is made to use aerial photography a choice has to be made from the many different methods available. For this type of survey it is hardly possible to fall back on airphotos that have already been made for other purposes. Thus airphotos have to be made according to specification.
There is a range between the large format vertical photography, carried out with a special airphoto camera from a special survey airplane by a specially trained airphotographer, and the oblique photo, taken with a universal small format camera from a conventional small airplane that is for rent on any airfield by a photographer that as only qualification possesses the required permits from the authorities. The highest level in aerial photography no doubt is the large format vertical photography, but this does not mean that it is also the most suitable type for all purposes. (Loedeman and Quaedflieg, 1979). What type of photography is best suitable in part depends on the requirements of the survey. Requirements that only the user can formulate and specify. The most common requirement for airphotos in recreation research is that the objects of study can be distinguished and counted separately.
Special requirements for the airphoto's in relation to watersport surveys are that: the airphotos should be clear (=sharp) enough to be able to distinguish sailing-boats from motorboats in a reliable interpretation; a distinction between sailing (with direction) and lying should be possible; coastlines should be completely included and lying places in marinas, occupied and unoccupied should be recognizable; no reflection spots should occur on the water (dependent on sun-angle and wind, can it be avoided?) in order to avoid misinterpretations or non-interpretable areas; there should be not too large a time difference between two adjoining runs, but the flightplan should also remain technically acceptable. (RWS, 1979).
Quite a list of requirements leading to more or less detailed specifications for the aerial survey, but also to different solutions in the different surveys that have been reviewed.

Selecting the type of aerial survey for watersport studies.
Once it has been decided to carry out the survey with airphotos, the next decision that has to be made is the choice between vertical and oblique airphotos (RWS, 1979; Driebergen, 1981a; Loedeman and Quaedflieg, 1979). Some considerations influence this choice.

Weather can be an obstruction for both vertical and oblique aerial photography. But, oblique airphotos are less demanding with respect to weather, and the choice for obliques is often made because of this lower weather dependency. (Stroband, 1971; Schrauwen and Terpstra, 1986).
Problems that the photo-coverage of the area is not without gaps were especially encountered in the earliest surveys with oblique airphotos, see for example figure 4.10., and thus the chance of obtaining a full coverage of the area seemed to be larger with vertical airphotos. Still, also in some vertical airphoto coverages certain areas have been missed, and with thorough planning and preparation also with obliques a full coverage can be obtained. (Stroband, 1971; Ashton and Chubb, 1971; PWF, 1977; Dodt and Van der Zee, 1984).

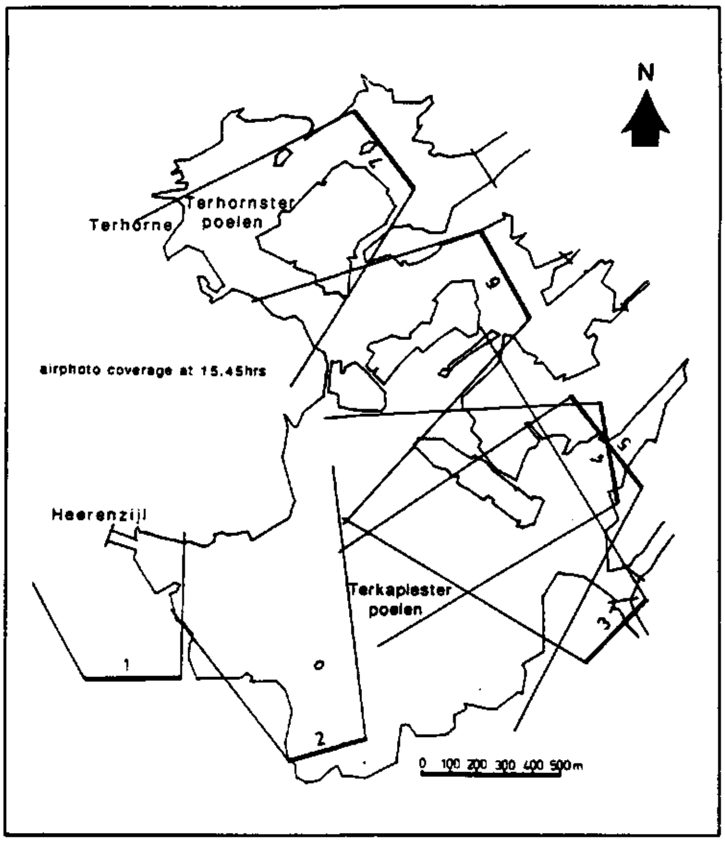

Figure 4.10. *Incompleteness of coverage by oblique photographs. One series of oblique photographs plotted on the map of the lake shows that the coverage is far from comprehensive. (CD&PW, 1970).*

For a lake as large as the IJsselmeer oblique airphotos were considered to be hardly suitable, because of the lack of fixed points -especially in the central part of the lake- that can serve for orientation for the plotting of the airphoto interpretation results (RWS, 1977; Meyboom and Hellinga, 1977; Dodt and Van der Zee, 1984; Schrauwen and Terpstra; 1986). But, because of the high costs of that, in 1981 a simple method of observation from the air was adopted: the *oblique reconnaissance*, in which a predetermined flight plan over the survey area is executed, and boats are counted visually. Only of the coastal zones, concentrations of boats and of marinas oblique slides are made for counting afterwards in the office. (Hagoort, 1986a; 1986b).

Vertical airphotos often provide the opportunity to study them under a stereoscope that gives both enlargement (4 to 8 times) and stereovision. For many users of airphotos this is the conventional way.

Oblique airphotos can be enlarged photographically, before interpretation, or, in the case of slides, projected on a screen. But only the lower 2/3 of each image are suitable for interpretation. Special interpretation procedures have to be devised.

When choosing for oblique photographs the direction of the view is another important aspect to consider. In the first inventory in 1969 on the Sneekermeer the oblique airphotos were taken viewing from land to water, see also figure 4.9., but in the Nieuwkoop survey it was decided to make the obliques from water to shore in order to clearly see the moored boats that otherwise might be hidden under overhanging trees. Oblique photography has advantages when objects may be hidden *under* other objects or elements: for example boats in the shelter of trees, and also if objects seen from above are much smaller than in oblique view. Vertical photography has advantages when a object can be hidden *behind* other objects or elements when seen in the terrain: for example, boats in a marina. (Schrauwen and Terpstra, 1986). See figure 4.11. for a comparison of oblique and vertical airphotos of watersport areas.

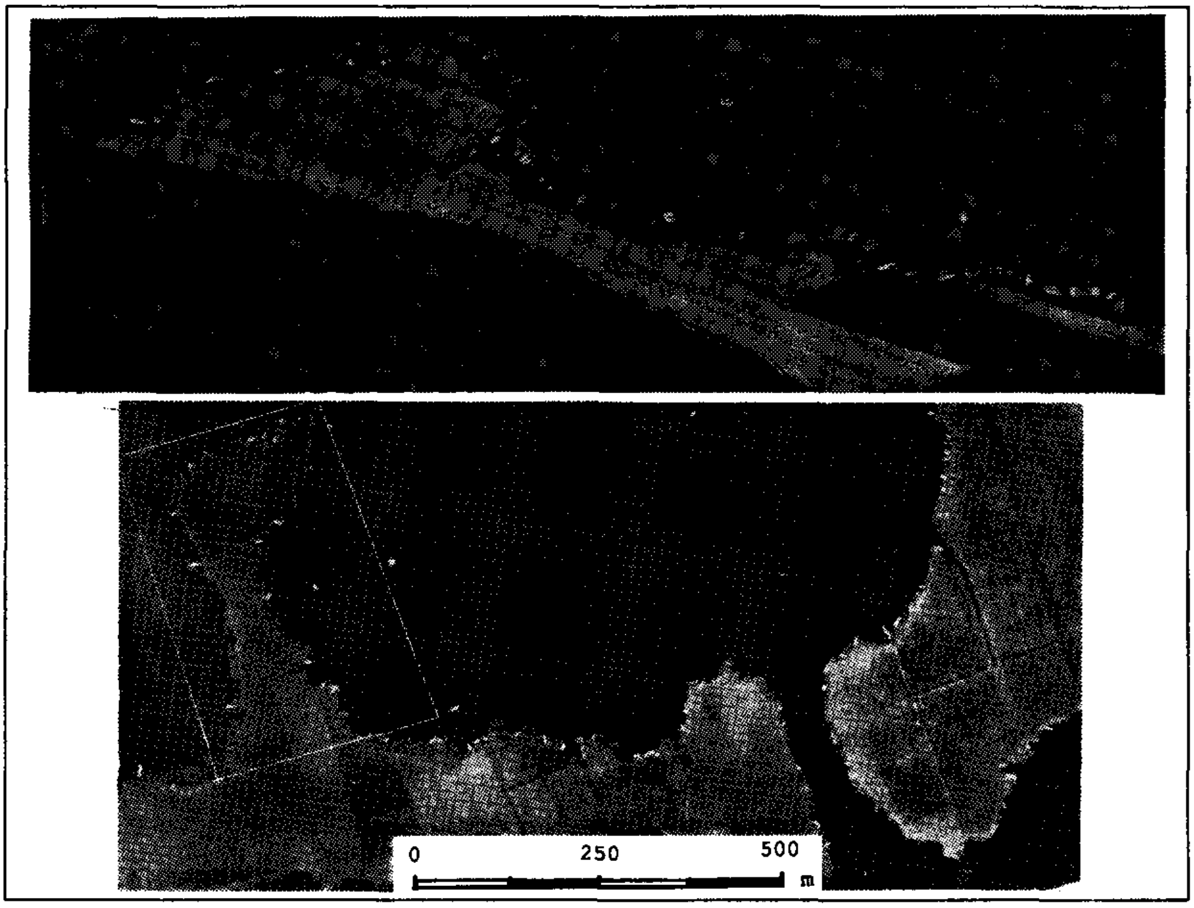

Figure 4.11. *Oblique airphoto (above) of part of the area covered by the vertical airphoto (below). The scale only applies to the vertical airphoto.*

Determination of the location of boats is easiest in vertical airphotos, especially if topographical features, such as shore lines and islands, also appear on them. If no topographical features occur, still the position of the boats can be determined taking into account the flying speed and the photo-interval. Oblique airphotos may give more problems because of the scale differences within the photo, but on the other hand they may show more topographical detail. (Schrauwen and Terpstra, 1986).

With vertical airphotos the transfer of interpretation data to a map may be difficult and time consuming, but it is possible to represent each identified object in its exact location. This is much more difficult with oblique airphotos. Often only a rough indication of location can be given using landmarks on the shore reference points. But how relevant is it to show the exact position of the boats? Often relative positions are good enough.

Double counting of boats can occur both in oblique and in vertical airphotos. With verticals this can be rather easily avoided by using stereovision. (Stroband, 1971). But also with obliques reasonably efficient methods have been developed to avoid double counting.

In general, vertical airphotos are more expensive than oblique airphotos, and visual observations are again cheaper than that. (CD&PW, 1970; Hendriksen, 1971; Schrauwen and Terpstra, 1986). Choices between the best technical solution and the cheapest solution are difficult, but often the budget will be decisive. Direct visual observations especially are worth considering when the density of the subjects to be counted is low (for example, 1 boat/ha), the distribution is rather homogeneous and the subjects clearly observable with the naked eye. Elaboration time is much shorter than with counts from airphotos. (Schrauwen and Terpstra, 1986). Of the fourteen studies, analyzed in some more detail for this overview, six were done with vertical airphotos, six with obliques, one with both vertical and oblique and one with visual observations and obliques. Almost all studies with vertical airphotos were done from 1975 to 1979. In the 1980's the oblique and the visual observations predominate. (See also table 4.3).

Table 4.3. *Vertical or oblique for watersport surveys from the air, in relation to format, film type and scale.*

Survey area	year	vertical or oblique	format	film type	scale
Sneekermeer	1969	oblique	6 x 6	panchromatic	various
Kagerplassen	1969	vertical	23 x 23	panchromatic	1:10000 ?
Friesland	1975	vertical	23 x 23	panchromatic	1:10000 & 1:5000
IJsselmeer	1976	vertical	23 x 23	panchromatic	1:20000
Zwarte Meer	1977	vertical	9 x 12	panchromatic	various
Limburg	1977	oblique + vertical	6 x 6	colour infrared	various
Friesland	1977	oblique	35 mm	colour slides	various
Veerse Meer	1977	vertical	23 x 23	panchromatic?	?
Randmeren	1979	vertical	23 x 23	panchromatic	1:8000
IJsselmeer	1982 1983 1984 1986	visual + oblique	35 mm	colour slides	various
Nieuwkoop/Kagerplassen	1982	oblique	35 mm	colour slides	various
Biesbosch	1983	oblique	35 mm	colour slides	various
Veerse Meer	1987	oblique	35 mm ?	colour prints	various
Michigan	1970	oblique	35 mm	colour	various

The choice between vertical and oblique, the type of camera, the photographic material, the flying hight and the scale are interrelated aspects (Thewessen and Bakker, 1987). Although the choice for format and film type may not be completely independent of that between vertical and oblique photographs it partly is, and therefore there are further choices to be made with respect to aerial photography. For the fourteen studies considered these choices have been summarized in table 4.3.

Most of the vertical airphotos used for watersport surveys have been made with large format cameras, but in several cases also medium and small format cameras have been used for that purpose. In oblique photography the use of 35 mm predominates however. In only a few cases 6 x 6 cm was applied. Using large format vertical photographs apparently implies using panchromatic film, with small format obliques the colour slides predominate.

The requirements with respect to the scale of the photographic material in most surveys can be simply summarized: as few exposures as possible on which the research subjects can be counted simply and cheaply. Scale in this context is less important than contrast, unless detailed differentiation between subjects is required. In practice, to reduce the costs often the minimum scale on which the subjects still could be counted well is chosen, but not larger. The considerations in the selection of the scale will be different for vertical photographs in which the scale is constant and for oblique photos in which the scale ranges from large (in front) to small (towards the horizon). (Schrauwen and Terpstra, 1986). All in all, there is no *ideal airphoto* for watersport survey. (Loedeman and Quaedflieg, 1979).
For more elaborated discussions on the arguments behind these choices the references, that have been quoted regularly already, should be consulted.

The selection of vertical or oblique together with a certain format and/or film type may imply the selection of a specific camera or airplane, but in many cases a range of equipment can still be chosen from.
Of course large format vertical airphotos can only be made with special cameras from a special survey aircraft. A 60% overlap and 25% sidelap are then more or less standard. The photography and often also the mapping of the photographed situations is carried out by specialized companies. It is with the medium and small format photography, carried out by the research institutes themselves, that a lot of experimenting has been done.
Also then the researchers were much more involved in aspects regarding the organisation and flight planning. Also for further details on these aspects the references quoted should be consulted.

Selection of day and repetition frequency of the survey.
The choice between the various posibilities with respect to the technical aspects of an aerial survey for watersports is just one of the decisions that has to be made. Another choice that has to be made is on what day(s) and on what time(s) the survey has to be carried out, and with what frequency during the day or the season. This choice may perhaps influence the results even more than all the other choices discussed so far, and may put some demands on further organisation.

Usually it is stated that for the flight day a very busy day should be taken because then the spatial behaviour patterns are shown most clearly (RWS, 1979). But also the weather conditions should be good (CD&PW, 1970; Hendriksen, 1971) not only to allow the photoflight but especially to create favourable conditons for watersport. Therefore the wish to fly on a peak recreation day leaves a very limited number of suitable days only. This means that suitable peakdays have to be selected well in advance and a plane has to be kept stand-by for each of these days. (RWS, 1977; Meyboom and Hellinga, 1977). But it also means that a great possibility exists that the survey cannot take place at all.
It may be questioned whether the survey day really should be a day with peak visit. Capacity problems of the area may result in spatial behaviour on such a peak day that is far from representative for that on the majority of recreation days. Should planning be concentrated on solving the problems that occur on only a few days per year, or rather be focused on the more normal days?
Whatever the answer on this question may be, even when the requirement for a survey on a peak day is maintained, it is advisable to make the criteria not too strict and also plan second and third choice days. When the need for information is not urgent it may not be a problem to postpone the survey or the whole project with one or two years. Otherwise less strict criteria should be applied directly from the beginning. It does not seem to be a good policy to only release the strictness of the criteria when the season approaches the end and many good, be it not optimal, opportunities may have passed already. If the budget allows more than one flight more flexible criteria can be applied for the first survey flight. Once that has been successful and the project at least partly saved, more strict criteria can be applied for the following flights.

The selection of dates has to be based on experiences in the previous seasons (Schrauwen and Terpstra, 1986). The watersport season in general lasts from April to October, with busiest months July and August. The peak usually is in July in the holiday period. The busiest days in the week usually are in the weekends, but in absolute numbers a weekday in the holiday season can be busier than a Sunday in pre- or post-season. (BM&RIN, 1984).
An overview of the dates for which watersport photo flights have been planned and on which dates they have been actually executed is given in table 4.4.

In order to assess the value of the survey results it should be known whether the survey day has been a representative peakday or normal day for the watersport. One method of checking this is looking at the weather situation of that day and compare it with the weather conditions throughout the season and the weather requirements of the activity. But the weather condition alone is not indicative, because still, the largest numbers of visitors occur in the weekends and especially on Sundays. For example, even though in the Kagerplassen survey Monday August 4th happended to be a specially beautiful and warm day in the main summer holiday period, it did not show a real peak visit. (Stroband et al., 1970). Therefore in some surveys counts at entrance gates to the area throughout the season have been used in order to judge whether the photoflight-date coincided with a representative *recreation day* (CD&PW, 1970; RWS, 1977; 1979; Meyboom and Hellinga, 1977; Peltzer, 1977; Broekhuizen and De Wolf, 1979; Van der Ploeg, 1984a; 1984b). In addition to counts at entrance gates counts of boats going in and out of the marinas and the number of boats moored there can also give a good impression of the representativity of the survey day. How representative the survey days of the reviewed studies have been is also presented in table 4.4.

The value of the knowledge of the number of recreationists at one single moment is limited (Loedeman and Van der Voet, 1979), therefore more surveys during a season and/or more flights during one survey day may give more complete information on the behaviour pattern. When the objective is to establish the size and distribution of the visit during a top day, one observation day can be selected, but when the size and distribution over the whole season is the objective, more days in that season have to be taken. (Schrauwen and Terpstra, 1986). More flights during one survey day may give more complete information on the behaviour pattern. Such high frequencies can only be carried out with the relatively cheap oblique photography. With vertical airphotos the number of coverages has to remain limited because of the costs, and in that case careful selection of the time of the flight is essential. (Stroband et al., 1970).

In the Michigan case study a test was performed in which the lakes were continuously photographed for one hour during a high-use weekend. This resulted in five complete *flights* per lake. The total numer of boats in each lake zone appeared to vary only slightly over a given one hour span. Therefore it was decided to fly once an hour from 8.00 to sundown (approximately 19.30). (Ashton and Chubb, 1971). Without such a previous test a similar approach was followed in the Sneekermeer survey, where airphotos were taken in nine sequences from 8.00 to 19.00 hours (CD&PW, 1970; Hendriksen, 1971). Also in the Limburg survey a large sequence (seven) of flights was made from 10.00 am to 19.00 pm (Loedeman and Van der Voet, 1979). These three surveys can be classified as *high repetition surveys.*

When only one observation on a day can be made, the time selected for that is usually around the maximum momentary visit. When more than one observation can be planned, then at least also the time of the maximum momentary visit is included. (Schrauwen and Terpstra, 1986). For watersport on large water bodies this is around 13.30 hours, according to Schrauwen and Terpstra (1986), but the maximum momentary visit is not the same for all days and may be different for different areas. See also Broekhuizen and De Wolf (1979) and RWS (1979). It may therefore not always be clear in advance what for a specific area and day will be the time of the maximum momentary visit. (See also Van Lier, 1973).

Table 4.4. *Different characteristics of the survey day of watersports surveys from the air.*

survey area	planned day	actual day		representativity	
		date	type	weather	peakday
Sneekermeer	1.Sunday in July 2.Saturdays	13-7	Sunday	yes	normal
Kagerplassen	1.Whitmonday 2.Sundays 15-6/19-7 3.Saturdays & summerholiday	4-8	Monday in summer-holiday	yes	no
Friesland	summerholiday(?)	30-7	?	-	normal
		4-8	?	-	no
IJsselmeer	Whitsuntide weekend	6-6	Whitsunday	yes	yes
Zwarte Meer	Sundays in peak-season	4-7	Sunday	-	yes
		18-7	Sunday	-	yes
Limburg	Easter,Ascension, Whitsuntide Sunday in holiday	..	Easter	-	-
		..	Ascension	-	-
		..	Whitmond.	-	-
		9-7	Saturday	yes	normal
		10-7	Sunday	yes	yes
Friesland	Sun- and weekdays in main holiday season	3-7	Sunday		
		19-7	Wednesday		
		31-7	Sunday		
Veerse Meer	Sundays in peak-season	two Sundays		yes	-
Randmeren	Sunday in peak-season 15-7/5-8; Whitmonday	5-8	Sunday	yes	normal
IJsselmeer	peakdays	25-7-82	Sunday	-	-
		14-8-82	Saturday	-	-
		23-5-83	Whitmond	-	-
		26-6-83	Sunday	-	-
		30-7-83	Saturday	-	-
		27-8-83	Saturday	-	-
		1-7-84	Sunday	-	-
		11-8-84	Saturday	-	-
		2-9-84	Sunday	-	-
		..-.-86	?		
Nieuwkoop/Kager plassen	peakday in holiday season	31-5	Whitmonday	-	-
		30-6	Wednesday	-	-
		21-7	Wednesday		
		25-7	Sunday		
Biesbosch	simultaneous with some of 4 Wednesdays + 4 Saturdays of field survey	11-6		-	normal
		13-8		-	normal
		10-9		-	normal
Veerse Meer	2 Sundays in peak-season, one in autumn holiday	16-8	Sunday	yes	-
		17-9	Sunday	-	-
		18-10	Sunday	-	-

Other times may also be selected because of other objectives, for example, estimating the overnight stay in boats in the area.
The duration of the survey flight and the number of photos made is, of course, also an important factor determining the feasability of a frequent repetition. The whole flight for the Limburg survey took about 45 minutes and 150 exposures, of which the Central Limburg area alone, the part on which the study concentrated, did not take more than 15 minutes and 40 exposures. (Loedeman and Quaedflieg, 1979). But for an area as large as the IJsselmeer, repetition of the survey more times on one day will be technically difficult, if not impossible, and at least very expensive. The complete coverage in 1976 was made from 10.45 to 15.30 hours in 23 runs. (Dodt and Van der Zee, 1984). Such a long duration of the flight also makes it more difficult to catch the maximum momentary visit.
The frequency of repetition and the timing of the survey flights of the case studies reviewed are presented in table 4.5.

When repetition of a survey on a single day can give insight in the behaviour pattern of the watersporters, and repetition over the season indicate what is the influence of season on this behaviour, repetition through the years allows comparison of different situations over a larger time span and can reveal development processes and trends. For this reason the airphoto survey of the Sneekermeer in 1969 was followed by a similar survey for a larger area in 1975 (PWF, 1977). Since then more surveys have been carried out to add more aspects to the knowledge but also to keep the knowledge up-to-date and to analyse developments. For the

Veerse Meer the study of 1977/78 has been repeated by one in 1987, again with airphotos (Bakker and Hell, 1988).

Table 4.5. *Frequency of repetition and timing of surveyflights for watersport surveys.*

Survey area	date	no of flights	time
Sneekermeer	13-7	9	8.00/19.00
Kagerplassen	4-8	1	12.30-13.00
Friesland	30-7 4-8	1 1	ca 9.00 ca 13.00
IJsselmeer	6-6	1	10.45-15.30
Zwarte Meer	4-7 18-7	3 3	11.00, 13.00, 16.00 11.00, 13.00, 16.00
Limburg	.. 9-7 10-7	1 7 3	14.00-16.00 10.18/20.10 10.28/20.24
Friesland	3-7 19-7 31-7	1 1 2	12.00-14.00 12.00-14.00 8.30-10.30 13.00-15.30
Randmeren	5-8	1	13.15-16.00
IJsselmeer	1982 1983 1984 1986	2 4 3 1	13.00-15.00 13.00-15.00 13.00-15.00 13.00-15.00
Nieuwkoop/Kager plassen	31-5 30-6 21-7 25-7	1 1 1 3	14.00-15.00 14.00-15.00 14.00-15.0 11.00-12.00 14.00-15.00 ca 17.00
Biesbosch	11-6 13-8 10-9	1 1 1	14.00-16.00 14.00-16.00 14.00-16.00
Veerse Meer	16-8 17-9 18-10	2 2 2	9.00, 14.00 9.00, 14.00 9.00, 14.00

Also for the Kagerplassen a comparison between results of surveys in 1969 and 1982 is possible, and for the IJsselmeer surveys have been carried out in several years already. See also table 4.3.

The selection of vertical or oblique together with a certain format and/or film type may imply the selection of a specific camera or airplane, but in many cases a range of equipment can still be chosen from.

Of course large format vertical airphotos can only be made with special cameras from a special survey aircraft. A 60% overlap and 25% sidelap are then more or less standard. The photography and often also the mapping of the photographed situations is carried out by specialized companies. It is with the medium and small format photography, carried out by the research institutes themselves, that a lot of experimenting has been done.

Also then the researchers were much more involved in aspects regarding the organisation and flight planning. Also for further details on these aspects the references quoted should be consulted.

Elaboration and interpretation.

Although most elaboration methods are very labour intensive, the elaboration of vertical photos appears to be faster than that of oblique photos (Schrauwen and Terpstra, 1986). The number of exposures per survey ranges from 90 to 2200 (Thewessen and Bakker, 1987). The elaboration time varied from 3 weeks to 6 months (Schrauwen and Terpstra, 1986). The number

of exposures used for counting varies from 50 to 90% of the total number. Not all photos need to be used. The ample overlap results in a number of exposures giving double information. Other exposures can not be used because of lack of contrast or being not sharp, having too much reflection from the water, or because the object has been photographed in the wrong way. (Schrauwen and Terpstra, 1986; Thewessen and Bakker, 1987). That a sometimes large part of the photographs is not used at all, and thus are *superfluous* does not make the costs of the survey significantly higher however (Loedeman and Quaedflieg, 1979).
The method of interpretation of oblique photos has to be different from that of vertical photos. From vertical airphotos that can be examined in stereo the boats can be interpreted in the area of overlap and marked on a transparent overlay. From oblique photos first a selection has to be made on which (parts of) photos the interpretation will be done.
In all surveys two main distinctions have been made. In the first place a distinction between motorboats and sailing-boats. (CD&PW, 1970; Peltzer, 1977). Often sailing-boats not actually carrying a sail perforce were counted as motorboats (Peltzer, 1977). These two categories then were again distinguished in boats lying along the shore, moored or anchored, and boats actually sailing. (CD&PW, 1970; Hendriksen, 1971; Peltzer, 1977).
In some surveys a distinction into more categories was made (Van der Vegt et al., 1979b; Van der Ploeg, 1984a; 1984b; RWS, 1979; Bakker and Heil, 1988), but these subdivisions could not always be made consistently (RWS, 1979; Broekhuizen and De Wolf, 1979).
The stereovision in vertical airphotos in general allows a qualitative analysis of the objects photographed. But when the boats are moving, their relative positions are different from one photograph to the other, and a double image is seen. (RWS, 1977; Meyboom and Hellinga, 1977). This may give some problems if it is wanted to identify the type of ship. On the other hand the double occurrence of a boat in stereovision without providing a stereo impression clearly gives an indication of direction and speed of movement (Dodt and Van der Zee, 1984). The ships observed on two consecutive photographs can be indicated on transparent overlays with a *double indication*. From the sequence of photography the direction of sailing of the ship is deduced, if not directly interpreted from the wake and the shape of the ship. The distance between the indications is an indication of the sailing speed. (RWS, 1977; Meyboom and Hellinga, 1977).

In the visual observation method counts are directly noted on paper or dictated on tape recorder. Counts from photos or slides will have to be made afterwards. (Schrauwen and Terpstra, 1986). Visual observations from the air therefore are a fast and cheap aerial survey method. Directly after the flight the analysis of the data can start. But the accuracy of the counting in this method is not too high, and hard to check. Therefore this method is most suitable for low densities with rather homogeneous distribution. Concentrations are more difficult to deal with. (Hagoort, 1986b).
In photo-count methods the objects to be counted are counted on the photos or slides after their location in the recreation area has been determined. Because parts of the area may have been recorded on more than one photo or slide, interpretation problems or double counts may occur. Therefore it is important to first establish the location of the objects in the area. This is done easiest in vertical airphotos, especially if topographical features also appear on them. If no topographical features occur, still the position of the elements can be determined taking into account the flying speed and the photo-interval. Oblique airphotos may give more problems because of the scale differences within the photo, but on the other hand they may show more topographical detail. (Schrauwen and Terpstra, 1986).

The elements can be counted directly from the photo material, or the elements are first transferred from photos to maps or overlays and counted from that (Schrauwen and Terpstra, 1986). See also figure 4.12. In some surveys boats were interpreted and mapped on transparent overlays and counted per grid-square. This method gives an accurate and for larger areas comparable inventory of boats from which a subdivision of lake areas according to boating density can be derived. (Dodt and Van der Zee, 1984).

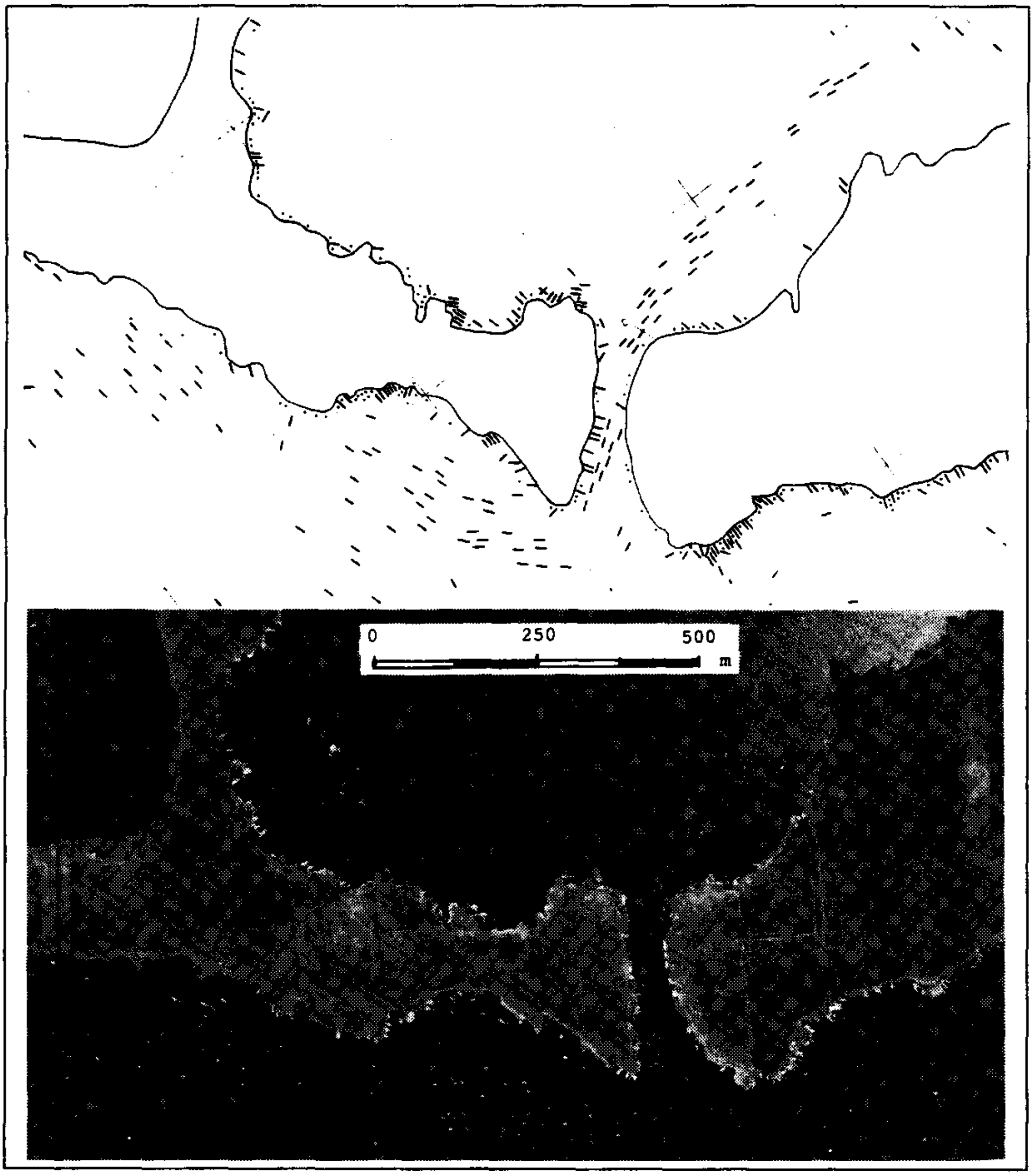

Figure 4.12. *A section of an interpretation map and the corresponding vertical airphoto. (PWF, 1977).*

Although in the transferring some mistakes can be made, the counting may be easier from transferred data than from the more complex photo-image. A systematic organisation of the counting procedure is necessary. Marking directly on the photos or on a clear transparent overlay which objects have already been counted is essential to avoid confusion. If counting is done by more than one person, uniformity in interpretation criteria should be established. Recounting, counting by more than one person or recounting of samples may be required to establish and/or assess the rate of accuracy. (Schrauwen and Terpstra, 1986).
When boats are moving, their relative positions are different from one photograph to the other. Therefore a moving boat can be easily recognized as such in vertical airphotos because of the lack of stereovision and will not be counted twice. But in oblique photographs this may be less easy, and the method of interpretation therefore has to be adapted.

When consecutive oblique photographs have an overlap, double counts can be avoided by drawing a counting boundary through at least two identical points on both photos, (Broekhuizen and De Wolf, 1979) and by comparing type, colour, position and direction of the boats on the different photographs (CD&PW, 1970; Hendriksen, 1971), or to select from photos that all depict a same unit of area the one that shows that area most clearly and mask out that area on all the other ones (Schrauwen and Terpstra, 1986; CD&PW, 1970). Determining the overlap area on slides can be a problem. If they are of large size, counting boundaries can be drawn on them as well. Otherwise slides are projected side by side. On one slide projection the counting is done, on the other an imaginary line is drawn to exclude the common area and counting is continued on that one on the area that is not in common. (Schrauwen and Terpstra, 1986). When subareas are photographed from different directions, in the time needed to fly around a boat could have moved over a considerable distance. The methods to avoid double counting mentioned so far do not help much in such cases, and double counting can not be avoided nor can it be established what rate of error it causes. (Broekhuizen and De Wolf, 1979). A similar problem occurs in vertical photographs where the small side lap between the photo strips may cause that ships sailing perpendicular to the flight line appear on two adjoining strips or are missed completely. Statistically both cases will compensate each other. (RWS, 1977; Meyboom and Hellinga, 1977; Dodt and Van der Zee, 1984). Anyway, it has to be accepted as an unavoidable inaccuracy factor of the method used (RWS, 1977; Meyboom and Hellinga, 1977).

In some surveys during the photo-flight day at a number of places in the field or from the water visual counts were made (CD&PW, 1970). But, since field counts often cannot claim to have the utmost accuracy and neither are exactly comparable to the photo counts it is difficult to deduce from them a correction factor to apply to photo counts. Other approaches to estimate the accuracy of the airphoto interpretation have been used too, but neither of these approaches has been very successful for the calibration of the photo counts.
Checks on the internal accuracy of the counts can also be done. In one survey a check counting was made for a random sample of photographs. Deviations of 1 to 1.5% occurred. (Broekhuizen and De Wolf, 1979). The reliability of counts on airphotos appears to be strongly dependent on the interest of those who have to do the counting. (Loedeman and Van der Voet, 1979). Counts made afterwards by other persons not involved in the survey appeared to deviate considerably, in average 15% (Broekhuizen and De Wolf, 1979).
Since it appears that there is no good method to really establish the accuracy of the interpretation and counting, the question may be raised how important this accuracy is. Of course, if the only aim is to know exactly how many boats are in a certain area, the accuracy is important. But for mere numbers entering and leaving an area, the net result being the number of boats being present at the time, simpler and much cheaper methods than aerial survey are available. The aerial survey is called in because of the need or want to know how these numbers are distributed over the area. But for the analysis of a distribution pattern it is not necessary to know exact numbers, relative figures can reflect the situation as clearly.

In order to know how the numbers are distributed over the area, the positions of the boats have to be indicated on a map. In all surveys this has been done, with simple or with more complex methods. Transferring the interpretation data from vertical photographs seems not to be too difficult. This has been mentioned as one of the advantages of vertical airphotos. (Schrauwen and Terpstra, 1986). With vertical photographs where the lakes are small enough to have parts of the shore with recognizable landmarks showing on all of them, transferring the locations of the boats on to the map is relatively easy. An optical pantograph or other transfer instruments can be used or it may be done by simple eye estimate when it is not crucial to give the position with the greatest degree of exactness. When many photos have no recognizable fixed features at all, plotting the locations of the boats becomes more of a problem. In the IJsselmeer survey therefore the transfer of data from airphoto to map has been a difficult and time consuming activity (RWS, 1977; Meyboom and Hellinga, 1977), in which very exact positions can not be expected. Transferring data from oblique photographs can be much more difficult than from vertical photos because of the different projection or angle of

view. The area registered on each photo is the intersection plane of a cone, the top of which is the focus of the camera, with the *mowing field*.
These intersections can be reconstructed and plotted on a map using the landmarks that can be identified on both photo and map, (see also figure 4.10.) after which the position of the boats can be transferred from the photo to the map using terrain features for the identification of the location which is only approximately indicated. (CD&PW, 1970; Hendriksen, 1971). A more accurate plotting of the positions of boats from oblique photos has been attempted using one-point quadrilateral grids. But many different perspective grids had to be constructed corresponding with different camera angles and aircraft elevations. (Ashton and Chubb, 1971). This is a very time consuming work and if the utmost precision in the indication of the location is not really relevant the eye estimate method applied in the other surveys is much quicker and easier.

The analysis of the interpretation data.
A busy day or even a peak day does not necessarily mean that *all* boats are out sailing. Always a number of boats remains in the marinas or other home bases. Therefore the *participation rate* has to established, in this context that means the percentage of the total recreational fleet, having a permanent lying place in an area, that has sailed out at a certain moment. (BM&RIN, 1984). It may be another measure to judge whether the survey day has really been a representative day. But also for planning and management of a watersport area it is important to know what is this participation rate on representative days, in order to be able to relate the maximum capacity that can be allowed in the marinas to the capacity of the lakes.
To establish the participation rate in many of the watersport surveys the counts of the boats out on the water have been related to the total capacity of the marinas or to the number of boats counted in the marinas at the same time. In one survey simultaneously with the photography counts were made of boats going in and out of the marinas and of the number of boats moored there (Broekhuizen and De Wolf, 1979). In other surveys the total number of lying places has been estimated on the basis of an airphoto count. The accuracy of such a count is influenced by the size of the boats and the visibility on the photos. Boats under trees and roofs are hard to identify. In one case the count was done on airphotos of a weekday in the pre-season, in which the occupation rate of the marinas was 90-95%. If the count has to be done on the same photos as for the rest of the survey, such occupation rates will not occur. Anyway this approach can only result in realistic participation rates when not too many boats come in from lying places outside the survey area, or leave to other areas. (BM&RIN, 1984).
In the different surveys no clear correlations have been found between the capacity of the marinas and the percentage of boats that sailed out, nor between the proportion of navigable water and the percentage of boats sailed out (RWS, 1979). But the participation rate has been found to be different for different boat types, and these differences vary again according to the type of area (RWS, 1979; Van der Voet and Dijkstra, 1971; BM&RIN, 1984), just as the overall participation rates vary from one area to another, ranging from over 50% to around 10%.

Participation rates and mere numbers of boats out on the water alone may in themselves be interesting enough, it is their distribution pattern over the water area that reveals which parts of the area apparently are more attractive and which less and may give an idea how to optimally manage a watersport area. That is why interpretations have been transferred to maps and in almost all the watersport surveys densities have been measured and density patterns analyzed.
For *displaying* the density patterns a simple indication of the position of boats on a map may suffice. Highest accuracy of location is not really required, approximate positions will suffice. Thus, for example, in the IJsselmeer survey in total 3250 ships were indicated on a 1:100000 map, giving an impression of concentration areas. These concentration areas could be further specified by analyzing the sailing direction of the ships. (RWS, 1977; Meyboom and Hellinga, 1977).

For *measuring* density, the number of boats per unit of area is a logical parameter. It can be established for the survey area as a whole, *gross density*, or just for the water part of the survey area, *net density*. Different areas then can be compared for their difference in overall boating density. But it will be more interesting to analyze spatial differences or patterns in density within one area. Two main approaches can be followed. The survey area can be subdivided in more or less homogeneous sub-areas or zones, for which the densities are established separately, or a grid is laid rather randomly over the survey area and densities expressed per grid-square reveal the spatial pattern. The size of the grid-squares varies from survey to survey. Grid-squares of 25 hectare, but also squares of 1 hectare have been used.
Based on the distinction into boats sailing and boats lying along the shore, three different types of intensities then can be expressed per square : total number of boats per ha of water; total number of boats sailing per ha of water; total number of boats lying per 100 m of (windward) shore. (CD&PW, 1970; Hendriksen, 1971). In some cases only two types of densities are expressed, densities of sailing boats and densities for the total number of boats (lying and sailing) (RWS, 1979).
Also when the survey area is subdivided into more or less separate sub-areas, zones or sectors (Broekhuizen and De Wolf, 1979; Ashton and Chubb, 1971; Peltzer, 1977), the use intensity is expressed in number of boats per ha of water (Broekhuizen and De Wolf, 1979; Ashton and Chubb, 1971), or per km^2 (Hagoort, 1986a). Often such subdivision of areas is according to more or less natural segmentation or depth zones (PWF, 1977; RWS, 1979; Driebergen, 1981a), and in one case also according to susceptibility to damage from recreational activities (Peltzer, 1977). In one survey density calculations were restricted to the *used surface*. This is the total surface area from which zones or depth categories with less than 5% of the total number of boats have been excluded (RWS, 1979).
In order to present the densities on a map in most studies the large range of different densities have been classified into different density categories.

Irrespective of which approach is used, the density measuring method gives an accurate inventory of boats that is comparable for larger areas and from which a subdivision of lake areas according to boating density can be derived.
A first step can be to compare overall or average densities of different areas. On the Kagerplassen in 1969 a density of 2.0 boats/ha was recorded, the average density found in the Sneekermeer survey was 0.7 boat per ha of water (CD&PW, 1970; Hendriksen, 1971), in the gravel pits along the Maas in 1977 0.8 boats/ha (Driebergen, 1981a). On the Randmeren densities of 0.7 to 1.0 boats/ha occur (Hagoort, 1986a; RWS, 1979), for the Zwarte Meer the number of boats per ha of water was in average 0.2 (Peltzer, 1977). On the IJsselmeer the boat densities of course are very different from those recorded on smaller lakes and ranges from 1 to 7 boats per km^2 or 0.01 to 0.07 boats/ha (RWS, 1977; Meyboom and Hellinga, 1977).
A second and may be much more interesting step is to compare the difference in densities within one area. In the Randmeren survey the highest densities of around 1 boat per hectare, is approached only in some narrower lakes in the depth category of more than 130 cm. On the larger lakes the densities in average are 0.2 boats/ha. (RWS, 1979). The highest densities (more than 0.25 boats/ha) occur almost exclusively in and just along the navigation channels (RWS, 1979; Driebergen, 1981a). Also in the Zwarte Meer area concentrations occur especially along the navigation channel, where values up to 5.5 boats/ha were recorded (Peltzer, 1977).
On the IJsselmeer density patterns vary too. Of the boats 70% to 80% is concentrated along parts of the coast of Friesland and North-Holland. Locally densities much higher than the average occur: 30 boats/km^2 near Enkhuizen. (Hagoort, 1986a; 1986b). From the first aerial survey of watersports on the IJsselmeer, based on one flight only, it was deduced that there appear to be certain routes leading to and from specific destinations as well as areas in which one cruises without specific destination. Especially crossings from one harbour-city to another appeared to be attractive. (RWS, 1977; Meyboom and Hellinga, 1977). The later reconnaissance surveys reveal that the highest densities occur around the time of 14.30 near the ports, which could mean that the sailing from port to port plays a less dominant role on these large waters than has been assumed (Hagoort, 1986a; 1986b). Not all information wanted therefore can with certainty be abstracted from observations at one moment.

Still, it can be observed that the sailing-lying behaviour of the water-recreationists in general is strongly determined by a rather constant distance and time that people are willing to sail. It is remarkable that people direct themselves to the attractive sites that are nearest to their point of departure. If more attraction points are situated at an equal distance from this point of departure people spread evenly over these points. (Van der Vegt et al., 1979a). In the Nieuwkoopsche Plassen and Kagerplassen area it has been observed that on more crowded days the large lakes are more intensively used, but that no higher intensities in the quieter areas are found (BM&RIN, 1984). This might either indicate that these quiet areas then already are used to their maximum capacity, so that additional users have to evade to other areas, or that on more busy days another type of users with different preferences is added to the existing group.

Although the Michigan case study reports that over a given time span the total number of boats varies only slightly (Ashton and Chubb, 1971), and also for the Nieuwkoop survey the variation in total numbers of boats during one day was reported to be but small (BM&RIN, 1984), in the Limburg survey counts made on photographs taken from a TV-tower indicate that within short time (20 minutes) large variations in numbers of boats may occur (Broekhuizen and De Wolf, 1979). The variation of boating densities in time may therefore be different for different types of areas. This variation may occur with respect to the time of day, but also with respect to the day of the week and the period of the season. Careful analysis of several sequences of images can reveal different behaviour patterns of watersporters over time. (Dodt and Van der Zee, 1984).
The time of the day is of strong influence. For the 1975 Friesland survey the densities in boats/ha were found to be clearly different for morning (1.4) and afternoon (2.8) in all sub-areas. This difference is even stronger when only the actually sailing boats are considered, 0.13 and 0.77 respectively. (PWF, 1977). Also in the Nieuwkoopsche Plassen the sailing trips are mainly made in the afternoons. Most sailing is done around noon. (BM&RIN, 1984).
On the IJsselmeer the highest densities occur around the time of 14.30 (Hagoort, 1986a). The highest density on the Sneekermeer in 1969, recorded around 15.45 hours, is 1.0 boat per ha of water (Hendriksen, 1971). But, since between 14.00 and 15.45 hours no airphotos were taken, this is not necessarily the maximum density (CD&PW, 1970).
The peak period of the day is related to the movement pattern. For Friesland it was found that in general people start to sail after 9.00 hours. The number of people sailing increases up to 12.00 hours. Between 12.00 and 15.00 hours is the time most used for sailing. The ratio sailing : lying then is 40 : 60. From 15.00 hours to 21.00 hours the number of sailing boats gradually decreases. After 21.00 hours hardly any sailing is done. (Van der Vegt et al., 1979a). Also for the Nieuwkoopsche Plassen en Kagerplassen area it was observed that the number of sailing boats increases gradually from 10.00 onwards to a peak of just over 50% between 14.00 and 15.00, and then decreases again (BM&RIN, 1984). See also figure 4.13. These movement patterns may vary for sub-areas. In some sub-areas there is a clear lying peak between 12.00 and 14.00 hours, indicating a *transit* function of these areas. Another group of areas is characterized by a reduction of the sailing structure of the pattern between 11.00 and 17.00 hours, that also never surpasses the 50% limit. This indicates a *lying* function of the areas. A third group is characterised because they do not show too large differences from the skewed general pattern and a sailing structure of the pattern that between 12.00 and 16.00 surpasses the 50%. This indicates a *sailing* function of these areas. (Van der Vegt et al., 1979a).
Still, the results found have to be placed in the perspective of the representativity of the surveyed day(s). the difference between a day in the weekend and a normal weekday, or a holiday, may result in a different behaviour pattern. So may the difference in weather condistions from one day to the other, as well as such differences through the seasons. again, the survey day selected determines what information can be obtained, the type of information wanted will determine the selection of the survey day.

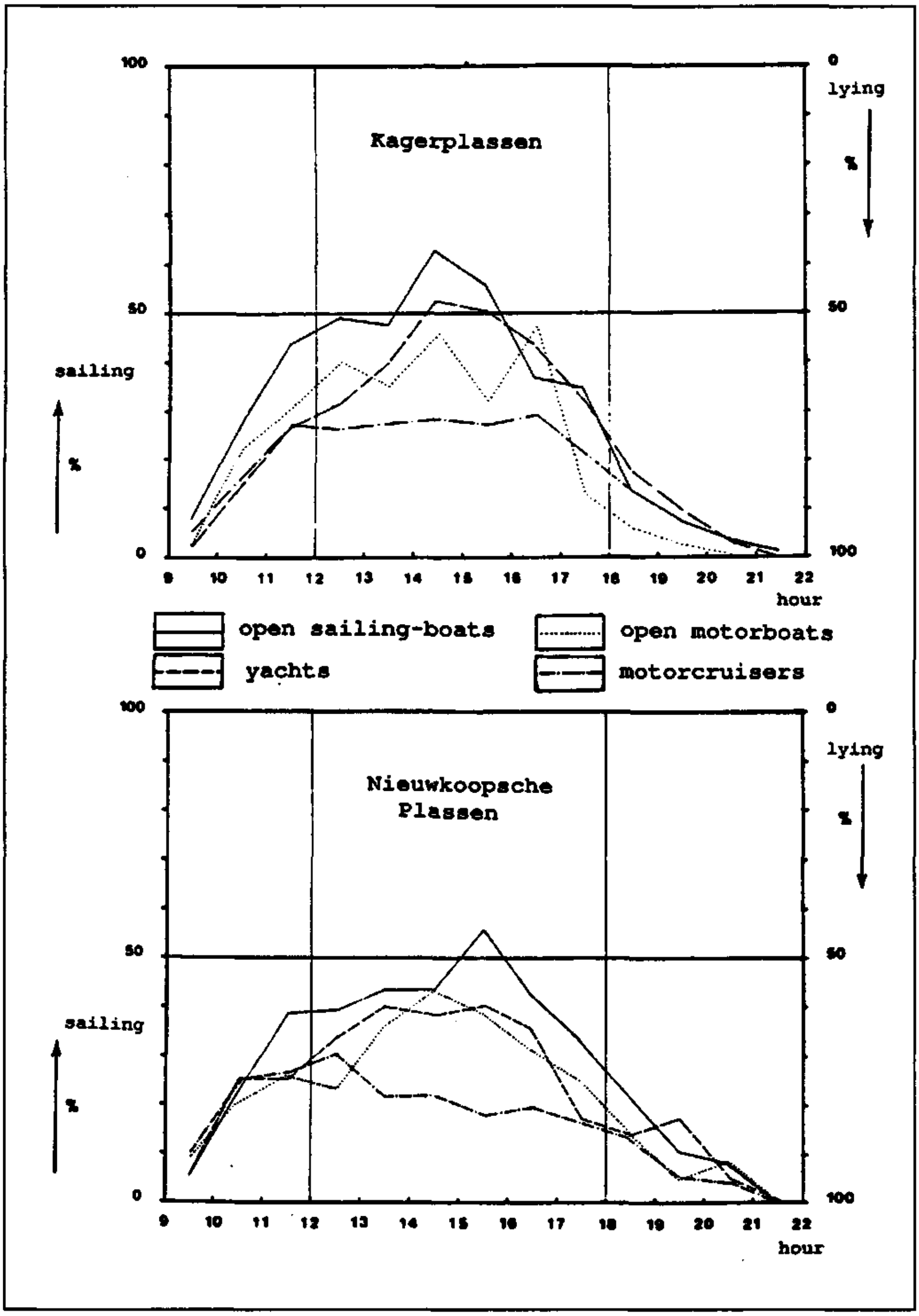

Figure 4.13. The sailing : lying pattern of different categories of boats on the Kagerplassen (above) and the Nieuwkoopsche Plassen (below) (BM&RIN, 1984).

Participation rates can differ considerably according to day of the week and during the season, and the distribution over the sub-areas can differ from day to day. In the Nieuwkoopsche Plassen area, for example, on the busiest days 40% more boats are present then on the quietest days, and Sundays clearly score higher than weekdays, both in pre- and peak season. Also a clear peak is observed in the holidays.

In the Kagerplassen area, however, the largest number of boats is not found in the holiday season but in pre- and post-season. This can be explained by the fact that many watersporters in their holiday move to other watersport areas. (BM&RIN, 1984).

Differences in participation rates, density and activity pattern between individual areas and periods can also be strongly influenced by the weather. For example, with strong winds less boats are sailing than with less strong winds, and on the IJsselmeer with westerly winds less boats are found than with winds from other directions (Hagoort, 1986b). The effect of seasons may be partly related to the general weather conditions inherent to specific seasons.
When for the same area a watersport survey is repeated after a number of years, interesting comparisons can be made. When comparing the results of the Kagerplassen surveys of 1969 and 1982, an increase in the total number of lying places with 80% is observed; an increase in boats counted with almost 50% and an increase in crude density of 8 boats/ha of water. The participation rates of 1969 correspond closely with the average over three Sundays in 1982. (BM&RIN, 1984). In the Veerse Meer in 1987, compared to 1977, relatively little has changed with respect to the distribution pattern of the boats, but the gross density increased from 2.8 to 3.2 per hectare, the net density from 1.2 to 2.2 per hectare and the density of sailing boats from 0.7 to 1.0 per ha (Bakker and Hell, 1988).
Thus, a much more clear distinction into types of watersports and watersport areas can be obtained when also the time dimension in the density pattern is considered.

It is normally assumed that with respect to watersports the recreational behaviour is mainly determined by the possibilities of the boat that one has (BM&RIN, 1984). The participation rates have been found to differ according to the type of boat, which may be related to the variation in motivation pattern for the different boat types (Van der Ploeg, 1984a; Van der Linden and Van Eijk, 1984). This again may determine that in the composition of the boats according to types for a watersport area fluctuations from day to day as well as during one single day have been observed. These differences may characterise the use pattern of the different boat types. For example, both in Friesland and in the Zwarte Meer area it has been observed that the ratio of sailing-boats to motorboats is not the same on all times of the day. Late in the afternoon there are relatively more sailing-boats than on earlier moments. This might indicate that people with sailing-boats stay until later times on the water than people with a motorboat, although weather will be a factor of influence too. (Peltzer, 1977; PWF, 1977).
Different watersport areas show different compositions of boat types using them. The distribution of boat types apparently has adapted to the character of the lakes. (RWS, 1979). A positive correlation between a large size of the water and a high percentage of sailing-boats has been observed (RWS, 1979; BM&RIN, 1984). On the IJsselmeer the majority of the recreational boats (80%) is sailing-boat (Kosters, 1985a; RWS, 1977; Meyboom and Hellinga, 1977) and on the Wadden Sea this percentage is even higher still (Kosters, 1985a). But in the Biesbosch only 4% of the boats is sailing-boat. Motor cruisers dominate here (70%) (Van der Ploeg, 1984a; 1984b). Still, the size of the water area alone is not always decisive. Other qualities of the water area in addition to size are of importance.

In most surveys also a distinction has been made into boats sailing and boats lying along the shore, moored or anchored. The proportion of these categories varies from one area to the other. In the IJsselmeer survey it was observed that most of the recreational boats are sailing, only about 0.5% are anchored or moored along the shore (RWS, 1977; Meyboom and Hellinga, 1977). On the Randmeren 38% of the boats counted on the lakes was not actually sailing but moored or anchored (RWS, 1979). In different sections of the Sneekermeer area in average 64% to 86% of the boats lies along the shore (CD&PW, 1970; Hendriksen, 1971), in the Limburg survey area this ranged from 83% to 31 % (Broekhuizen and De Wolf, 1979), and in the Biesbosch it was found that of all boats 74% is lying (Van der Ploeg, 1984a). So only on the very wide water people are actively sailing. In the smaller watersport areas no clear correlations between size of water surface and percentage of actually sailing boats can be observed.
The sailing-lying behaviour also shows variations in time. See also figure 4.13. In the morning more boats are lying along the shore than during the afternoon (PWF, 1977; CD&PW, 1970; Peltzer, 1977; Bakker and Hell, 1988). A variation in the sailing : lying ratio according to type of boat has been observed too. People with motorboats apparently are more stationary recreating than those with sailing-boats. (Peltzer, 1977; Broekhuizen and De Wolf, 1979; Van der

Ploeg, 1984a; 1984b; BM&RIN, 1984). To this difference in sailing-lying behaviour is related a difference in timing, duration of trips and distance covered per boat type (Van der Vegt et al., 1979a; 1979c; Broekhuizen and De Wolf, 1979; Van der Ploeg, 1984a; Van der Linden and Van Eijk, 1984; BM&RIN, 1984).

The large proportion of boats found anchored or moored indicates that apparently there is a large desire to be on the water without actually sailing (Hendriksen, 1970). And since such a large proportion of boats makes or wants to make use of the shore, the capacity of a watersport area is determined by the length of its usable shoreline rather than its surface of water (Van der Voet and Dijkstra, 1971). Therefore it will be useful to analyze what is the distribution pattern over the shorelines and what characteristics of the shoreline make them suitable and attractive.
For mooring (=lying along the shore) both the physical suitability of the shoreline is important as well as prohibitions on mooring. In addition to that the aspect windward shore versus lee shore has to be considered. (PWF, 1977; CD&PW, 1970; Hendriksen, 1971).
A classification of shores according to their suitability for mooring can be made. Some, mostly physical, aspects can be inventoried from airphotos, information on aspects of a more legal character has to be obtained from other sources. With the aid of the airphotos then an inventory can be made indicating along which type of shoreline boats are lying. (PWF, 1977).
In Friesland in many cases the available suitable shoreline appeared to be not sufficient, even when disregarding the windward shore aspect. Boats were moored at sites that are not really suitable or where mooring is prohibited.
All in all 46% respectively 50% of all boats were found lying along the 18% of suitable shoreline. The suitability classification apparently is one made from the viewpoint of the terrain manager. Especially the categories *prohibited* and *unsuitable because of sensitive vegetation* may be physically (or nautically) suitable for mooring and possibly be even very attractive for that purpose, and thus actually used. The airphotos give information about the places where boats lie along the shore and it can be established where boats lie on places where this is not allowed.
Of course, only the number of boats actually lying along the shore can be taken into account. How many of the boats that are sailing would also have liked to get a place along the shore can not be assessed. (PWF, 1977).
If instead of a previously made classification from the terrain managers point of view the apparent suitability and attractiveness of shores for mooring is considered, an analysis of the distribution pattern of moored boats over the available shores can give the necessary information.
Although not in all surveys a particular preference for certain shores is observed (Broekhuizen and De Wolf, 1979), in many cases the preference for a type of lying places is evident (Van der Vegt et al., 1979a; 1979c; BM&RIN, 1984).
One aspect is that shores located nearest to the point of departure appear to be most attractive, indicating that people only sail as short as possible distances to go ashore as quick as possible (CD&PW, 1970; Hendriksen, 1971; Van der Vegt et al.,1979a).

In the Sneekermeer survey for a limited number of shorelines a series of photos could be selected on which individual boats could be clearly recognized. See also figure 4.14. In this way it could be analyzed how long individual boats remained on the same place along the shore. The largest number of boats remained approximately two hours along the shore, 34% of the boats lies along the shore two hours or less, 37% seven hours or longer. (CD&PW, 1970; Hendriksen, 1971).
In the previous sections it has become clear that several characteristics of a water body are of influence on the type of watersports activities. The recreational use is related to a variety of factors. The presence, size and location of specific facilities such as: marinas, lying places, trailer slopes, and overnight accommodation, is an important factor determining the spatial pattern of recreational use. But also *area related factors* highly determine the use of an area. (BM&RIN, 1984). Area related or area specific factors are factors that have a direct relation to geographical area characteristics in contrary to non-area specific factors (Van der Vegt

et al., 1979a). For watersport the area related factors are shape, compartimentation, size and depth of the waterbodies and canals and their interconnectivity, that is, the connections with neighbouring waterbodies (BM&RIN, 1984).

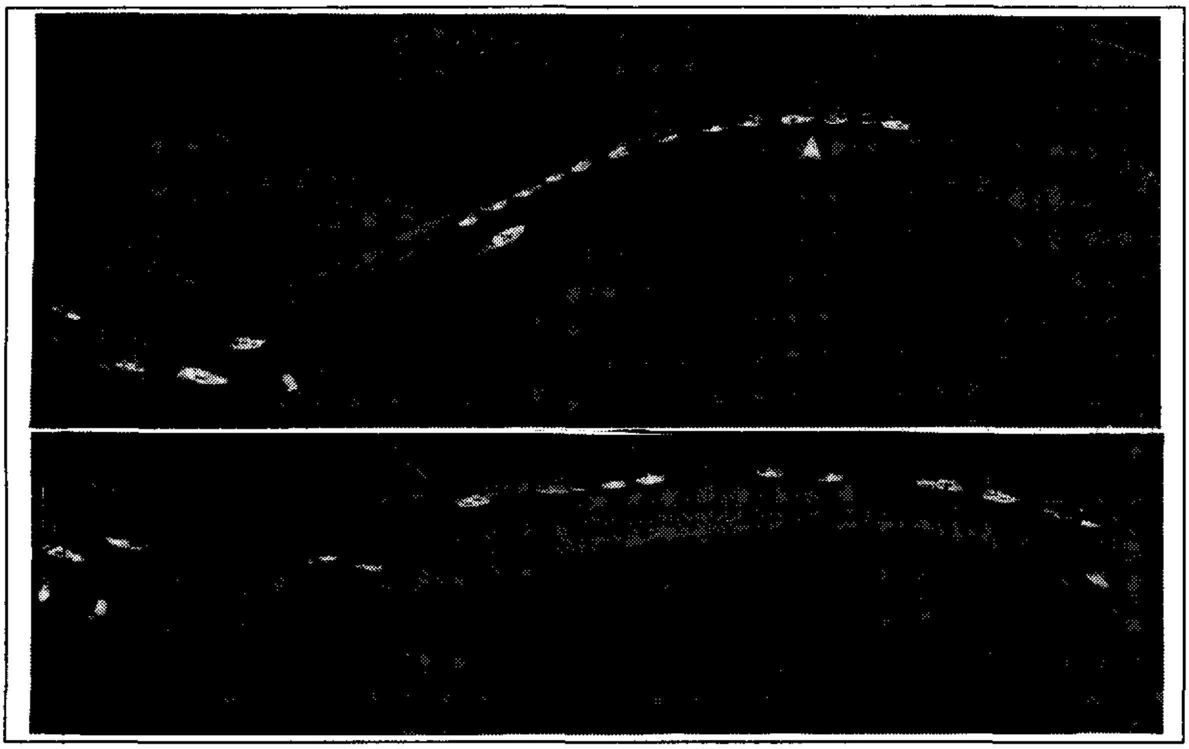

Figure 4.14. *Two sets of oblique airphotos of the same site taken in the course of one day. With such a series the sailing : lying behaviour of individual boats can be analyzed.*

With respect to the size of the waterbody it has been observed that the larger the area the larger the proportion of sailing-boats and -though less strongly correlated- the lower the proportion of boats that is not actively sailing. But, since the majority of the boats in a watersports area is not actively sailing but lying along the shore, the amount and quality of shorelines is of utmost importance. It has become apparent that the number of boats on a lake is related to the amount of shore and that a high shore : area ratio results in high boating densities (Ashton and Chubb, 1971).
The characteristics of a water body that determine its suitability and attractiveness for watersports therefore can be expressed by the relation between the surface of the water and the length of the shoreline and some other additional characteristics, such as depth of the water and type of shore. The OW-factor is the ratio between shore-length (O=*oever*=shore) and water-surface (W=water) that can be used as an indication for the rate of compartimentation. For a circular waterbody the O-W factor would be 1. (Van der Voet and Dijkstra, 1971). For the Slotermeer, in Friesland, this is 1.3, for the Kagerplassen 7 and for the Prinsenhof, also in Friesland, 9.5. (Hendriksen, 1970).
See also figure 4.15. The OW-factor can be calculated gross, for the total shore-length, or net, for only the usable shoreline length. When comparing the two lake complexes of the Kagerplassen area, different use intensities were compared with certain characteristics of the two lake complexes as expressed in table 4.6. (Van der Voet and Dijkstra, 1971).
The difference in character between the two lakes is reflected in a difference in recreational use. The ratios between the OW-factors, as well as between the gross densities and net densities of the two lake complexes are all approximately 2.5. In some respects, however, the behaviour pattern of the recreationists on both lakes is similar, for example, the proportion of boats that left their home-base, in both cases around one quarter, and the small proportion of motor cruisers that is actually sailing. (Van der Voet and Dijkstra, 1971).

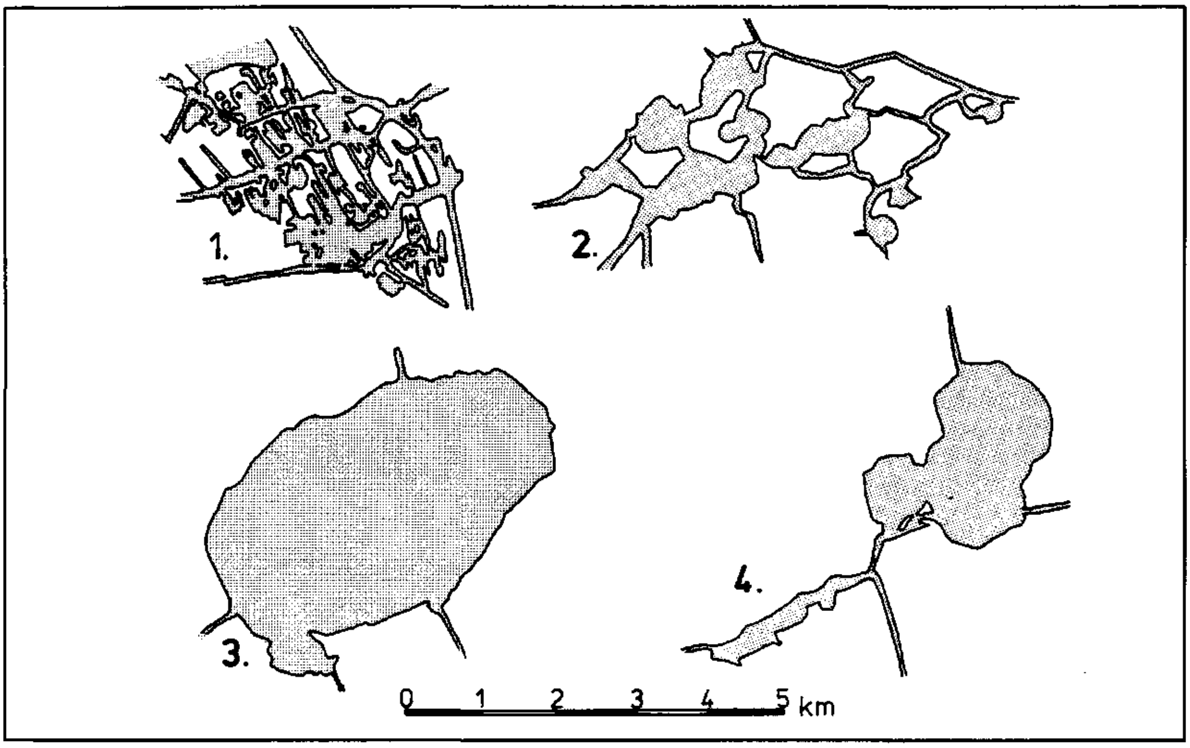

Figure 4.15. *Four different lake complexes with different OW-factors.*
1. Prinsenhof, OW = 9.5; 2. Slotermeer, OW = 1.3 ;
3. Kagerplassen, OW = 7; 4. Braassemermeer, OW = 2.6.

Table 4.6. *Comparison of the Kagerplassen and the Braassemermeer.*

	Kagerplassen	Braassemermeer
surface	420 ha	520 ha
total shore-length	51 km	21 km
usable shore-length	28 km	7 km
O-W factor	7.0	2.6
O-W factor (usable shore-length only)	3.8	0.9
total number of boats/ha =gross density	8.0	2.9
number of boats that left their home-base/ha =net density	2.0	0.8

(Van der Voet and Dijkstra, 1971).

On the Randmeren the percentage of sailing-boats is relatively low in the narrower lakes and high on the wider and larger lakes, except for the Veluwe-meer, where it is lower, possibly because of the numerous islands and relatively shallower water. (RWS, 1979). Would there be an inverse relation between percentage of sailing-boats and O-W factor, sailing-boats preferring the open water? The open water also shows a higher proportion of the number of actually sailing boats (BM&RIN, 1984). In the Randmeren area two large lakes also show a high percentage of sailing boats, but this is not surprising, because sheltered mooring places or anchorages are almost absent. Other large lakes show a considerable amount of lying boats (moored or anchored) just as the narrower lakes. (RWS,1979). May be the chance to find a good mooring site after sailing is of more importance in the selection of the water area than size or shape.

The influence of depth is of course strongly related to the type of boat.

In the Randmeren more than 70% of the motorboats and sailing-boats sails on water deeper than 130 cm. On some lakes however many boats also sail in shallow zones with less than 80 cm of water. The distribution of boat types apparently has adapted to the character of the lakes. (RWS, 1979).

In addition to the physical characteristics mentioned so far, several physical or juridical restrictions of access to water areas may influence the distribution of boats over the area. Areas can be physically closed with logs and chains or just by *no entry* signs. Dredging of canals can improve accessibility. Rules and regulations restricting accessibility may be issued. The accessibility of certain areas can be restricted completely or only in certain seasons, for certain types of boats, or for the water area only. Restrictions on mooring or anchoring can be made for certain types of shores. With an airphoto count it can be determined whether such a spatial zonation is effective. For the Kagerplassen this has been done and in the areas that are completely closed for recreationists or boats, no boats have been observed. In areas with restricted accessibility only types of boats were observed for which access is allowed, with only few exceptions. Whether a boat has a permit or not cannot be seen, of course, on airphotos. (BM&RIN, 1984). In the Biesbosch the survey made clear that 8% of the motorized boats was violating the zoning. Of the other boat types almost none did so. (Van der Ploeg, 1984a; 1984b).

Some overall conclusions.
Because there have been so many different approaches to watersport surveys from the air, it is very difficult to come with general conclusions. Still, an attempt is made to at least arrive at some.
The comparison of the various studies does not lead to a clear preference of vertical over oblique airphotos or over aerial reconnaissance flights. What is the best approach will depend from case to case on the specific circumstances. But, it can be concluded that in general recreational boats can be detected on airphotos with a level of accuracy that is at least sufficient to give an impression of the spatial distribution.
And it is especially this spatial distribution that can provide information that is important in the context of land evaluation for recreation.
Thus the question of objective 7 can in this case be answered positively.

The various studies also made clear that, when properly timed, single airphoto coverages can reveal spatial distribution patterns. However, the use of sequences of airphotos, or of visual reconnaissance flights, during one day, during one season, or after several years, can significantly increase not only the amount of information, but also its value by adding the temporal aspect of the behaviour pattern.

Shoreline recreation monitored from the air.

It has already been observed that in the so-called watersport the shore appears to be often more important than the water area. But, in addition also a lot of recreationists aim for the shoreline from the land side. This type of recreation is also called beach recreation and amphibian recreation. The pressure on the shoreline environment can be great, but often is not evenly distributed. Therefore for a good management of such areas knowledge is necessary about the use patterns, that is, the spatial behaviour of the recreationists in relation to the different elements or components of the landscape. The use of airphotos to obtain such knowledge seems a good approach for the same reasons as for the watersport surveys. The type of information needed is similar: how many people visit the area and how do they distribute over the terrain. Of course, also here information about motives, place of residence and other characteristics of interest can only be obtained by an enquiry survey. But for the spatial patterns airphotos may be the best tool. Of the several surveys that have been carried out in the Netherlands, only two will be used as an example to discuss the possibilities and limitations, one in Limburg and the other in the Randmeren. Both have been carried out side by side with a watersport survey.
The Limburg survey was done with oblique small format colour slides, and the Randmeren study with large format panchromatic vertical airphotos.

Selection of the type of photography.

The scale to be used has to be much larger than that used in watersport surveys, since the objects to be identified, persons, are much smaller.

It has been stated that in oblique photography the scale in which an object still can be recognized is smaller than in vertical photography, and that this is most obvious with the recognition of persons, that on vertical photography only can be identified by their shadow. Even on stereopairs of 1:2500 sitting persons can hardly be distinguished whereas this is very well possible on oblique photography of the same scale. In oblique photography the limits are between 1:5000 and 1:7000 for the recognition of persons. (Loedeman and Quaedflieg, 1979). For the Limburg survey of shoreline recreation a flying hight of 150 m was necessary to obtain the right scale. Although the quality of the photographs after the first flights for the watersport survey was such that photography of shoreline recreation could be thought of, the conclusion afterwards was that for the shoreline recreation in such a complex area a different approach seemed necessary and that perhaps better a large format camera could be used. (Loedeman and Quaedflieg, 1979).

For the Randmeren beach survey a scale of 1:2000 was chosen (RWS, 1979; Driebergen, 1981a). Since the main objective for this survey was to get a comprehensive overview of the spatial distribution of recreation over the area, other methods such as enquiries and visual counts have not been considered. Only with airphotos in a short time with little man power such an overview over a large area can be obtained. That only one moment is registered is the only disadvantage. (Driebergen, 1981a).

Selection of day and time.

With respect to the selection of the proper day and time for the survey, as well as to the choice for a certain frequency of repetition, the same considerations as for a watersport survey apply. For the Limburg survey a sequence of flights was planned, but for an area as large as the Randmeren this was considered to be too expensive (Driebergen, 1981a).

The Limburg survey was carried out in a weekend in the summer holiday, July (9th and 10th), see also table 4.3. Not all flights planned could be executed because of weather condition and other problems. On the Saturday of two flights planned only one was executed. On the Sunday only a part of the area was covered five times as planned, the rest of the whole area was only was covered three times. On this day simultaneous with the flights fieldwork was carried out. (Loedeman and Quaedflieg, 1979). An enquiry survey was carried out among visitors of some specific subareas, for which also counts were executed to verify the accuracy of the airphoto counts. Mechanical traffic counters have been installed at the entrance roads to one area from May 15th to July 15th to relate the traffic on the survey day with traffic data for the whole season. The survey day appeared to be the third in the ranking of peakdays. It was assumed that this result would also be representative for the other areas. (De Vet, 1979). Also for the Randmeren flight day it was stated that a very busy day should be taken, because then the spatial behaviour patterns are shown most clearly and the attraction of the quiet areas will appear. Therefore it was thought necessary to fly on a Sunday in the peak-season or on Whitmonday. Because Whitmonday was still in the preparation phase six Sundays were selected from July 8th to August 12th with a preference for the Sundays between 15-7 and 5-8. The flight day became August 5th (see also table 4.3). (RWS, 1979). This was the last Sunday of the main holiday period (Driebergen, 1981a). The flight should be on the busiest moment of the day. Although the maximum momentary visit usually occurs around 15.00 hours, the flight was done from 13.05 to 13.55 hours. (RWS, 1979). Weather conditions were good. No days with better conditions were recorded for that season. Still, the number of people counted are relatively low compared to previous studies in the area, even when taking into account that the time of photography has been well before the maximum momentary visit and the counts thus are probably about 50% of the day visit. Later studies reveal that beach visits in the Randmeren area have decreased in the 70's. All in all it can be concluded that the survey day has not been a peak day, but still a reasonably busy day, when compared with numbers of visitors recorded in the recent years. (RWS, 1979; Driebergen, 1981b). With respect to the desirability of doing the survey on a peak day, the same observations as made for the watersport survey also apply here.

Organisation.
In the Limburg survey of all concentrations of shoreline recreationists airphotos have been made, recording the sites used and the number of people at each site (De Vet, 1979). To localize such concentrations first a reconnaissance flight was made. For this survey no preplanned strict flight plan could be maintained, since the location of concentrations was not known in advance. The photography appeared only possible in a *slalom* type of flight. A more orderly way of flying would have taken too much time and exposures. (Loedeman and Quaedflieg, 1979).

Elaboration and interpretation.
The elaboration and interpretation will pose similar problems and solutions as with the watersport surveys.
In the Limburg survey the areas were distinguished in beaches with facilities like toilets, parking, first-aid post, etc. and other areas without such facilities. It appeared not to be possible to count the exact number of people, not only because persons may be partly hidden by other objects (bushes, dikes, cars, tents, umbrellas) but also if they cluster together in groups it is difficult to accurately count them. Motorcars, however, could be easily counted. Therefore the number of people was estimated by applying the average number of persons per motorcar, as recorded by visual counts in the field, on the number of motorcars counted. The estimated proportion of visitors that came by car was taken into account too.
A maximum error of 50% could occur by a cumulative error in all these factors. The error will be smallest if the time is taken closest to the time of the maximum momentary visit. The airphoto approach therefore was concluded not to be really suitable to determine numbers of visitors with reasonable accuracy, but is useful for recording the place and the size order of the concentrations. (De Vet, 1979). And it is the possibility to inventory and analyze the spatial patterns that is the main objective in this case.
To structure that analysis, in the Randmeren study the beaches have been subdivided into 6 to 8 strips of 15 meter width parallel to the waterline. On the water 4 strips of 50 meter width have been indicated. These strips again were subdivided by lines perpendicular to the shoreline, as much as possible along logical terrain features or clear differences in use pattern. (RWS, 1979; Driebergen, 1981b). The 200 meter zone on the waterside also is about the distance from the shore that is still included in the photographs (Driebergen, 1981b). For each beach in the Randmeren area the number of people on the different terrain types and in the water, their distribution over the different distance zones from the shoreline, as well as the number of cars have been recorded (RWS, 1979). See for example figure 4.16.

Spatial patterns.
In the Limburg study more than 50% of the people were found in the areas without facilities. For all areas the maximum number of visitors was found around 16.00 pm. The airphotos showed that on many places it was pretty crowded but not really full. (De Vet, 1979). Just as with the watersport surveys the results of course have to be placed in the perspective of the representativity of the days and times selected and finally used.
In the Randmeren survey much more details of the spatial distribution of the visitors have been presented. In general the densities were found to be low as compared to peak densities observed in other studies in the same area and elsewhere. The larger the area of the beach, the lower the density that was observed.
The number of people on or in the water varies from 13 to 26%, but is in average 19%. Of these, 57% was swimming or bathing, 29% floating in a rubberboat or on an airbed and 14% was windsurfing. No clear relation between visitor density and percentage of people in the water could be found.
This will of course be also strongly influenced by the type of day, and especially with respect to the weather conditions.
A high percentage of the windsurfboards, 83%, is found on the water at the time of the survey. For rubber boats or airbeds this is 50%. The relation between surfers, floaters and swimmers is 1:2:4. This relation is different for different beaches, mainly because of differences in numbers of surfers. The relation floaters : swimmers always ranges around 1:2.

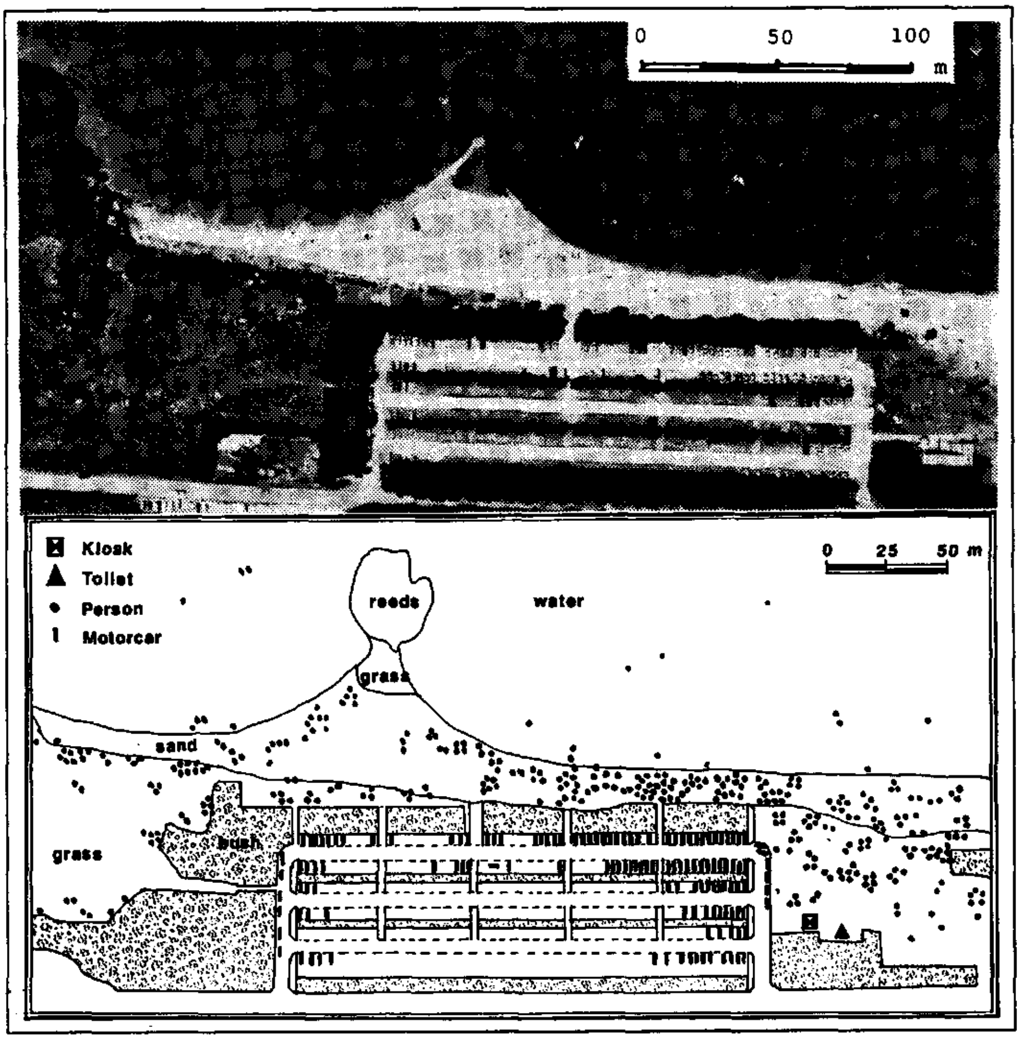

Figure 4.16. *An airphoto of one of the beaches of the Randmeren with its corresponding interpretation (RWS, 1979).*

A comparison of the distances over which the swimmers, floaters and surfers in average have been observed is presented in figure 4.17.

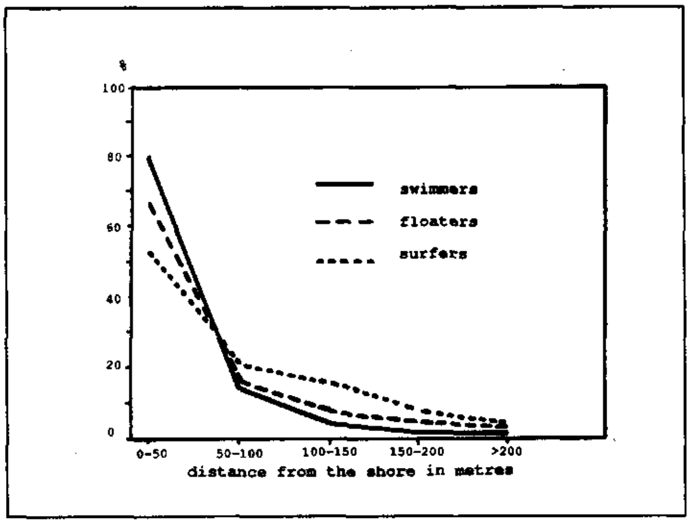

Figure 4.17. *Average distance that people venture into the water. (Derived from RWS, 1979).*

Of the swimmers 70 to 90% is within 50 meter from the shoreline, and 94% within the 100 meter zone. Only at the most crowded beach, that also has the highest percentage of people in the water, swimmers range over larger distances. The presence or absence of a floating demarcation line is of clear importance for the spatial pattern. Where this line is close to the shore (50-100 m) 90% of the swimmers is within 50 meter of the shoreline. Where the line is at larger distances or absent higher percentages of swimmers occur at larger distances. For rubberboats and airbeds (=the floaters) the demarcation line has a similar influence as for the swimmers. In general the percentage of floaters remaining close to the shore is lower than that for swimmers, 78% stay within the 100 meter zone. For the windsurfers this percentage is still lower. It can therefore be stated that windsurfing as type of recreation is of a less amphibian character than floating in rubberboats or on matresses and swimming or bathing, also because of the high use percentage of the surfboard (83%). Windsurfboards and rubberboats/airbeds constitute the transition between (small) watersport and shoreline and amphibian recreation.
Still, this does not make windsurfing a full-sized watersport. Because of the small action range from the shore, only 10% is more than 150 meter from the shore, it can be classified as a rather wet type of amphibian recreation. Only in shallower areas windsurfers tend to roam over wider ranges.
76% of them was found on water with depths of less than 80 cm, only 4% on water deeper than 130 cm. About 50% of the was within 100 meter from the shore, 75% within 200 meter.
When analyzing the distribution of people over the different distance zones on the land it appears that every zone further away from the water contains half the number of people that are in the previous zone, see figure 4.18, but this is mere coincidence.

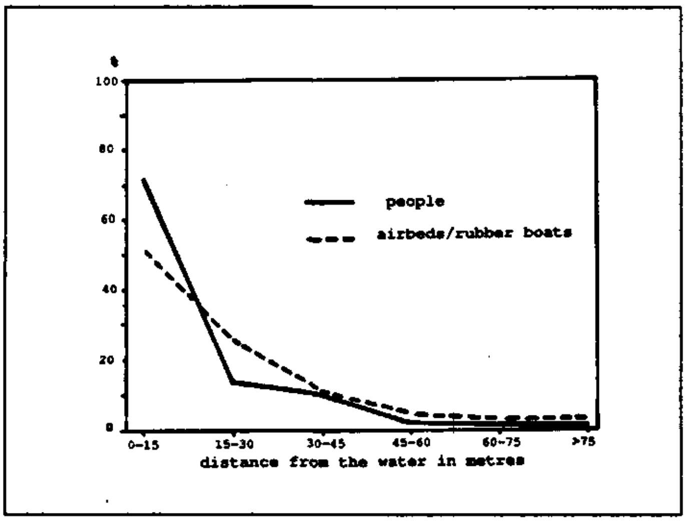

Figure 4.18. *Average distance that people sit away from the water. (Derived from RWS, 1979).*

Three types of beaches can be distinguished:

1. Beaches with wide strips of sand. Here the reduction by 50% per zone indeed occurs, because no preferences with respect to covertype are possible and only distance to the water plays a role.
2. Beaches with narrow strips of sand directly along the water and adjoining grass as a covertype. Here the *normal* distance related distribution is disturbed by the preference to sit on grass. A border effect occurs at 15 to 25 meter from the shoreline: a high score for the 15 to 30 meter distance zone.
3. Beaches with narrow or wide zones of grass directly along the water. The highest percentages are recorded here in the distance zone of 0 to 15 meter, because two preferences coincide: that for nearness to the water and that for sitting on grass. (RWS, 1979; Driebergen, 1981b).

Apparently the preference to sit close to the water prevails and only after that the choice between grass and sand is taken. At beaches where grass is coming close to the waterline many people sit on the grass as close as possible to the water. Clear border effects occur. On beaches with wide sand zones such border effects are hardly noticeable.
This spatial pattern of preference is clearly visible because of the relatively low number of visitors on the survey day. On real peak days the patterns will show less clear because then also second and third choice sites will be occupied.
With respect to the rubberboats/airbeds a similar distribution can be observed, though in a lesser degree and more shifted towards the waterline. Of the rubberboats/matresses 72% are found in the first distance zone, against 52% of the people. See also figure 4.16. Windsurfboards in even stronger degree occur in the first distance zone.
The preference for sitting along a wooded edge clearly appears to be subordinate to sitting near to the water. It also is observed that people, in addition to considering factors such as shoreline, wooded edge and covertype, try to settle as close as possible to the parking place of their car. (RWS, 1979). Important in this respect are the attributes carried to the beach, that include small boats, outboard engines, tents, windscreens, chairs and picnicksets. This requires good accessibility by car (Van Duin and Loos, 1969).
The relation of this recreation equipment to the number of people and cars can be analysed, at least for the larger equipment that can be seen on the photographs. One out of every 8 to 14 people has brought a rubberboat or airbed, this means one such item on every 3 to 5 cars. The number of windsurfboards carried is much smaller and shows a larger variation according to the beaches, because not all beaches are equally suitable for windsurfing. (RWS, 1979).
Also other studies have found that in coastline recreation the distribution of use is closely related to the parking facilities, and that the carpark acts as a *honey pot*. In this way some areas are subject to heavy use, whilst areas more remote from carparks remain isolated, because few people will move far from their car. Thus, the provision of parking places ensures that some areas are readily accessible, whilst other areas are kept relatively isolated. The recreational pressures are thus directed towards some particular zones and the integration of intensive recreational use with the maintenane of undisturbed habitats is achieved by informal zoning. (Usher, 1973)
In the area of the Kagerplassen and the Braassemermeer (the Netherlands) the largest concentrations of recreationists occur on shores that are accessible by car, because of the shoreline recreationists 81% came by car. Of the total shorelenght of the Kagerplassen 59% is inaccessible by car, cycle or motorcycle. For the Braassemermeer this is 34% .
Also the space between road and water is of importance. The more open space, the higher the attractivity, because people can move their car close to the site and do not need to carry their equipment very far. (Van der Voet and Dijkstra, 1971).
For the Veerse Meer area two shoreline recreation surveys have been carried out with airphotos with a ten year interval (1977-1987). A slight decrease in númber of visitors on a peak day was observed, but most striking was the shift in distribution pattern towards areas more designed for windsurfing. (Bakker and Hell, 1988).
Although visual aerial reconnaissance does not seem to be so appropriate for the survey of shoreline recreation, because of the relative large numbers of objects that normally are involved, in some cases it can and has been used. For example, counts of anglers along the coast of the IJsselmeer have been carried out in 1975 and 1976 from the air by visual observation. For such a large area as the IJsselmeer this method appeared to be very suitable. The coastline is very clear and concentrations of anglers rather low. The costs are relatively low as compared to other methods of counting.
Because a study on national level revealed that most anglers are already along the shore at 9.00 hours, the counts were carried out between about 7.00 and 10.00 hours. The survey was repeated on seven different days in 1975, from early August to end of November, and on eight different days in 1976, from mid June to end of November.
Counting was done with the *naked eye*. Observed numbers of anglers were indicated on the map. A distinction was made between riparian anglers and *boat* anglers.

Part of the IJsselmeer coast can not be used by anglers because of poor accesibility, too shallow water or prohibition of access. The number of anglers have been expressed in densities per kilometer of suitable coast. They vary strongly for different sections of the coast. The number of anglers also varies according to whether it is a weekday or a day in the weekend, and decreases from summer to autumn.
An enquiry survey was carried out in 1977. This revealed that around 9.00 hours in average 80% of the riparian anglers and 50% of the boat anglers is present. The momentary visit at the time of counting then has to be multiplied with 1.25 and 2 respectively to arrive at the number of the total day visit. (Van Ginkel, 1980).

So, also in the case of shoreline recreation the recreationists and/or their vehicles can be detected on airphotos with a sufficient level of accuracy to determine spatial distribution patterns. And also in this case sequences of airphotos can significantly contribute to the information by adding the temporal aspect.

Direct monitoring of recreation on land.

Aerial surveys for direct monitoring of recreation on land are less numerous than those for recreation on water and along the shoreline. Still some examples are available to demonstrate what is possible also in this type of terrain. Very often it is the motorcars used by the recreationists that are the objects of interpretation. For many people the motorcar serves as a mobile picnic basket from which they do not move away too far. (Kouwenberg, 1975).

Motorcar centred surveys.
In the Dartmoor National Park airphotos were used for the recreation survey that was concentrated on observations on one single peak day. Unfortunately no specifications about type, scale and timing of the airphotos are mentioned in the available publication. (Joint Schools Survey, 1970).
The inventory of all parked cars at the time of photography revealed major concentrations, minor concentrations, connecting roads with associated verge parking and extensive areas of moorland and farmland. This reflects the recreation system consisting of concentrations of visitors (nodes) and road networks (links) set within areas of varying character. The relationships between them can be expressed in terms of flows of people. Sets of links in the network have been called *circuits*. In addition to the aerial survey information has been collected on: the characteristics of the visitors by interviews, the activities they carry out at the various places by field observations, and the flows of visitors from outside the defined area and between various places within it by recording car numbers at different places in the system. The registration numbers of vehicles that were recorded were fed into a computer. The length of stay of each vehicle was calculated for each place, and when numbers are matched for the complete set of nodes in the system the movement patterns of individual vehicles throughout the day could be reconstructed. This information on trip patterns was supplemented by the aerial survey which indicated the amount of use made of different parts of the road network during the photographing period. The length of stay was found to be different for different places, as was the pattern of coming and going cars. Visitor peaks were experienced in mid-afternoon. (Joint Schools Survey, 1970).

In another study the *weekend day-trippers*, who set out from London in the morning, spend the afternoon at the coast or in the country and then trek back to the city along congested roads in the evening were the target of a survey. From automatic traffic counts on three primary radials from London it was estimated that in 1967 Sunday traffic on these roads varied on average from 17% to 40% above normal weekday volumes.
Because in many types of recreation the car has become the focus of activity, it should be regarded as the basis of in any study for recreation. Still, the survey was to be aimed at the activity generating the traffic and not at the traffic itself.
The aerial survey technique was used in order to cover a large area on a sufficiently comprehensive scale with limited manpower and restricted budget. Helicopters were used,

coordinated by radio with ground interview teams, since fixed-wing aircraft were considered to be not suitable because of their lack of manoeuvrability in confined survey areas where frequent 360° turns prove necessary.
Two helicopters were used for the survey, each carrying one observer to take photographs or plot information on maps. A total of 16 hours' flying were logged. A maximum duration of two hours was allocated to any one flight. Many of the routes were covered two or three times during the day, in which at least one time photographs were taken with 35 mm cameras. Observations were plotted directly during the flight with activity defined by code letters and symbol notations on specially prepared folders of coloured 2.5 inch scale maps. Vibration did not present any difficulties in either plotting or photography.
Of course the weather should be good enough not only permit flying and photography but also entice the public out of doors to pursue the activities to be studied.
The outside ground interview teams were linked by radio to the aerial survey and covered wider areas of coast and countryside than in similar ground surveys but for the rest did not differ in approach. The teams assessed the exact volumes of motor vehicles in particular areas at intervals, the occupation of vehicles, the extent and nature of activity near and beyond the vehicles, including an assessment of space standards, and carried out interviews to establish places of origin, composition of groups, etc.
It was found possible to interrelate the activities of aerial and ground observers by radio communication and so devise a more dispersed and wide ranging approach than would be possible by ground survey alone.
The aerial survey covered approximately 250 square miles of coast and countryside and 148 major parking locations were examined for maximum activity during the day. This activity reached a late morning peak on the coast and a late afternoon peak inland. Several hundred photographs were taken of activity sites and, in addition to accurate observation and photography of major parking points, the general distribution of activity beyond these locations was also assessed. (Furmidge, 1969).

In both cases the motorcars of recreationists could be detected on airphotos or by direct aerial observations with a sufficient level of accuracy to determine spatial patterns that can be related to the pattern of recreational resources. In the second case repetition of the survey during one day significantly contributed to the value of the information by adding the temporal dimension to the spatial pattern.

People centred surveys: use of a time-lapse camera.
Analysis of the distribution pattern of persons in terrestrial recreation areas is often difficult because of trees and shrubs partly or completely obscuring the field of view. Only for small open areas with high use density this may be possible. Because there is apparent imbalance in space use, analysis of the spatial behaviour pattern of the visitors may be very interesting and useful for the planning and management of such areas. *Crowding occurs at a number of choke points, but although these may occupy only a fraction of the total area, the number of people using them is so high that it colours our perception of that area out of all proportion to the space actually involved. The fact that there may be lots of space somewhere else little mitigates the discomfort.* (Whyte, 1980).
The aerial survey does not seem to be the most appropriate tool to study such relatively small areas. For comparable areas, city plazas, the spatial behaviour of visitors has been studied by mounting time-lapse cameras overlooking the plazas and recording daily patterns. Although also people were interviewed the study concentrated mostly on just watching people to see what they did. This approach could well be used for small recreation areas. Some of the results found for these city plazas will be valid for densely used recreation areas as well.
Off-peak use often gives the best clues to people's preferences. When a place is jammed, a person sits where he can. This may or may not be where he most wants to. After the main crowd has left, the choices can be significant. What attracts people most, it would appear, is other people. What people *do* reveals a different priority than what people respond to questionnaires. Self-congestion, the tendency for people to sit and move into already existing concentrations or flows, is independent of culture. People tend to settle down in an area

where sitting is physically comfortable, but especially where it is *socially* comfortable. This means choice in sitting up front, in back, to the side, in the sun, in the shade, in groups, off alone. Presence of water in all sorts of forms will be of importance too. Such patterns may be analyzed by just recording one or two moments, but with the time-lapse camera a whole series of records is made that provides a time dimension to the spatial pattern.
Specifications for the use of a time-lapse camera have been stated to be: a small, inconspicuous camera, that would cover any desired angle of view from wide angle to telephoto close-up, automatically take a picture at any set interval from a half second to ten minutes, run unattended for up to 48 hours, and automatically adjust to any change in light from dawn to dusk and beyond. Small, light, excellent and inexpensive super-8 cameras are available to do this job. They make it possible to store time, retrieve it for later study, replay it to others.
Taking the film is easy, so is showing it. But the crux is evaluating. This can be an enormously time consuming and tedious activity. Time lapse does not save time, it stores it. The problem with evaluation is that there are so many bits of information that they are somewhat overwhelming. For evaluation the chief tool will be the viewer. Special procedures have to be developed to analyze the movement patterns. A good preparation and organisation is essential, comparable to that of the high frequency aerial surveys. Taking care that a clock is recorded in each picture serves not so much to tell the (exact) time, but to mark the place in the sequence of every single photo. *In most cases a wide angle lens setting is best, because* usually overview is more important than details. All things being equal, the longer the interval between frames the better. For one thing the camera will operate longer before a refill is necessary. It also may make evaluation easier. But the interval must be short enough to not miss any significant movement. For sitting patterns ten seconds is fine, but for pedestrian movement two seconds is about right. (Whyte, 1980).

Although no aerial survey, this technique certainly belongs to remote sensing. In this approach it are the people (recreationists) themselves that are detected. By this direct monitoring the spatial behaviour of people can be analyzed. In the study of Whyte intervals were sometimes so short that individual persons could be followed.This is interesting from the point of view of studying social interactions and movement patterns. but if only the choice of space and the analysis of spatial patterns are the objective of study, intervals could be taken larger, for example, once an hour. In that case also a normal camera with motor-drive can be used instead of super-8. Then also the elaboration becomes less of a bottleneck, although it still remains laborious. The procedure becomes more comparable to that discussed for the watersport and shoreline surveys. The use of sequences remains essential in this approach.

5. INVENTORY, ANALYSIS AND EVALUATION OF RECREATIONAL RESOURCES.

5.1 THE IDENTIFICATION AND INVENTORY OF RECREATIONAL RESOURCES.

Relating recreation to its resources.

In the previous chapters the attention has been focused on how to get an overview of recreation types that are apparently relevant for land evaluation, by inventorying the recreational facilities, by analyzing the recreational impact or by directly monitoring the recreationists or their vehicles. It has been indicated also that in the process of inventorying the spatial pattern may become apparent, and when using sequences also the temporal aspect of that pattern. Analysis of that pattern may reveal to which elements in the landscape particular types of recreation are related, and thus give an indication of what are their requirements with respect to the land qualities. For some types these seem rather obvious, but for many they are not, see also chapter 1.2.

The characteristics of the resources that apparently have such qualities, can be compared with other elements of the land(scape) in the same area and similar elements in other areas to give insight in the factors that determine whether a land(scape) element becomes a recreational resource or not. In this respect all three aspects of suitability for recreation have to be taken into account.

For the *physical suitability*, that determines whether an activity is at all possible, the physical characteristics of the resource, that apparently determine its suitability for recreation, should as much as possible be described by quantitative or qualitative parameters. For recreational LUT's the parameters usually are of a completely different type than those commonly used for agricultural LUT's, see also chapter 1.2. Often specific parameters have to be developed, that in some cases are applicable to one recreation type only. See for an example figure 1.16.

However, never too absolute a value should be attached to such parameters, but only a relative one. The assessment of the physical suitability is the subject of land evaluation in the strict sense.

The assessment of the *scenic quality*, that can be called *landscape evaluation*, has a large degree of subjectivity. Careful analysis of actual use and spatial behaviour patterns may make it possible to also identify certain parameters for it.

With respect to *accessibility*, for certain recreation types the distance factor may be less critical than it can be for many other LUT's, because the journey may be an integral part of the recreation experience. Still, also here comparative analysis may reveal the influence of accessibility.

Which of the three aspects is most important in determining the actual use pattern and potential suitability will vary from one situation to the other, and depend on the type of recreation and the type of landscape. See also chapter 1.2. and figures 1.7 to 1.13.

Identifying and analyzing potential recreational resources.

Once resources have been identified out of the analysis of actual recreational use, and their suitability expressed in parameters for each of the three aspects, landscape elements matching the same parameters can be inventoried also for areas where no actual recreational use is observed. This can give an indication of the available potential that may be developed.

Of course, high scores in the parameters for all aspects results in a very high potential. When the resource still is not actually used, or far below its capacity, the reasons for this should be

investigated. Probably still in one or other aspect a sofar unnoticed deficiency is present. But, recreational use may also be frustrated by other uses of the same resources.
When not in all aspects high scores are found, it has to be investigated whether by relatively simple means a dormant potential can be activated.
For example, a physically suitable site in attractive scenery only may need to be made (more) accessible. Or, a very accessible site with good physical suitability could do with some improvement of the scenic quality. Or, it may be worthwhile to create a physically suitable site for a certain type of recreation within an accessible area of very attractive scenery.
Comparison of actual recreational resources with such potential resources may reveal which factors at the moment determine the use or non-use by recreation. It may also appear that certain types of landscape elements on their own have insufficient attraction for recreation, but in combination with other elements can be a valuable recreational resource.

Suitability assessment.

The degree in which one has to interfere in an actual situation in order to approach an optimal functioning could be a measure for suitability. *No interference necessary* is the most favourable situation and being suitable then means that the values of the area studied =the actual situation= meet the requirements. It is better not to comprise all suitability factors into *one* single formula, because then the influence of each individual factor on the suitability is not clear. Also the different factors can not be determined with the same degree of objectivity. (Sas, 1988). This also corresponds to the development of Kiemstedt's overall V-value of 1967 into a more complex stepwise evaluation of the landscape for recreation in 1975.

The provision of recreational or tourist facilities is considered as belonging to the *intangible benefits* in the same way as the creation of employment, nature conservation and aesthetic considerations.
Benefits are first assessed in physical terms, for example, estimated numbers of tourists. These are then, so far as practicable, translated into economic terms, on the basis of stated assumptions about prices, etcetera.
The evaluation of intangible benefits presents special problems. Land used for recreation or protected as a nature reserve does not necessarily produce directly measurable benefits, and in particular it is difficult to translate such benefits into economic terms. Other approaches to assess value to recreational land use have been attempted. Sometimes pseudo-economic approaches are used, trying to translate the effort people apparently are willing to make to got to a specific recreation area into monetary terms. Thus, the time or distance of the journey, the purchase of recreation equipment, etcetera, expressed in money. See for example Kroon (1986). Still, such approaches are not, yet, really satisfactory, and, moreover, it may be questioned whether the economic approach should dictate the planning for recreation always. In place of a purely commercial approach, a political decision may be needed to set aside areas of land for aesthetic, educational, conservational or other needs.
This calls for methods of rating land in terms of land qualities which have a positive or negative effect on its use for recreation or conservation. For example, sustained carrying capacity expressed as man-days per year per unit of area could be one measure of land suitability for recreation. Scarcity of land of a given type and distance from centres of population is frequently relevant. (FAO, 1977). Therefore in this context the concept of capacity may have a key role.

Carrying capacity for recreation.

Carrying capacity refers to population sizes that are maximally sustainable over time (Van der Ploeg, 1990, p 30). With respect to recreation, carrying capacity can have a variety of meanings and may be understood in different situations and by different people in totally different ways (Patmore, 1972; 1973; 1983). Capacity issues have been classified into three groups (Joint Schools Survey, 1970; Rodgers et al., 1973; Goodall, 1985; Gunn, 1988), or two (WTO, 1983b; Van der Voet, 1985), or even four (Patmore, 1983). Not everybody gives the same classification, but still most commonly found are the *physical, ecological,* and *psychological* capacity. See figure 5.1. Some add to that the *economic* capacity (Patmore, 1983; Goodall, 1985), but this is of a different order, and, though not unimportant, will not further be discussed.

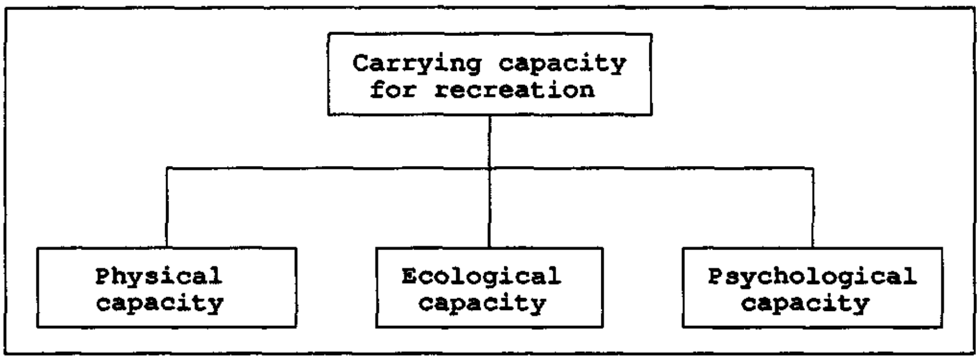

Figure 5.1. *Three types of carrying capacity for recreation.*

Physical capacity is the maximum number of people a site can physically accomodate for a given activity (Rodgers et al., 1973; Patmore, 1973; 1983), the number of vehicles and people that can actually get into an area (Joint Schools Survey, 1970), or the absolute limits of beach and sea to absorb varied activities (Patmore, 1972). It represents the finite capacity of a site (number of seats in a theatre or stadium, number of places on a parking lot) (Goodall, 1985; Rodgers et al., 1973; Patmore, 1972; 1983). Of course, when two shows are performed on one day, the total number of visitors to the theatre per day can be doubled. So there is also a time dimension involved. (Patmore, 1983).
The concept is less easy to apply for informal recreation in an open-country situation. The physical limits then may not be imposed so much not by the site itself, but by such ancillary facilities as car-parks and access roads. (Patmore, 1972; 1973; 1983; Rodgers et al., 1973). It is rare that any site is used to its physical capacity for any activity, except for spectator sports, for few people would tolerate the degree of crowding this would entail (Patmore, 1973). The psychological carrying capacity will be reached faster than the physical one.

Ecological capacity is concerned with the level of recreational activity an area can undergo before irreversible ecological damage is sustained (Rodgers et al., 1973; Joint Schools Survey, 1970; Patmore, 1983; Van der Voet, 1985; Goodall, 1985), or serious conservation problems arise (Patmore, 1972; 1973), and can be expressed in the maximal allowable number of people per unit of area (Van Lier, 1988). It refers to a certain threshold level of activity beyond which physical deterioration of the resource will occur or damage to natural ecosystems will become irreversible (WTO, 1983b). Other terms used in this respect are *biophysical* (Goodall, 1985), or *environmental carrying capacity* (Patmore, 1972; Goodall, 1985; Van Lier, 1988).
Ecological capacity is as much a matter of management objective and method as of level of use (Patmore, 1983). Sustainability of use, a key issue in any proper land evaluation, is often a case of respecting the *ecological margins* (Van der Ploeg, 1990).
The ecological capacity of a natural environment is based on a number of mutually dependent factors, the most important of which are the vegetation type, soil quality, topographical properties and in some cases also the fauna of the area. The carrying capacity of the vegetation is broadly speaking related directly to its productive and regenerative

capacity. (Kontturi and Lyttikainen, 1985). *Sensitivity* (for particular use) and *resistance* (regeneration power) of the resource ecosystem determine carrying capacities of parts of the ecosystem for different use forms or an assembly of them. (Van der Ploeg, 1990).

Psychological or *perceptual capacity* (Rodgers et al., 1973; Goodall, 1985; Joint Schools Survey, 1970; Patmore, 1973; 1983), is the most important but the least tangible one concerning recreation. It represents the number of people a site can absorb before the latest arrivals perceive the site to be *full* and seek satisfaction elsewhere (Rodgers et al., 1973; Patmore, 1973), the degree of crowding that users are prepared to accept before they seek alternative sites (Patmore, 1972; Joint Schools Survey, 1970), the maximal number of people per unit of area that in an area in a certain time can engage in one or more recreational activities without disturbing each other (Van Lier, 1988), the level of use above which the satisfaction or enjoyment derived from the recreational experience is impaired (Goodall, 1985).
Other terms used in this respect are *behavioural* (Goodall, 1985), *social* (Patmore, 1972; 1973; Goodall, 1985; RMNO, 1985a; Gunn, 1988), and *recreational* capacity (Van der Voet, 1985; Van Lier, 1988).
Capacity in this sense is an intensely personal affair and very difficult to assess. It will vary from one person to another, and for the same person with respect to time, mood and activity (Rodgers et al., 1973; Patmore, 1973; Goodall, 1985). Individuals have different psychological perceptions of crowding. Some prefer crowds, while others prefer to be completely dissociated from people. (Ashton and Chubb, 1971; Patmore, 1983). Thus, there is a distinct difference between *density* (numbers per area) and *crowding* (feelings of too many people) (Gunn, 1988).
With informal recreation the limitation is rarely the physical amount of space available, but the willingness of people to accept intrusions into personal space. The beach is *perceived* as full rather than actually full in the physical sense. Differences in character of the area do influence the perception of crowdedness. More people can use a heavily wooded area without sensing crowdedness than will be the case in more open areas. (Patmore, 1983). Therefore levels of satisfaction will not be the same for all areas and types of recreational use (Ashton and Chubb, 1971; Patmore, 1983). There are also certain use forms that *psychologically* exclude each other (Van der Ploeg, 1990).

It should be noted that full capacity use of facilities and resources often is limited to a few hours per day, to only the weekends or to a short peak vacation season (Clawson and Knetsch, 1966). But, if even such short spells of high pressure cause irreversible damage, measures are needed.
It can be argued that the maximum use level identified by either ecological or psychological capacity, whichever is the lowest, sets a use threshold which should not be exceeded for any area in the short-term. (Goodall, 1985).

5.2. MAIN APPROACHES TO LAND EVALUATION FOR RECREATION.

In addition to the three different aspects of suitability, and the different levels of detail (reconnaissance, semidetailed and detailed) (FAO, 1977), there are different contexts that lead to different approaches in land evaluation for recreation (Van der Zee, 1986; 1988c; 1990).

Recreation approach.

The starting point may be an apparent (often rapidly increasing) demand for recreation that is exerting an increasing pressure on the available resources. (Van der Zee, 1986; 1988c; 1990).

After identification of the major demands, properly defining them as recreational LUT's and analyzing their requirements, an inventory is made of the land units, landscape elements or resources, that are in varying degrees suitable for these LUT's. Actual use then is compared with the potential of the resources and this gives an indication of the possibilities for further development. These possibilities can be the new development of yet unexploited resources or measures to achieve an optimal use of the presently used resources. (Van der Zee, 1986; 1990). This approach is called the *recreation approach*. It can be considered as being more or less user-oriented.

Tourism approach.

Another starting point can be the notion that a certain recreational resource is available and that development of that resource might attract recreationists from elsewhere, then often called *tourists*, who will spend money to obtain goods and services and thus have a positive influence on the economy of the region (Van der Zee, 1986; 1988c; 1990). After a first exploratory definition of the resource the potential demand should be identified. That means: for what type of recreational LUT's would this resource be suitable, where are concentrations of demand for this LUT and what alternative competing supplies of resources for this demand are available? In other words, what is the chance that development of the resource will attract sufficient numbers of tourists to make the investment worthwhile? (Van der Zee, 1986; 1990). Only when this question has been answered positively further studies should be undertaken as to where best to develop what facilities. This approach is called the *tourism approach*. Although the user should not be lost out of sight, this approach is more resource-based.

Conservation approach.

Sometimes the central issue is, that recreationists are attracted by resources that are also considered to have high value from a point of view of nature and/or landscape conservation and that may be damaged by (too high a) recreational pressure (Van der Zee, 1986; 1988c; 1990), sometimes to such an extent that the quality and quantity of the recreational resources is endangered. In this respect (outdoor) recreation can be as destructive as any industry. This certainly is not only a *luxury* problem of the rich western countries. The impact of recreation on the landscape in developing countries, though usually slight as yet, will certainly become more obvious as standards of living rise (Robinson, 1972). In such a case the development of recreation and tourism should be stopped or at least strictly controlled.

After a first inventory of the resources involved, the recreational LUT's attracted by them have to be inventoried and analyzed, especially with respect to their impact on the resources and also to the spatial behaviour patterns. Actual use and potential use are compared and possible future developments identified. These future developments can be anticipated and guided or deflected making use of the knowledge of factors influencing the spatial behaviour. Thus with proper management the main conservation aim may be achieved without banning recreation completely. (Van der Zee, 1986; 1990). This is called the *conservation approach*. A variation on this approach is to only identify which recreational LUT's, with respect to their impacts, could be tolerated in which parts of the area without objection to the major aim of conservation: the *permissive approach* (Van der Zee, 1986; 1990). Examples of the use of this approach are the Meyendal case in the Netherlands (Van der Meulen et al., 1985) and the Stiavnicke Vrchy landscape area in Czechoslovakia (Krajcovic et al., 1985), just to mention a few.

Each of these approaches can be carried out on each level of detail, see figure 5.2.

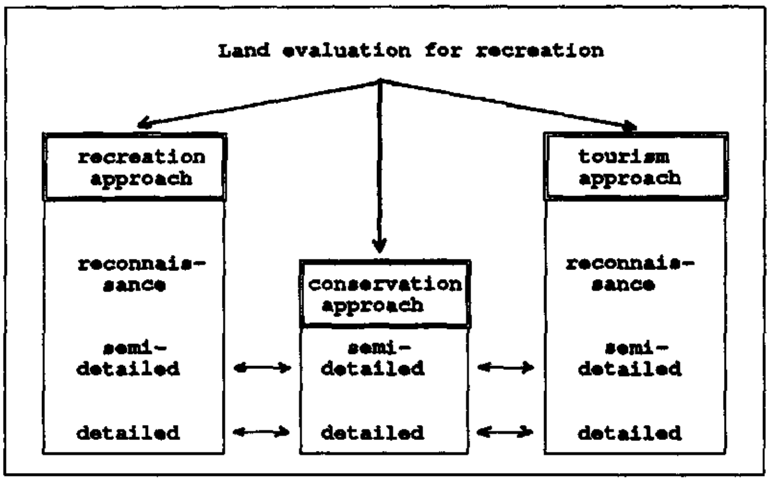

Figure 5.2. *The different approaches and levels of land evaluation for recreation. (Van der Zee, 1986; 1990).*

The approaches on different levels of detail.

The recreation approach.

Thus, in the recreation approach in a reconnaissance survey a first inventory of resources can be made with a rough suitability grading. Then a further semi-detailed suitability analysis can be made for only the most promising resources, after which a detailed analysis would be necessary to establish the proper management of the finally selected resources. An example of such a multistage approach of landevaluation for recreation is given by Dill (1962) for the north-eastern USA. It was carried out in three levels.

First the whole area was inventoried by a sample approach. A random sample of plots was drawn, that were examined to identify five pre-defined basic types of recreation sites. Data on the number of potential sites were related to data on the total acreage of forest, idle land or pastoral land in the sample universe in order to compute the rate at which the potential sites occurred. Thus an indication was obtained on what type of areas are most promising for a search for potential recreation sites.

The sample approach can only give information on the potential number of sites, but not on their distribution and location. Therefore in the next phase on airphoto mosaics or photo-index sheets the areas with the highest potential are indicated, that should be analyzed in more detail for *possible* sites.

Of these areas detailed stereoscopic analysis of airphoto's is carried out to exactly locate the possible recreation sites. They can be directly marked on the airphoto and additional information on the type of cover at the site, the landuse in adjacent areas and the ease of access by roads can be indicated, thus evaluating the suitability of each site for the different recreational land utilisation types. (Dill, 1962). On the basis of that suitability classification it was decided how further planning should be carried out.

Landevaluation for recreation in a more or less single stage with the aid of airphoto interpretation has been described by Olson et al. (1969) for Michigan, USA. Here three outdoor recreation activities were considered: boating, swimming and camping. And for the definition of resource requirements it was assumed that the aim was to identify potential sites of regional significance. Therefore, because of the general availability of lakes and streams in Michigan and the North Central States no site was considered significant which did not provide water access across dry ground. Minimum sizes for water and dry land were also adopted in order to

eliminate the large number of locations which can be developed for local use but contribute little to regional recreation opportunities.
Another single stage project was carried out by MacConnel and Stoll (1969) for the Connecticut River Valley, USA. The land bordering this river was evaluated on airphotos with respect to access, parking areas, picnic and camping areas, scenic overlooks, and other picturesque sites and vegetation. Analyses to evaluate the shoreline for beach sites, docking sites, shoreline fishing and hiking all could be made.

In some British examples of landevaluation for recreation airphoto interpretation was not actually used, but could have been used very well. (Van der Zee, 1986).
For example, the seven elements analyzed for an evaluation of the resource base of Snowdonia National Park: scenic resources -relief and landform landscapes; ecological resources; land-use landscapes; natural resources for recreation; man-made resources for recreation, including facilities; roads for recreation; and, water for recreation. (J.W.Gittins in: Rodgers et al., 1973). On some of these categories airphotos may give more detailed information than the topographical maps, for example vegetation cover, or the information is easier to translate into terms of recreational resource parameters from the airphotos, for example relief and land form. The interpretability of the facilities has been discussed in chapter 2.2 in detail already. Thus, use of airphoto interpretation might have given more detailed information, or more rapid or up-to-date information, and could have made the fieldwork that remained necessary more eficient. Of course,on a reconnaissance level the extra amount of detail may not really be necessary, and, apart from that, always a balance has to be found between the amount of information ideally wanted and the limitations put by the available budget.
In the North York Moors conservation project, recreation was one of the activities for which the evaluation was carried out (Statham, 1972), in which five main classes of recreation activities were considered. The method applied consisted of four main stages, of which the first one, the identification of landscape types, could have been very well done by airphoto interpretation.
The other stages refer to grading procedures of the landscape types distinguished for the different recreational activities. The criteria for these activity gradings were partly objective (for example, car parking capacities) and partly subjective (for example, attractiveness to walkers). (Statham, 1972).

In a German approach to landevaluation for recreation, the study carried out for Sauerland by Kiemstedt et al. (1975), many different recreational land utilisation types have been defined and the evaluation has considered the aspects physical suitability, accessibility and scenic quality. Not only the landscape is included, but also the settlements as concentrations of recreational accommodation, facilities and infrastructure. Because of its complexity the evaluation can only be carried out when using a computer.
Although in the inventory phase no airphotos have been used, quite some data, though not all, could have been obtained by airphoto interpretation.

The tourism approach.
In the tourism approach the reconnaissance phase would have to give the answer on the question whether the available resource will be able to attract enough tourists or not. If yes, then further analysis can be carried out to determine where best to concentrate the development of what type of facilities. (Van der Zee, 1986). So if, for example, a country such as Botswana wants to exploit its major touristic resource, which is wildlife and wilderness (KCS, 1985; Fowkes, 1985), it has to realize that with respect to the main sources of tourists, Western Europe and North America, it has heavy competition from East Africa where wildlife viewing can be combined with a beach holiday, and that nearby concentrations of demand, mainly from South Africa, are relatively small. (Van der Zee, 1985a; 1986). See also figure 5.3.

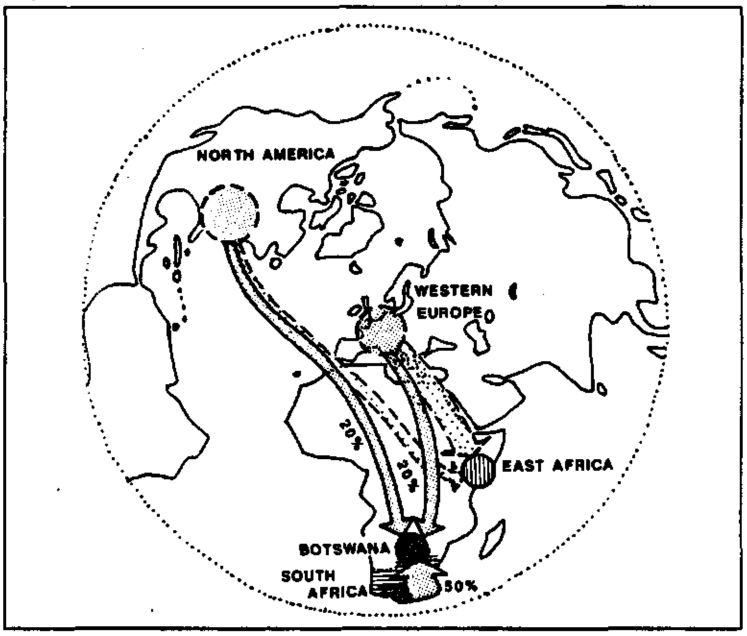

Figure 5.3. *Botswana's competetive position with respect to the major flows of wildlife oriented tourists. (Van der Zee, 1989).*

Still, about 40000 tourists in 1984 brought in about 14 million US$ (Fowkes, 1985), and made tourism ranking fourth as a foreign exchange earner after diamonds, beef and copper-nickel (KCS, 1985), which makes it worthwhile to investigate the possibilities to further tap this resource.

Tourism is seen as a form of resource and land use which is not destructive of the natural environment, but rather is conservative, when compared with the land utilization types associated with livestock (Florence, 1980), and can bring in large revenues if properly organised and managed (KCS, 1985).

So far three main types of tourists seem to have been attracted:

- big game hunters that are after trophies (safari-hunters);
- big game *hunters* using a camera only or just viewing wildlife;
- game hunters that are after meat (non-safari-hunters).

(Campbell, 1971; Von Richter and Butynski, 1973; Mpaphadzi, 1984).

These then are the three main recreational or touristical Land Utilisation Types for which an evaluation of the recreational resources should be made.

First, it should be assessed whether all three are really relevant to carry out a full evaluation. The share of each in the 40000 tourists can be a good indicator for that. In the 1970's the real hunters amounted only around 1000, of which less than 20% safari-hunters (Von Richter and Butynski, 1973). Even if this number since may have doubled or tripled, it remains but a small share of the total number of tourists.

Of the tourists about 20% comes from North America, 20% from Europe, and 52% from South Africa (Fowkes, 1985). For the first two groups Botswana has to compete with other African countries, especially in East Africa. See also figure 5.3.

The game hunters that are after meat almost exclusively come from neighbouring South Africa (Von Richter and Butynski, 1973). Their contribution to the economy may not be large enough to make an evaluation from the tourist approach worthwhile, but in the conservation approach would still be justifiable.

A preference list can be made indicating in descending order the desirability of individual species to the safari client, whether hunter or viewer, and to the non-safari hunter of South-

Africa (Von Richter and Butynski, 1973). Matching this preferences with the habitats of the species concerned will reveal the areas with the most promising resources for tourism development. Probably a similar procedure in the past has already resulted in the establishment of National Parks and Game Reserves. But these areas then may be ranked into order of priority for further analysis and/or development on a semi-detailed level.
On that level, a more detailed analysis of the habitat may be necessary, for which remote sensing may be a very useful tool (Florence, 1980; Hommel, 1990), as well as *aerial monitoring* of the major wildlife species, that at least in northern Botswana is carried out regularly (KCS, 1985).
In addition, the specifications for facilities have to be defined. Lodging facilities comprise safari lodges and fixed camps. European clients camp more (68%) than South Africans (52%) or North Americans. (Fowkes, 1985). So, depending on the market sector at which is aimed, the attention will concentrate on one or another type of facility. Accessibility has to be looked into. Air-strips have, to some extent, removed reliance on road transport -roads being impassable from November to March, the rainy season- for access to fixed camps. (Fowkes, 1985). Is the existing infrastructure sufficient, or do new elements have to be constructed?
An evaluation of sites where facilities have to be established is something for the last, the detailed stage of the evaluation, when the results of the preceding stages have given positive results.
In this case already at the reconnaissance level it is clear, that the conservation approach should be considered. Tourism will not only benefit of a proper conservation policy, it will be completely dependent on it.
Fortunately, the government of Botswana has realized the importance of wildlife as a renewable resource and rules and regulations are implemented to utilize wildlife without endangering the survival of species already since the early 1970's. (Von Richter and Butynski, 1973; Van der Zee, 1985a; 1988c).

The conservation approach.
Only in the conservation approach it may be expected that analysis is required directly at semi-detailed or even detailed level. This approach may be, or better, ought to be called in at this level in the two other approaches (Van der Zee, 1986), since *land suitability* should refer to recreational use on a sustained base.

Relation between approaches and methods.

Of course there may be more approaches or variations on these approaches possible, and it may be clear that *landevaluation for recreation* can not be one single uniform procedure applying one standard recipe. There is not one overall suitability of *landscape for recreation*. Each approach and each recreation type requires a tailor-made procedure, and will find different landscapes or landunits matching their demands.

With respect to the methods involved, the reconnaissance level could be based on interpretation of a single (small scale) airphoto coverage only, or may be even of a satellite image. For semi-detailed analysis larger scales and sequential coverage might be necessary to give more information about trends and about the impact on the environment. The detailed level may require special purpose photography to assess spatial behaviour characteristics. (Van der Zee, 1986).
In all of these approaches *the central issue is: what are the relevant recreational land* utilization types and what are their requirements with respect to recreational resources.
These requirements can not and should not exclusively be expressed in terms of physical suitability. The overall attractivity of the landscape as a scenic setting for the recreational activities is also of importance. Not less important is the spatial aspect, the location of the

(potential) recreational resources with respect to and distance from other landscape elements and the major population concentrations (=sources of recreationists or tourists). The amount and type of infrastructure to cover that distance is also of importance. This together makes it an aspect that might be summarized in the term *accessibility*. (Van der Zee, 1988c).

5.3. INTERPRETABILITY OF PHYSICAL SUITABILITY AND ACCESSIBILITY.

The interpretability of the physical suitability for recreation strongly depends on what has been identified as requirements, and what as parameters to assess the suitability. Since there is a large range of recreation types, each with its specific requirements, the discussion has to concentrate on the interpretation of some of the major categories or landscape elements involved.

Most of the observations and statements made in this discussion are based on many years of experience in instructing people from all parts of the world in the basics of airphoto interpretation. They are often so common and self-evident that quantified accuracy tests have never been thought necessary. The accuracy that can be obtained depends on the one hand on the scale and quality of the photographs and on the other hand on the skill and the experience of the interpreter as well as on the amount of detail that should be distinguished.

In addition also the interpretability of the accessibility infrastructure will be discussed on the base of general experience as well as on the results of the Enschede case study.

Water.

Water of a certain extent and depth for many recreation types is a basic resource.

The interpretation of water bodies.

Water is a category that even on satellite imagery often can be identified with reasonable accuracy. For example, in the monitoring project in south-eastern Sri Lanka with SPOT images the larger reservoirs could be easily identified on the panchromatic images, although with the smaller ones still some misinterpretations occurred. In the multispectral images the reservoirs were still much easier to distinguish from other landuse/cover categories, even though they appeared in colours varying from dark blue to light blue, white and light pink in the image of the dry season. This difference in colour depends on the sediment load of the water, the amount of water vegetation (pink) and on the angle of the sun. (Van der Zee and Cox, 1988). Of course the very small water bodies will escape observation because of the low resolution of the imagery as compared to airphotos.

On airphotos water bodies can be identified with very high accuracy, despite a large variety in appearances, from very dark toned clear water bodies, to very light toned turbid water or water covered with water vegetation. The difference in reflection caused by the difference in sun-angle on two successive photos often is very helpful in identifying water bodies. Only very small water bodies that are obscured by overhanging vegetation may be missed.

In the Michigan study of Olson et al. (1969) the size of unobstructed water surface was considered to be the primary factor for boating. Bridges, snags protruding above water, shoals or any obstacle restricting the free use of power boats were considered disqualifying. For a high capacity boating site at least 400 hectares of unobstructed water surface were taken as criterion, and boating potentials were only considered regionally significant if at least 15 hectares of unobstructed water were available. In addition dry land space for parking and other permanent facilities was considered a requirement. Minimum requirement of a regionally significant swimming potential is 15 hectares of unobstructed water surface. Olson et al. (1969) in their survey did not have any problems identifying waterbodies and establishing their sizes.

Of course, there is a danger that parameters to determine suitability are selected because they can be easily interpreted rather than that they are really the most significant ones. For example, on the scale of the airphotos used 15 ha would be the minimum size of water that can be detected, and therefore was taken as parameter, rather than the 10 ha that already could be considered as suitable for swimming.

The interpretation of streams and waterfalls.
Water in streams and small ponds, as well as waterfalls, can be a resource for certain types of recreation. Their interpretation is less easy than that of water bodies. Streams can be identified by their linear pattern, but the tones or colours may vary strongly. In the SPOT images of south-east Sri Lanka they sometimes appear in dark or red tones (riverine forest), sometimes in light tones (dry barren river bed). Some were clearly recognizable, some were more difficult to trace and some were missed completely. The lack of spatial resolution of the multispectral image cannot be compensated by the better spectral resolution. But the stereo viewing possibility of SPOT made it possible to make an almost complete interpretation of the drainage pattern. (Van der Zee and Cox, 1988). So it is also with airphoto interpretation, depending on the scale of the photos and the size of the streams or rivers the interpretation is more or less easy. Streams and rivers may be identified by the reflection characteristics of their water, of their barren river beds, or of their specific riverine vegetation, but most likely by a combination of these in addition to the stereo impression. Identifying streams may not be difficult, assessing whether and how much water they have at the time of photography may be sometimes more problematic.
In the study of the Mae Sa valley in northern Thailand water in the form of reservoirs, ponds and streams could be easily detected on the airphotos and the presence of waterfalls and rapids at least suggested. Waterfall-sites, because of their nature, all occur in narrow steep sloped valleys that are easy to detect in the airphotos when viewed stereoscopically. See also figure 5.4. An inventory of sites that are likely to have a waterfall does not seem to be difficult. But often only observations in the field can reveal how much water they actually have and whether the site is suitable for recreation in other aspects. (Van der Zee, 1988e). See also chapter 1.2. and figure 1.16.

Determining area and depth of water.
After identification the size of the water body can be established by planimeter measurement. Here some problems may be encountered, because although the identification of a water body as such may be relatively easy, the exact delineation of its shorelines may be less simple. Parts of the shore may be hidden by overhanging vegetation or its shadow. Belts of shoreline vegetation may mask the transition from water to land, and also at shallow shores this transition may be less clear, especially when the water level is subject to fluctuations. This inaccuracy with respect to the size of the water area can be relatively large for the smaller water bodies, but will become negligible for the larger ones. Anyway, by taking ample margins the water bodies that are clearly large enough can be classified as suitable, and those that are definitely too small as unsuitable, leaving only the marginally suitable ones for further detailed analysis when necessary.
The depth of the water is something that cannot consistently be assessed by airphoto interpretation. In clear water under-water features can be observed to a certain depth, and methods to arrive at depth estimates have been developed for such cases, but such waters are an exception rather than a rule. In turbid water only indirectly some indications of depth may be found, such as the presence of vegetation growing in the water, rocks or sand banks emerging from it or navigation aids demarcating shallows. In most cases, however, depth can be established only by plumbing or sounding.
About the quality of the water, so very important with respect to recreational use, also nothing can be derived from airphotos, except in the most blatant cases of pollution.

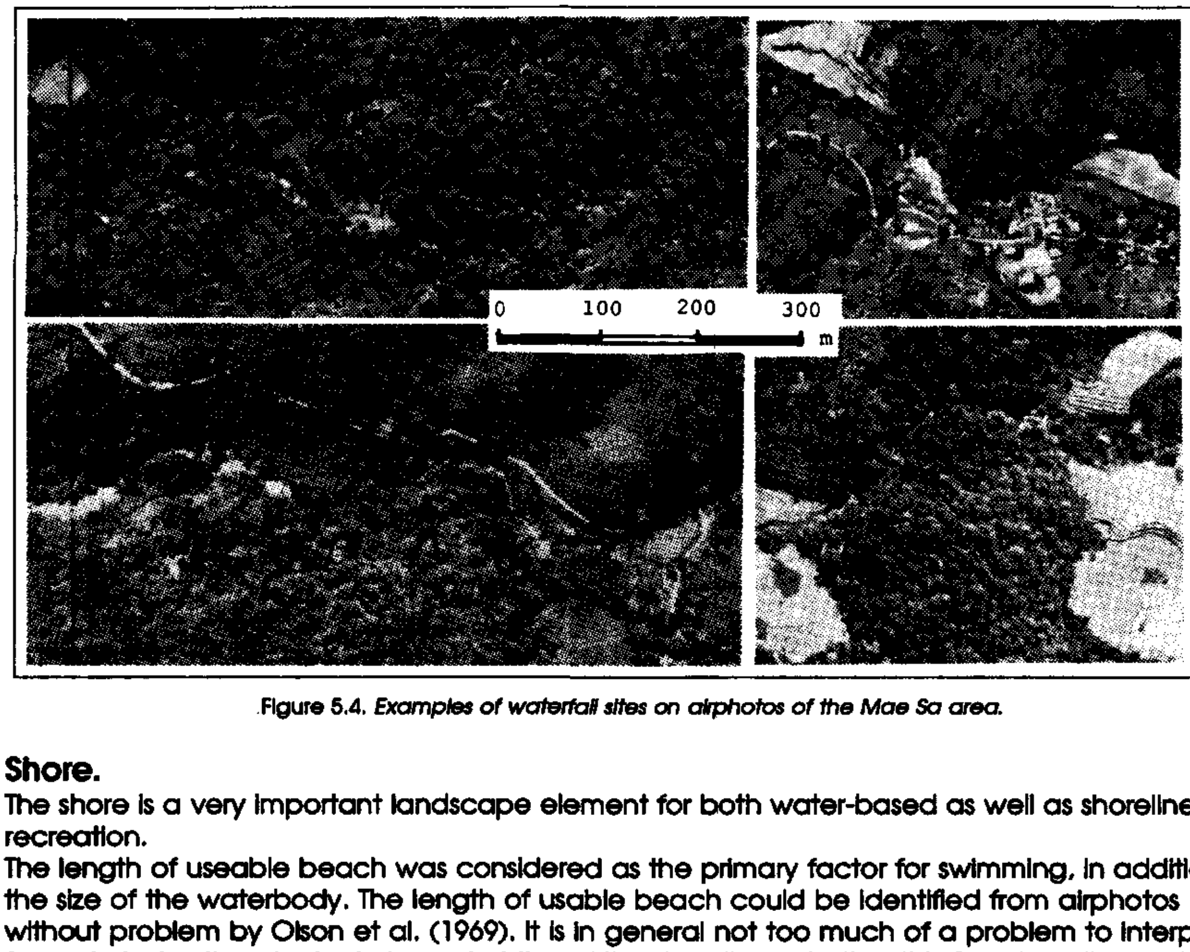

Figure 5.4. *Examples of waterfall sites on airphotos of the Mae Sa area.*

Shore.

The shore is a very important landscape element for both water-based as well as shoreline recreation.

The length of useable beach was considered as the primary factor for swimming, in addition to the size of the waterbody. The length of usable beach could be identified from airphotos without problem by Olson et al. (1969). It is in general not too much of a problem to interpret from airphotos the physical characteristics of the shoreline, whether it is firm dry soil or wet swampy land, cragged rock or sandy beach. Also the shoreline vegetation can be classified into its main types. To know detailed species composition is not really relevant in the context of recreation studies. Wide belts of reeds make the shore unsuitable both for shoreline recreation and for mooring. Trees and some shrubs may provide shade and shelter for shoreline recreationists, but may take the wind out of the sails of the water sporters. Of course from airphotos it cannot be determined whether it is allowed to moor or walk along a certain shore. See also the sections of chapter 4.2 and 4.3 on shoreline recreation.

For beaches the length and width of usable beach can be rather easily determined, although the influence of the tides may cause some problems in exactly determining the edge between land and sea. Distinguishing between suitable sandy beach and unsuitable muddy shores in most cases is relatively easy. Also rocky areas can be easily determined. But it is hard if not impossible to assess from airphotos the force of the breakers and the strength of the currents along the shore.

Forest.

Forest in many instances is also considered as an important resource for recreation.

Depending on the definition of forest, with respect to minimum density and size of trees and minimum extent of the area covered with them, the identification of forest just as such hardly will be a problem.

It is also a category that on most satellite images can be rather easily interpreted, although consistent subclassification may be more difficult. For example, in the monitoring study in south-eastern Sri Lanka on the panchromatic SPOT image of the dry season the natural forest could not be separated from the dense shrub lands. Together they could be easily delineated in the big Yala nature reserve, but in the rest of the area with more scattered remnants it was less simple and confusion with irrigated agriculture sometimes occurred. In the multispectral image of the dry season the colour contrast between agriculture and forest/shrub was much clearer. Only the edge of the forest is less clearly defined as in the panchromatic image. In an image at the end of the wet season it is very difficult to distinguish forest from other vegetation types, because all have the same hue of red. (Van der Zee and Cox, 1988f).
Is forest not really difficult to interpret on satellite images, on airphotos it is even easier and even a less experienced interpreter will already be able to delineate forest areas and arrive at a classification into major categories according to density, hight and major types (coniferous - deciduous) of trees. In the study of the Mae Sa valley in northern Thailand, for example, the interpretation of forest areas has not given any problem (Van der Zee, 1988e), although no real quantitative accuracy analysis has been made.
Only when volume of timber or fuel-wood have to be determined, or a more detailed species composition has to be established, accuracy problems are met. But in the context of recreation studies such details are seldom necessary.

Roads.

Roads so far could not be consistently interpreted from satellite images, not even from the high resolution SPOT images. In the SPOT images of south-east Sri Lanka, in panchromatic the roads sometimes appeared as white lines, sometimes as dark lines or sometimes just as straight lines that cut across field patterns. In many places the lines were less clear or blended completely with the surroundings. In the multispectral images some roads could be distinguished as white lines, others as red lines (trees lining them), but in general, fewer roads could be identified on these images than on the panchromatic ones. The better spectral resolution cannot compensate for the coarser spatial resolution. A consistent and complete interpretation of the road network was not possible. (Van der Zee and Cox, 1988f).
In airphoto interpretation the identification of roads seems to be so easy, but in reality still a large amount of inaccuracies occurs. In the study of the Mae Sa valley in northern Thailand, for example, the main roads and the non-paved motorable roads could be interpreted rather consistently. On the panchromatic SPOT image of the same area the main road appeared also clearly, but for the minor non-paved roads no completeness of interpretation could be claimed because of the lack of resolution. (Van der Zee, 1988e). See also chapter 2.2.
In the Enschede case study it appeared that with respect to the total length of roads, the airphoto interpretation was more up-to-date than the topographical map. With respect to a detailed sub-classification no high accuracy could be achieved however, but the topographical map was not accurate anymore on that aspect either. See also chapter 2.2., tables 2.2., 2.3. and 2.4.

Possibilities and limitations.

The main problem with respect to the interpretation of the physical suitability of recreational resources lies more in the definition of the parameters than in the interpretation. Once parameters are defined, identifying them by airphoto interpretation in many cases can be done by routine procedures. But, there are also parameters that are hard to identify. Not all information can be collected by airphoto interpretation. There are limitations. Thus, the answer on the question of objective 5 is that not *all* recreational resources can be consistently inventoried by remote sensing, but *many*, and not *all aspects* of the recreational resources can be deduced from airphotos. Applying airphoto interpretation to these many resources

and those aspects that can be identified and reserving other approaches to those not identifiable, can contribute to an efficient preparation for land evaluation for recreation.
It should also be stated that too rigid adherence to a given set of standards or parameters can give problems unless operational procedures permit recognition of additional figures by the interpreters, such as the case of a sewage treatment plant discharging its waste water on an otherwise perfect recreational site (Olson et al., 1969). Thus, even when focusing the interpretation on a pre-defined set of parameters, always an eye should be kept open for additional information that may be available in the image and can contribute to a good land evaluation.
Also the temptation to make quality judgements and eliminate some acceptable sites as less desirable than other nearby sites should be avoided during the inventory process. A site considered most desirable may prove unavailable or unacceptable for other reasons. If then other potential sites were not identified the inventory has to be repeated. Inventory and management decisions have to be separated. (Olson et al., 1969)

5.4. INTERPRETABILITY OF SCENIC QUALITY.

Assessing the scenic quality of the landscape.

Analysis of the spatial behaviour pattern reveals that most recreational use is restricted to small concentration points and that large parts of recreation and park areas are the scene of little activity, but provide the scenic setting for the recreation activities. The scenic quality therefore is one of the three aspects determining the suitability for recreation. The analysis and assessment of this scenic quality is the subject of *landscape evaluation*.

Aesthetic value and visual quality.

The scenic quality often is associated with the aesthetic value of a landscape, which again is embodied in its visual quality. Aesthetic values are linked to the experience of a particular landscape at a specific time and therefore involves a direct interaction between a person and particular landscape features. (Vining and Stevens, 1986). Good visual quality should provide the individual with a sense of place and should contribute to the individual's ability to orient himself or herself in space (Smardon, 1986). The way in which landscapes are seen and valued for their scenic quality is different from one person to another, thus highly subjective (Clawson and Knetsch, 1966; Rodgers et al., 1973; I.Zonneveld, 1984; Smardon, 1986; Zube, 1987). It is perhaps one of the most difficult aspects of the environment to analyze and measure (Smardon, 1986). Still, most people would agree that some areas are inherently more attractive and outstanding than others (Clawson and Knetsch, 1966). Although it is clear that in the evaluation of the landscape's quality the subjective component plays an important role, it cannot be left out, but should be rationalized and made understood (Alonso et al., 1986).
A basic distinction of methods to analyze the visual quality of the landscape is that between professionally based and publicly based.

Methods to analyze the visual quality of the landscape.

Professionally based methods rely principally upon *experts* in the selection and evaluation of method components and in the assignment of descriptive labels to the land. (Chenoweth and Gobster, 1986). It is a descriptive model, also called formal aesthetic model, that assumes that aesthetics are inherent in the landscape so that a description of landscape characteristics can presumably provide an evaluation of its aesthetic quality. (Vining and Stevens, 1986). Public- or user-based methods, or public preference model explicitly incorporate the viewpoint of the public, and rely on public groups, frequently user and interest groups, either to make some judgment of landscape quality or to define content categories for the analysis, or both.

(Chenoweth and Gobster, 1986; Vining and Stevens, 1986). The professional approaches have been called elitist, and it has been objected that expert valuations of landscapes may differ from those of the public. Empirical studies of expert versus lay judgments of landscape quality suggest that this objection may be a valid one. (Chenoweth and Gobster, 1986).

Surveys and questionnaires have been a very popular means of assessing the opinions, attitudes, and perceptions of the general public. (Vining and Stevens, 1986). Typically, participants are shown a landscape, either in person or simulated with a photograph or videotape, and asked to indicate the extent of their preference for that landscape (Baumgarnter, 1981; Vining and Stevens, 1986; Chenoweth and Gobster, 1986; Zube, 1987). Another approach is the *visitor employed photography* in which respondents are given cameras and response forms as they enter the landscape study area. They are asked to photograph things around them, that according to them add to or detract from the scenic beauty of the area. (Chenoweth and Gobster, 1986). Although with such enquiry surveys subjective judgements can be clustered into reasonably objective results, the approach is rather laborious and still not free of suggestive and subjective tendencies.

Care should be taken to not consider *the public* as one homogeneous entity (Chenoweth and Gobster, 1986). The best approach to assessment of viewer attitudes appears to be a combination of public sampling with professional assessments based on training and experience in visual analytics (Yeomans, 1986).

Still, a problem with both survey and perceptual preference assessments is that the link between preference, or attitudes and opinions, and actual behaviour in the landscape may not be explicitly evaluated. It is therefore suggested to observe or measure behaviour in the area concerned.

The spatial behaviour of recreationists appears to be closely related to the spatial structure of the landscape and reveals preferences for certain landscapes and landscape elements. A missing element in the analysis of the behaviour, however, is the reason for the behaviour. Another disadvantage is that the behaviour of non-users or non-participants is not recorded. (Vining and Stevens, 1986).

The landscape elements, that appear to be preferred according to the behaviour analysis, are reproducible by photography and sketches and accessible in cartographic form as well (Neef, 1984), and therefore can be described according to objective characteristics to which their apparent attractivity can be related (Defert, 1952). For comparative purposes these characteristics should be quantified (Cosgrove and Jackson, 1972). Airphoto interpretation in this context can be a relatively fast, reliable and economic method to cover the need for data (Dodt and van der Zee, 1984). Approaching landscape evaluation in this way it can become a more objective method.

Analyzing the visual structure of the landscape.

The visual resource is the consistently definable appearance of the landscape and may be described by the measurable visual elements; topography, water, vegetation, sky, human/animals and structures and the pattern of interaction among these elements. (Schauman, 1986). These elements are mentioned in many approaches of analysis of the visual quality, be it in sometimes slightly different terminology, such as slope, soil, surface form, terrain form, etc. (See for example also: Alonso et al, 1986; Felleman, 1986; Yeomans, 1986).

The interpretation of airphotos for landform or terrain and soils, including the assessment of slope steepness, is common practice for many geomorphologists, soil scientists, land resource surveyors, and related experts. Also airphoto interpretation of land use and vegetation has become a matter of routine for the specialists in those fields, and it is not too difficult for an interested researcher to obtain the same skills after some training. Of course, in the context of landscape evaluation the assistance of such experts could be called upon to cover these fields, rather than to try and master all aspects in one person.

More specific in some approaches of the visual analysis of the landscape is the analysis of the visual structure of the landscape.
In the approach to landscape evaluation for recreation developed by Kiemstedt (1967, 1972 and 1975), in addition to the aspects : climate, land use types, and relief, he used forest- and water-borders, because of the importance of the *border effect*. In his later studies to these borders were added hedgerows and lines of trees.
The approach of these factors was based on the same principles on which several Dutch methods of analyzing the spatial structure of the landscape are based. One of the first was that of Van der Ham and Iding (1971), further elaborations and adaptations have been made by the Werkgroep Helmond (1974) and the Grontmij (1975), just to mention a few.
Since for perceiving the spatial structure of the landscape, the eyes are man's most important sensors, the inventory is restricted to the elements that visibly structure the landscape and to the open areas in between these elements. The elements are characterized by size, shape and density or transparency, the open areas by extent and the type of elements bordering them. The spatial arrangement of these elements, that may be called the *visual structure* of the landscape, is of importance because it contributes to the visual information that again is strongly related to the *attractivity* of the landscape. In addition also the landuse and the fieldpattern are considered as contributing to the visual structure and, of course, the relief, be it that in a generally flat country such as the Netherlands relief is a quite peculiar factor.
De Veer (1984) gives an overview of the Dutch approaches used. Instead of visual structure of the landscape also the terms *landscape image* or *landscape physiognomy* are used (De Veer, 1984; I.Zonneveld, 1984), and space structuring elements then are called *image carriers* (De Veer, 1984). The way in which the spatial structure is analyzed is different from one approach to the other. There is not yet a common opinion on the best or most proper way to analyze the visual structure of the landscape (Felleman, 1986), but, in the context of this study, a further discussion on that topic is not really relevant. Whatever the details of the approach, they all have in common that they consider land use and landform/relief and space structuring elements.
Where vegetation, land use or landform as such are part of the categories to be inventoried, the use of airphoto interpretation is part of common practice.
Since most methods do not ask a very detailed classification, the information can be obtained from a topographic map as well. After all, this is also derived from airphotos. Only if the map is relatively old and more recent airphotos are available they are very useful for up-dating. It could be questioned whether the methods were designed first in that simple set-up, after which it was concluded that topographical maps could serve to provide the necessary data, or, that the topographical maps *a priori* were decided to be the main source of information and that the method was designed accordingly.
The space structuring elements, such as: tree lines, hedgerows, solitary trees, solitary buildings, dikes, etcetera, are also represented on the topographic map, but less clear than in an airphoto. By airphoto interpretation in addition to the mere presence of the element, also its size and height can be identified, and under certain conditions also its transparency can be assessed. See also figure 5.5.
For the inventory and analysis of both space structuring elements and landuse, fieldpattern and relief, originally topographic maps have been the main source of information in addition to field observations, and values were expressed per grid square. But the later methods relied in stronger degree on airphoto interpretation using units delineated by more natural boundaries. Recently also satellite image analysis has been tried for the inventory the linear vegetation. (Janssens and Gulink, 1988).
In the original method the size of the space was assessed by observations in the field, indicating for a complete viewing circle over which angles of observation which viewing distances were obtained. (Van der Ham and Iding, 1971). In order to save time and labour, the Helmond Werkgroep (1974) carried out these measurements on the map, after the space

structuring elements had been inventoried and indicated, partly also by airphoto interpretation.
Directly interpreting the size of spaces from the airphotos in stereoscopic view may have the advantages of hight perception and a more realistic impression of the space structuring elements, but may be frustrated by the fact that many spaces are not completely comprised in one stereo model, but are divided over two or more. On smaller scales this may be a bit less of a problem, but then the interpretability of the individual elements again may become more difficult. No well-described experiences with such direct airphoto interpretation of the spatial structure of the landscape have been found yet.

Figure 5.5. *A section of the landscape around Enschede on a vertical airphoto shows the amount of detail that can be obtained with respect to the elements that contribute to the visual structure of the landscape.*

Sightlines and viewsheds.
The structure of the landscape determines which portions of the landscape can be seen as well as the content and composition of available views. Also this aspect plays a central role in most analyses of scenic quality. (Felleman, 1986). In the Dutch methods mentioned the viewpoints were always taken more or less in the centres of the open spaces. To characterize the landscape in a neutral or objective way this may be justified. But, with respect to how people experience the landscape the places from which they look at the landscape should be considered. Thus, the landscape can be divided into seen, partially seen, and unseen areas from existing roads, trails, waterways, or other means of public access to and through the area. (Yeomans, 1986).
Landform, in the Dutch methods understandably playing a rather subordinate role, in other countries may be a as important, if not more, as hedgerows and tree lines. The terrain configuration will strongly determine what views are possible and what parts of the terrain block the view from a certain point.
To some degree, topographic maps and air photos will be helpful in determining seen, partially seen, and unseen areas. If digital terrain data are available, computer assistance can prove of

great value, particularly when dealing with large geographic areas. (Yeomans, 1986). Otherwise, sightlines from the viewer position to the environment, that are equated with light ray paths from the environment to the viewer, and, except for some particular cases, are assumed to be straight (Felleman, 1986), are established in the form of cross-sectional diagrams from a point, or points of observation, thus determining seen and unseen areas. (Yeomans, 1986). See figure 5.6. Key viewpoints can be determined on the basis of the number of times an area or specific site will be seen, the duration of the view(s), the number of observers viewing the area and the distance over which the area or site is seen. (Yeomans, 1986).

In the method of analyzing viewsheds, developed by the French military, sightlines are established on the topographic map, and a cross-section is constructed for each. Straight lines may then be drafted on the section to simulate sightlines from an observer position (or a proposed project) to the environment, indicating hidden and visible points. (Felleman, 1986). See figure 5.6.

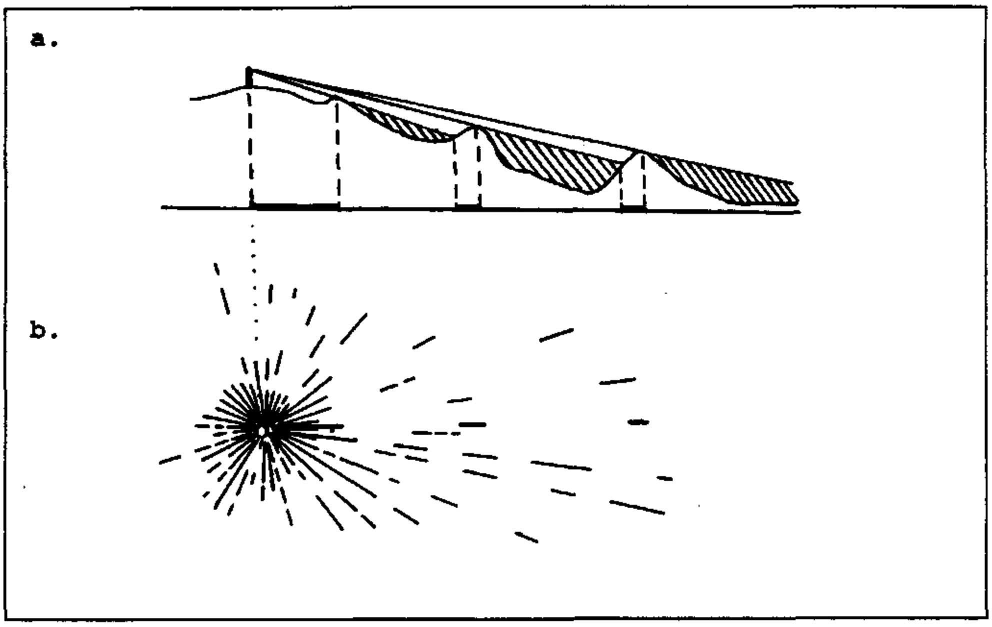

Figure 5.6. *a: sightlines, indicating which areas can be seen (blank) and which not (shaded) from a given point, with the projection of their visible extent on the horizontal plane (heavy line); b: a viewshed as the sum of the sightlines from one point. (derived from Aguiló and Ramos, 1981).*

The *viewshed*, or *visual basin*, from a given point is defined as the portion of the landscape seen from that point. By extension, the viewshed from large structures, such as a dam or a large building, would be the sum of viewsheds of all their points. (Aguiló and Ramos, 1981; Alonso et al., 1986).

The other way around, the viewshed is also the area from which the viewpoint or object can be seen. It is its *visual sphere of influence*. (Van der Ham and Iding, 1971).

Viewsheds can be determined directly in the terrain and annotated on a map. More common is the manual determination by profiles from viewing points as plotted from topographical maps. Only it is difficult to include restrictions of visibility due to vegetational formations or buildings. (Alonso et al., 1986). In that respect airphotos can have advantages. Colwell (1950) already observed that points from which excellent views of the surrounding terrain can be gained can be easily detected by stereoscopic airphoto interpretation, and also that they enable to determine whether certain objects of scenic interest will be visible from certain vantage points or will be obscured by intervening terrain. However, as with the analysis of large open spaces, the analysis of viewshed by airphoto interpretation may be frustrated, because of viewsheds *not being completely included in one stereo model. In this context* the rapid technological developments should be mentioned, that provide computerized tree-dimensional models in which the observer can *move around* and see on a screen what he would see in reality.

Possibilities and limitations.
In the analysis of the visual structure of the landscape airphotos can give more detailed information than topographical maps, and the inventory can be done more comprehensively and rapidly than by mere field observations.
What has to be inventoried depends on the method selected for assessing the scenic quality. Some methods do not use very detailed information. But, it should be kept in mind that sometimes methods have been kept simple just because of the impossibility to collect detailed information in an efficient way, and no doubt would have been made more elaborate when access to airphotos would have been available.
When analyzing the visual structure of the landscape it also should not be forgotten that man perceives the landscape also by other senses, it is a *multi-sensorial landscape* (Bartkowski, 1985). But these ways of perception are more difficult to survey and analyze.
And, in any event, how well designed the analysis methods may be, it should be kept in mind at all times that scenic beauty is not restricted to any firm parameters. (Yeomans, 1986).
The assessment of the scenic quality always will depend on the type of person or group that experiences the landscape. And, moreover, this assessment may change over time for the same person or group. Therefore airphoto interpretation can not be but a tool, however useful.

5.5 ACCURACY OF THE RESULTING LAND EVALUATION.

After the discussion of all the aspects of the evaluation of recreational resources a question that still may be asked is that on how accurate the resulting land evaluation is or can be. This question cannot be answered simply, leave alone in quantified terms, for the overall situation. What actually is *the accuracy of a land evaluation*? Different aspects of such accuracy may be distinguished. And then there is a whole complex of interrelated factors that affect this accuracy.

Aspects of accuracy.

First of all there is the question of accuracy in the sense of *reliability of identification*, that is, whether all recreational land utilisation types and all recreational resources have been incorporated in the land evaluation procedure, and if not, what consequences this has for the value of the result. It relates to the *completeness* of the inventory.
In order to answer this question it should be known how many of the land utilisation types and/or the resources have been missed. Usually this is not known at the time of the evaluation procedure, because otherwise they would have been included still. Only when afterwards it is discovered that some categories have been omitted, an estimate of the importance of this for the total result can be given. But chances are large that it never will be known.
Another possibility is that for the land evaluation only the *relevant* land utilisation types are selected. Of course in such a case arguments should be given as to the criteria for the selection, for example, the number of participants engaged in it or the area occupied by it. It then can be expressed in more or less quantified terms: the land utilisation types considered in the evaluation comprise x% of the total number of recreationists and/or y% of the total area under recreational use.

One criterion of course can be that, if a land utilisation type has not been identified at all, it apparently is not relevant.

This reliability or completeness aspect is not only applicable to the land utilisation types, but also to the resources. Have all the recreational resources be identified and included in the evaluation process. This will depend on how well the relation between the different land utilisation types and their respective resources can be identified. Some relations are quite apparent, but some relations, important though they may be, can have escaped the attention. Also in this case the completeness can only be quantified if afterwards such omissions are discovered. But again, chances are great that it will never be known for certain whether the inventory of recreational resources has been really complete.

When the completeness aspect of accuracy has been assessed, that is, it has been established whether all land utilisation types and all resource types have been considered, then the next accuracy aspect is how well their extent and location have been recorded. This relates to the *reliability of delineation* and the *results of measurement*, which again are dependent on the method used for the inventory. Assessing this requires a control with undisputed accuracy in this respect. A complete inventory and measurement in the field for representative samples could serve as such. But in the approaches discussed so far either the cost aspect would be prohibitive, or the precision and completeness of the control not undisputable. So therefore also in this respect a real accuracy assessment is hard to get.

In addition to the completeness and precision of the inventory of both land utilisation types and resources an accuracy aspect is involved in relating the two in a suitability assessment. How well can the suitability of certain land units be assessed for certain land utilisation types? In some cases the parameters are rather clear and can be quantified and even tested before applying them in a land evaluation procedure. But in many cases parameters can only be defined tentatively, involving an element of subjectivity, especially where quality judgements have to be incorporated. Even though procedures can be designed to approach such judgements as objectively as possible, subjectivity cannot be avoided completely. It is this element of subjectivity that is highly susceptible to change.
It is not easy, if at all possible, to determine an accuracy of the suitability assessment. How often a land utilisation type is allocated to the wrong site? How can this be known? And if it happens, is it the result of a wrong suitability assessment or of other factors?
If the suitability after all was less then assessed this may become apparent because the land utilisation type allocated to the land unit did not develop according to the expectations. The number of visitors may remain lower than expected, or the costs of maintenance may turn out to be higher, or there may be other indications. It will however be extremely difficult to clearly relate this to a mistake in the suitability assessment, because there may be many other explanations possible for a sub-optimal performance of a land utilisation type, for example in the organisational or management sphere. And if after all the suitability would have been higher than assessed, how will this ever be revealed? Higher numbers of visitors, lower maintenance costs? Other land utilisation types might have been allocated to the same unit if this higher suitability would have been known. However, the decisions to allocate land to different uses, whether recreational or not, is only partly governed by suitability criteria and for the other part by political, social, economical and other considerations.
In many cases suitability is only relative and less suitable sites can be upgraded by investment in certain improvement measures such as levelling, drainage, planting of trees, creation of access roads.
All in all it appears to be impossible to give a clear accuracy statement with respect to the suitability assessment.

The different aspects of accuracy, the different components of land evaluation for recreation and their interrelations have been summarized in figure 5.7.

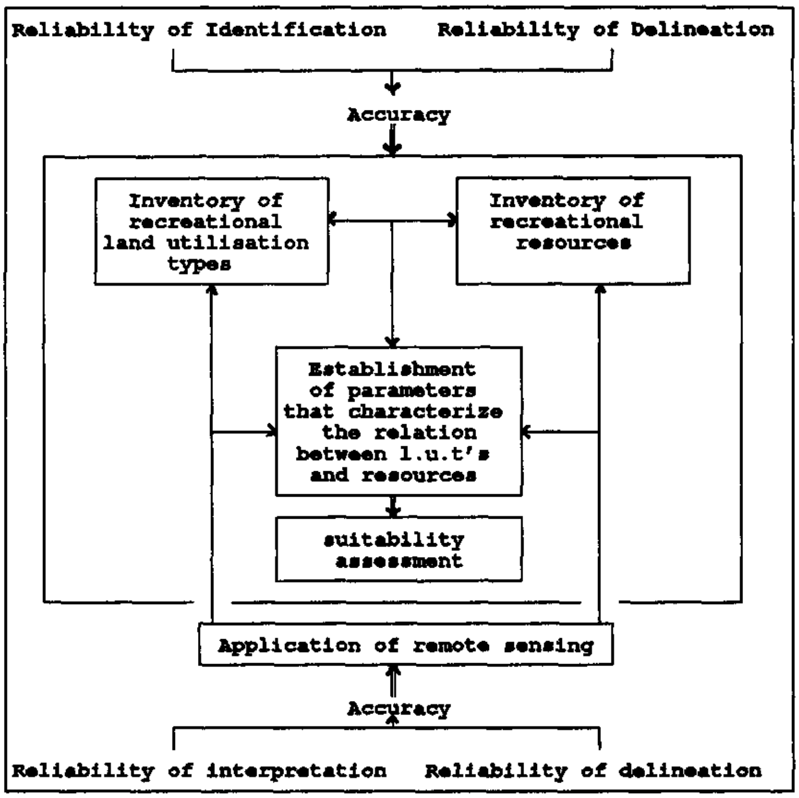

Figure 5.7. *The components of the land evaluation for recreation that are subject to accuracy aspects.*

The influence of the level of detail.

The sources of inaccuracy or incompleteness discussed so far will be more or less the same in all three approaches to land evaluation for recreation, although certain differences may occur. In the recreation and conservation approaches it may be more essential to have as complex an overview as possible of the recreational land utilisation types. In the tourism approach a conscious selection of the most promising land utilisation types will be made, for which it may not be relevant to first have a comprehensive inventory of all potential ones.

The requirements with respect to completeness and precision will be strongly determined by the level of detail at which the land evaluation is carried out. At the reconnaissance level these requirements will be less high than at the detailed level. this is reflected in the methods that can be applied: satellite images versus large scale airphotos, single coverages versus sequential coverage.

Whenever remote sensing is used for the inventory and analysis the accuracy of the interpretation plays a crucial role both with respect to completeness and precision. See also figure 5.7.

Certain recreational facilities and activities can be clearly and almost completely inventoried, others with difficulty or even not at all. The same applies to the landscape elements that constitute the recreational resources. Since there is such a large and varied range of both recreational land utilisation types and recreational resources it is impossible to specify an overall accuracy rate for this aspect.

Reliability of the method.

Summarizing it can be stated that it is not only difficult to really define what should be considered as the *accuracy* of a land evaluation for recreation, but that it is almost if not completely impossible to determine such accuracy. There seems to be no possibility for an objective quality control.

Therefore it is imperative that the different steps in the evaluation procedure are well documented and argumented and that assumptions made and criteria used are made explicit. Then at least another party repeating the procedure with the same data, assumptions and criteria would come to the same results. This relates to the *internal consistency* of the procedure.

Also a land evaluation carried out for another area with different data, but based on the same assumptions and criteria, then would give results that are comparable. But the consistency of the method as such is no measure for its accuracy.

Making the procedure clear and transparent will allow other parties to scrutinize and criticize it and contribute to improvements, and in the end may result in a general acceptance of the method as a reliable tool, even if no exact accuracy can be measured.

6. SUMMARY AND CONCLUSIONS.

6.1. SUMMARY.

The context of the study.

The aim of this study is to fully explore the possibilities of remote sensing as an input into land evaluation for recreation.

Recreation and tourism have become an inseparable part of the modern lifestyle and are still growing in importance. Recreation is widely recognized as a source of economic development and for many a country or region it is a major sector of the economy. As such it can play an important role in economically weak regions. This applies also to developing countries.

With increasing population, mobility and participation in recreational activities also the demand that recreation makes on the land increases, leading to more pressure on finite resources of land and water almost everywhere in the world. This threatens not only nature but also the quality of recreation itself.

This almost explosive development of recreation resulted in an increased concern for appropriate planning of recreational facilities and resources. More knowledge is needed to achieve such planning.

The complex relation between recreation and the landscape may be conveniently presented in a land evaluation procedure. The conventional methods to obtain sufficiently comprehensive and reliable data for such a procedure are labour intensive, expensive, time consuming and thus impractical. Therefore it is investigated whether airphoto interpretation can be a useful tool, especially in the inventory and analysis phase.

Some concepts.

Recreation has been defined as: refreshment of body or mind by activities (or a planned inactivity) undertaken because one wants to do it, without any moral, economical, social or other pressure. For specific studies this comprehensive definition may be restricted to make it operational.

Tourism can be defined in two different ways: 1. tourism as a special (travelling) type of recreation; 2. tourism as an economic activity, providing goods and services to tourists.

When discussing recreational resources, recreation usually is restricted to recreation outside the home settlement. Resources are only resources when man identifies and appreciates them and is able to use them as such, and this also applies to recreational resources. They can be called original recreational resources if they have not been created or maintained in the first place for recreational use. The recreational facilities in that case can be considered to be derived from them.

Recreational facilities can be distinguished into resource based, most often occurring in rural areas, and user oriented, predominantly in or near urban agglomerations.

Land evaluation is a method or procedure in which specific land uses or land utilisation types (LUT's) with their requirements are confronted with land (mapping) units (LU's) with their characteristics and qualities in order to establish which land units are in what degree suitable for which land utilisation types. Land suitability implies suitability for sustained use.

Remote sensing commonly is understood as the registration and interpretation of images of the earth's surface in order to survey and monitor phenomena and processes on or near this surface. As such it includes a whole range from multispectrally scanned satellite images to photographs taken from a high tension power mast.

Land evaluation for recreation.

In the context of land evaluation for recreation the land utilisation types are different types of recreation for which the land units can be interpreted for their recreational resources. The recreational land utilisation types should be described according to the activities carried out, these activities carefully defined and sometimes divided into sub-activities that each have their own requirements with respect to the resources. With respect to the requirements of the recreational land utilisation types three different aspects can be distinguished: the *physical*

requirements, the *scenic quality* and the *accessibility*. The relative importance of each of the three aspects will differ from one type of recreation to the other, and the recreation types can be classified accordingly.
A more detailed classification can be obtained on basis of two other aspects: whether the type of space used is linear, nodal or areal, and whether the character of the land used is mountains, forest, coast, water or rural. To that a subdivision according to popularity of the activity can be added.
The characteristics of the land units should be described related to their physical suitability, scenic quality and accessibility, in qualitative and as much as possible in quantitative terms. In order to assess the suitability for sustained use also ecological aspects should be considered. In order to confront the requirements of the land utilisation types with the characteristics and qualities of the land units, they both have to be described in the same format by the same parameters as objectively as possible and preferably in quantitative terms.

The potentialities approach.
In land evaluation for recreation it may be logical to take the demand for recreation as a starting point, but it is difficult to actually determine and measure this demand. The demand for recreation is influenced by a number of interrelated factors, that can be distinguished into three groups: user related, area related and user-area relationships. In addition a distinction should be made between actual, latent and potential demand.
Different approaches to determine the demand for recreation are possible, but most of them are very labour intensive and time consuming and still do not offer a guarantee for completeness and comprehensiveness. Therefore it is considered to be worthwhile to investigate the possibilities of approaching the demand indirectly by way of analyzing the supply side. This is the potentialities approach, that starts with an inventory of the recreational infrastructure, the complex of recreational facilities.
To answer the question whether the recreational land utilisation types can be identified via the facilities has become *Objective 1*. Derived from this is *Objective 2*: to answer the question whether recreational facilities can be identified with a sufficient level of consistency by remote sensing.

Assessing the accuracy of an airphoto interpretation.
To establish how well the different categories of recreational facilities can be identified on aerial photographs in itself is no easy matter. In order to determine how accurate the interpretation has been it has to be compared with other sources of information on the same category, but the accuracy of these sources themselves sometimes is questionable. Even by simple field observations it is not always easy to clearly identify the objects of study. The example of the accuracy with which farms could be interpreted in an area around Enschede, the Netherlands, illustrates this dilemma.
In addition there will be differences in accuracy between individual interpreters, depending on skill, experience and familiarity with the topic and area studied. This is illustrated at the hand of house counts in case studies in Italy and Spain.

The airphoto interpretation of recreational facilities.
The recreational facilities have been distinguished into primary facilities, comprising the stay accommodation and the accessibility infrastructure, and the secondary facilities, that comprise the entertainment facilities.

The interpretation of stay accommodation.
Of the stay accommodation the hotels and restaurants comprise a wide range of building types. Case studies in the Netherlands, Spain, Thailand and Indonesia are used to assess the interpretability of this category. Another category of the stay accommodation are the camping-grounds that range from very simple ones to very luxurious ones. Examples from the Netherlands and Spain illustrate the possibilities of an inventory of camping-grounds, of the

delineation of their extent, and of establishing occupation rates on them by airphoto interpretation.
The third category of stay accommodation, the second homes, comes in a very large variety. They may occur grouped in complexes, but also individually dispersed in the countryside. Examples from the Netherlands, Spain, Thailand and Indonesia are used to assess the possibilities of reliable airphoto interpretation of this category.

The interpretation of secondary facilities.
Also the secondary facilities comprise a very large variety. Examples from the Netherlands, Great Britain and Spain are given for the interpretation of sportsfields. The interpretability of swimming facilities is illustrated by examples from the Netherlands an Spain. In addition, several examples of other sports facilities are discussed.
With respect to the interpretation of facilities for informal pursuits, such as watersports facilities, walking facilities, visitor attractions and entertainment facilities, and allotment gardens the results of several case studies are discussed.

The interpretation of accessibility infrastructure.
The accessibility infrastructure is part of the primary recreational facilities and the road network is the main category of it. The case study in the area around Enschede, the Netherlands, is used to assess the accuracy of airphoto interpretation for this category.

The interpretation of the relation between facilities and resources.
Objective 3 is to answer the question whether remote sensing can reveal to which resources the recreational facilities, and thus their associated land utilisation types, are apparently related. It is not strictly necessary that the facilities have been identified by airphoto interpretation. Once the location of the facilities is known airphotos can be used to analyze their relation to other elements in the landscape.
Objective 4 is to answer the question whether the relations meant in objective 3 can be defined into parameters that are both identifiable by remote sensing and relevant in the land evaluation procedure.
The analysis of the relation between facilities and resources and the determination of parameters is illustrated by examples from the Netherlands and Thailand.

Analysis of development processes.
Objective 8 is answering the question whether the use of sequences of airphotos or other remote sensing images can contribute significantly to the information aimed at in the other objectives.
Sequences or time series of airphotos or satellite images can be used for *monitoring*, watching in order to warn. Real monitoring cases applied to recreation are but few, because the spatial resolution of satellite images is too coarse and the costs of repetition of airphoto flights often inhibitive. More common is the use of existing sets of airphotos to compare the present situation with situations in the past and analyze the changes in retrospective monitoring. In both *real* and *retrospective monitoring* usually only one set of airphotos is used to make a complete and comprehensive bench-mark map. The other sets then are merely screened for differences that are annotated on a copy of that map. Changes can be presented in a special change map and/or in a (cross)table.
With respect to recreation the most obvious changes in the landscape are caused by the physical facilities. Especially when the development occurs in a spontaneous gradual process it is hard to recognize. In such cases interpretation of sequences of aerial photographs may make the process clear and may even reveal a certain pattern in it. The factors determining the suitability and/or attractiveness of recreational resources may become more apparent by such analysis. But, even when using sequences, airphoto interpretation can only give part of the answers.

The possibilities of sequential airphoto interpretation are illustrated with examples from Sweden, USA, Spain, Thailand and the Netherlands. The potential of SPOT satellite images for analyzing recreational development is discussed at the hand of an example from Thailand.

Analysis of spatial behaviour of recreationists.

Recreational activities are not evenly distributed in space nor in time. There are concentration points next to areas that are almost unused, and peaks in time next to periods with hardly any use. Recreational activities are not necessarily confined to recreational facilities either. Therefore, for the planning of proper management of recreational resources, detailed information is needed on the spatial behaviour of recreationists within a single landscape or landscape element, as well as on the time dimension in that behaviour. Two approaches in which airphoto interpretation can be used to obtain such information in a relatively cost-effective way can be distinguished. In *indirect monitoring* the spatial behaviour of recreationists is studied by analyzing the visible impact that it has on the environment. This results in *Objective 6*, which is to answer the question whether the impacts of recreation on the landscape can be inventoried with remote sensing, and if so, what infomation can be obtained from that that is of relevance for land evaluation for recreation.

In *direct monitoring* the recreationists themselves and/or their vehicles are identified and their spatial distribution in the terrain analyzed, preferably on sequences of airphotos. This leads to *Objective 7*, which is to answer the question whether recreationists themselves and/or their vehicles or equipment can be detected on airphotos with a sufficient level of accuracy, and if so, whether this would contribute to information that is relevant to land evaluation for recreation.

Analysis of the impact of recreation.

The analysis of the impact of recreation on the environment not only can give an impression of the spatial behaviour of recreationists, but is also relevant for its own sake. It reveals which parts of the landscape are more damaged by recreation and which less. Three main groups of impact are discussed. The airphoto interpretation possibilities to analyze the *impact by physical facilities* have already been discussed in previous sections. The use of airphoto interpretation for the study of *impact on animals* is largely restricted to the analysis and monitoring of the different types of habitat available. Of the *impact on vegetation* most attention has been paid to the effects of trampling.

The effects of trampling can be distinguished into different phases from slight degradation through severe degradation to complete disappearance of vegetation. Only this last phase in the process of recreational erosion can be more or less easily studied by airphoto interpretation.

This recreational erosion is a gradual process in which there are numerous small, almost imperceptible changes per unit of time. Often the extent of such changes and their cumulative effect can only be really judged by comparing sequences of airphotos.

The interpretation of recreational erosion.

Examples of the use of airphoto interpretation for studies of recreational erosion from Denmark, Germany and the Netherlands are discussed. The subjectivity factor in the interpretation is analysed by a comparison of two interpretations of an area on Schiermonnikoog, the Netherlands.

Comparisons of recreational erosion are usually expressed in path densities and extent of completely bare areas. In addition to that also the patterns of the spontaneous paths can be analyzed. Three main types of path pattern have been distinguished: the parallel path-pattern, the radial path-pattern and the fan-like path-pattern. These patterns could be correlated to behavioural characteristics of the recreationists. Thus the inventory and analysis of the effects of recreational trampling may give a further detailed indication of the relation between certain recreation types and specific landscape elements and also reveal something about the spatial behaviour of the recreationists.

Also water and shoreline vegetation can be influenced by recreation and the analysis of some of these impacts by airphoto interpretation is illustrated by a number of case studies from the Netherlands.

Watersport surveys from the air.

In direct monitoring a lot of experience has been gained in the Netherlands with surveys of watersport. The increase in importance of watersport results in an increasing pressure on its resources. For an optimal management of these resources information is needed on the total number of boats present in an area, on how many of these boats actually sail out on a representative day and on what is the sailing and lying behaviour of watersporters in time and space. Especially to answer the last part of the question the aerial survey seems to be a logical solution. The advantages seem to outweigh the disadvantages. Of course it has to be realized that airphotos as the only tool will not suffice.

The choices between aerial reconnaissance, vertical or oblique aerial photography, and of the type of camera, the photographic material, the flying hight and the scale are interrelated. The watersport surveys in the Netherlands have been compared for these aspects. The interpretability of recreational boats is discussed as well as the arguments for the selection of the day(s) and time(s) on which the survey has to be carried out, and of the frequency of repetition during the day or season. There have been surveys of high repetition, that is, with several flights on one day, but also surveys with only one or two flights on a day.

The special type of survey requires also special interpretation and elaboration methods and procedures. Boats are identified and marked in their approximate or exact locations on a map, distinguished in sailing boats and lying or moored boats, and according to type of boat. The possibility to establish the accuracy of counts on the photographs, as well as the relevancy of this accuracy is discussed. The distribution pattern of boats on the water area reveals which parts of the area apparently are more attractive and which less. This may give an idea of how to optimally manage a watersport area. For this reason in almost all the watersport surveys densities of boats per unit of area and/or per length of shoreline have been determined and density patterns analyzed.

Not only spatial patterns have been detected in this way, but also behaviour patterns in time. A large proportion of boats that sails out on a particular day can be found lying along the shore during a major part of that day. Thus the capacity of a watersport area is determined by the length of its usable shoreline rather than its surface of water.

Monitoring shoreline and land recreation.

Similar studies have been carried out for beach and shoreline recreation. In such studies the scale used has to be much larger because the objects to be identified in general are much smaller: persons, tents, motorcars, surfboards, rubber boats, etcetera. Both vertical and oblique airphotos have been used and two Dutch case studies have been compared. Also in this case the selection of the proper day and time for the survey and the choice of a certain frequency of repetition are important for an optimal result. Absolute accuracies and spatial distribution patterns related to different sections of beach and separate distance zones from the waterline are discussed.

Aerial surveys for direct monitoring of recreation on land are less numerous than those for recreation on water and along the shore. Still some examples are available. Very often it is the motorcar that is the object of interpretation. Two examples of motorcar centred surveys from Great Britain are discussed. For a people centred survey a time-lapse camera has been used in an urban environment in the USA with satisfactory results.

Relating recreation to its resources.

Through the inventory of recreational facilities, the analysis of the recreational impact, or the direct monitoring of recreationists or their vehicles, the spatial pattern of recreation may become apparent. When sequences of airphotos are used also the temporal aspect of that pattern may be captured. Analysis of that pattern can reveal to which element in the landscape particular types of recreation are related and give an indication of their

requirements with respect to the land qualities. The characteristics of the resources that apparently have such qualities can be compared with that of other landscape elements in the same area or with similar elements in other areas to give insight in the factors that determine whether a landscape element becomes a recreational resource or not. All three aspects of suitability for recreation have to be taken into account, of course.
Once resources have been identified out of the analysis of actual recreational use, landscape elements matching the same parameters in all three suitability aspects can be inventoried also for areas where no actual use is observed. This can give an indication of the available potential that may be developed. The reasons for absence of use have to be investigated. Comparison of actual recreational resources with potential resources may reveal which factors determine the use or non-use by recreation and could be used to refine the definition of parameters.
The degree in which one has to interfere in an actual situation in order to approach an optimal functioning can be taken as a measure for suitability. It is better not to comprise all suitability factors into one single formula. In addition to physical suitability, scenic quality and accessibility also the carrying capacity should be considered. Three kinds of carrying capacity for recreational use are distinguished: physical, ecological and psychological.

Three approaches to land evaluation for recreation.

In land evaluation for recreation three main approaches have been distinguished: the *recreation approach* that is more or less user-oriented, the *tourism approach* that can be considered to be more resource-based, and the *conservation approach* in which priority is given to environmental considerations. Each of these approaches can be carried out at reconnaissance, semi-detailed and detailed level, except for the conservation approach that perhaps should start directly at semi-detailed level.
American, British and German examples of the recreation approach are discussed. The tourism approach is illustrated at the hand of the example of Botswana. Several examples of the conservation approach are mentioned.

Remote sensing of recreational resources.

Objective 5 is to answer the question whether the recreational resources can be consistently inventoried by remote sensing, especially when applying the parameters mentioned in objective 4.

Interpretability of physical suitability and accessibility.

The question of objective 5 can not be answered in general. For the different categories of resources that are related to the physical suitability: water bodies, streams and waterfalls, shores and forest, as well as for roads, the main infrastructure category determining accessibility, the interpretability is separately discussed in more detail.

Interpretability of scenic quality.

There are areas that are not or little used for recreation but nevertheless are of great importance for it by providing the scenic setting for the recreational activities. The analysis and assessment of the scenic quality is the subject of landscape evaluation. Scenic quality often is associated with the aesthetic value of a landscape, which again is embodied in its visual quality. In the evaluation of the scenic quality the subjective component plays an important role. Professionally based and publicly based methods to rationalize and understand this subjectivity are discussed. Also the actual spatial behaviour of recreationists can be taken as an indicator. The landscape elements that apparently are preferred according to the behaviour analysis can be inventoried. Such elements can be considered to make up the visual structure of the landscape, and the analysis of this visual structure can be a first, objective step in landscape evaluation.
Reference is made to the approach developed in Germany by Kiemstedt and to several Dutch methods. For the inventory and analysis phase in these methods originally topographical maps have been the main source of information in addition to field observations. Values are

often expressed per grid square. Later methods relied in stronger degree on airphoto interpretation and also satellite images have been used recently.
The visual structure of the landscape determines which portion of it can be seen from a certain point, as well as the content and composition of the available views. Therefore the determination of sightlines and viewsheds plays a central role in most analyses of scenic quality.
The assessment of scenic quality always will depend on the type of person or group that experiences the landscape and moreover may be subject to changes in time.

The accuracy of land evaluation for recreation.

The question how accurate the land evaluation for recreation is or can be can not be answered simply. First of all it is difficult to define what actually is the accuracy of a land evaluation. Two main aspects of accuracy can be considered: reliability of identification, which relates to the completeness of the inventory, and reliability of delineation, which influences the results of measurement of both the recreational land utilisation types as well as the recreational resources. In addition also an accuracy aspect is involved in relating the two in a suitability assessment, but it appears to be impossible to give a clear definition of this.
It is not only difficult to really define what should be considered as the accuracy of a land evaluation for recreation, but it is almost, if not completely, impossible to determine such accuracy. There seems to be no possibility for an objective quality control. This makes it even more imperative to make the procedure clear and transparent, documenting all steps, assumptions and criteria. In this way another party repeating the procedure with the same data, assumptions and criteria should come to the same results. It will also allow other parties to scrutinize and criticize the procedure and contribute to improvements in such a way, that in the end the method will be generally accepted as a reliable tool, even if no exact accuracy can be measured.

6.2. CONCLUSIONS.

From the general aim objectives have been derived formulated as questions on which an answer is required. The conclusions will be presented grouped according to the objective that they are related too.

Objective 1.

Can the recreational land utilisation types be identified via the facilities?
This question can not be answered positively in general.
The potentialities approach can not achieve a complete and comprehensive overview of the recreation pattern of an area. Neither is there always a clear relation between a type of facility and a specific recreational land utilisation type. Still, an impression of the spatial pattern of recreation at large can be obtained in this way, in addition to an overview of a limited number of specific recreational land utilisation types. It makes this approach a useful tool for a quick overall reconnaissance.
And because it is very difficult to get a comprehensive and up-to-date overview of recreational facilities even at reconnaissance level from existing sources or data bases, it remains worthwhile to explore the possibilities to inventory these facilities with remote sensing.

Objective 2.

Can the recreational facilities be identified by remote sensing with a sufficient level of consistency?
The answer on this question has been restricted to facilities that occur in rural areas, and varies according to the type of facility.
Hotels and restaurants can not be interpreted from airphotos with high reliability. But especially in rural settings it is possible to indicate buildings that could belong to this category, making it possible to concentrate field observations on only these marked sites and come to a more

or less complete inventory with a minimum of effort. Thus, airphoto interpretation can still be useful, especially in situations where other data sources are scarce or far from complete.
An inventory of camping-grounds can be made with airphoto interpretation rather completely and consistently, though not with a 100% accuracy everywhere. Also the delineation of the extent of the camping-grounds can be done fairly precise. For establishing occupation rates on camping-grounds field observations have to be synchronized with the airphoto flight and this will only be possible in special surveys.
For an inventory of second homes airphoto interpretation can not give consistent and comprehensive results. When they occur grouped in complexes it may not present too big a problem, but for those that are individually dispersed in the countryside it is almost impossible. Even by simple field observations it then is not easy to definitely identify second homes as such. But, it is possible by airphoto interpretation to mark all buildings and objects that could be second homes, making a more efficient field observation programme possible. In this way airphoto interpretation can still be useful, especially because data on this type of facility are seldom available.
With respect to sports facilities, the range of different types is so large, that no general conclusion can be drawn. Some types of facilities can be identified with an almost 100% accuracy, other types are far less easy to identify or are not identifiable at all. The same applies to the category of visitor attractions, as well as entertainment facilities.
For watersports facilities it is concluded that most types can be interpreted with sufficient consistency and completeness. Still, there are certain types of facilities that are hard to detect.

A consistent interpretation of the footpath network, as the main facility for walking, is not possible. But for allotment gardens an almost 100% accuracy can be obtained.
With respect to the accessibility infrastructure, excluding footpaths, it is concluded that airphoto interpretation can provide an up-to-date impression of the total road network, with good accuracy of the total length. This is especially relevant for situations where no large scale up-to-date topographical maps are available. For a detailed subdivision into different categories of roads the accuracy is not high enough in most European situations. But in many situations in developing countries such detailed subdivisions may not apply and the airphoto interpretation accuracy can be higher.
Also, airphotos can not say anything about the degree of recreational use that is made of roads, neither about the juridical, social and economic aspects of accessibility.

Thus, airphoto interpretation can only lead to reasonably comprehensive and accurate inventories of a selected number of facility types, not for an overall inventory of all types.
Nevertheless, it still is thought to be a useful tool for getting a first impression of the availability and especially the spatial distribution of various types of facilities. It can help in establishing which other ways of obtaining information should be used for which facilities. Use of airphoto interpretation becomes most relevant where other sources of data are insufficient or completely lacking.
Satellite images, however, are not suitable at all for the interpretation of recreational facilities.

Objective 3.

Can remote sensing reveal to which resources the recreational facilities, and thus their associated land utilisation types, apparently are related?

For this type of analysis it does not really matter whether the facilities themselves have been inventoried by airphoto interpretation or by other means. Although there are some limitations inherent to airphoto interpretation, it still offers a better and more comprehensive view on the landscape than many other approaches and thus a unique opportunity to analyze the relation of recreational facilities to their resources. Using sequences of airphotos can even enhance this opportunity. The approach is especially relevant for areas where the relation between recreation and its resources has not, or hardly, been studied so far.

Objective 4.

Can the relations meant in objective 3 be defined into parameters that are both identifiable by remote sensing and relevant in the land evaluation procedure?

The conclusion has to be that, in general, this is not possible, either because no parameters can be defined, or because these can not be consistently identified by remote sensing. Using sequences of airphotos may help in only a number of cases.

Objective 5.

Can the recreational resources be consistently inventoried by remote sensing, especially when applying the parameters mentioned in objective 4?

Once it has been established what elements in the landscape have to be considered as recreational resources and parameters to measure their rate of suitability have been defined, the identification of these resources by airphoto interpretation in many cases can be done by routine procedures. But, there are also parameters that are hard to identify, and not all information can be collected by airphoto interpretation. Thus, many recreational resources can be consistently inventoried by remote sensing, but not all. Neither can all aspects of the recreational resources be deduced from airphotos.

Especially with respect to the scenic quality of the landscape there are serious limitations as to what can be achieved by remote sensing. However, many approaches require the inventory of large amounts of data on landscape elements. For this inventory airphoto interpretation often can give the most detailed results in an efficient way. Even SPOT images have been used with success in a number of approaches.

Applying airphoto interpretation and other remote sensing techniques to the many aspects that can be identified, and reserving other approaches to those not identifiable, can contribute to an efficient preparation for land evaluation for recreation. Again, this approach is particularly relevant for areas for which other sources of information are insufficient.

Objective 6.

Can the impacts of recreation on the landscape be inventoried with remote sensing, and if so, can this provide information that is of relevance for land evaluation for recreation?

The impact on the environment by physical facilities for recreation can be inventoried by airphoto interpretation with the same accuracy as these facilities themselves can be interpreted. See objective 2.

The impact of recreation on the vegetation can only be interpreted from airphotos when it has reached the ultimate stage of the trampling process: beaten paths and bare areas. For establishing absolute values of impact and very precise locations airphoto interpretation is not really suitable, because of a too high degree of subjectivity or lack of inter-observer reliability.

However, for comparing different situations in space and/or time, when the interpretation is done by the same person, airphoto interpretation is excellently suited. It then in fact is the only method to reveal the results of a process that is very gradual in nature. The method is most successful in open terrain and much less applicable in wooded or forested areas.

The analysis of the patterns of spontaneous paths, for which airphotos are also very suitable, can give interesting information on the spatial behaviour of recreationists. It should be used then in combination with other types of surveys to make the information really relevant for land evaluation purposes.

Analysis of the impact of recreation on water and shoreline vegetation by means of remote sensing so far has been much less successful.

The impact of recreation on animals as such cannot be inventoried by remote sensing. Still, remote sensing can contribute to the study of this type of impact. The inventory and analysis of different types of habitats and of changes in their extent and character in several cases has been based on remote sensing. Also counting of animals can be done by either remote sensing or by visual aerial reconnaissance surveys.

Of course there are many more types of impact by recreation on the environment, but the chances to identify them by remote sensing are but small, if it is at all possible.

The application of airphoto interpretation to studies of impact of recreation is relevant for developed countries as well as for developing countries. Impact studies can reveal which parts of the landscape are more likely to be influenced and/or more sensitive to impact. Such information is important in the land evaluation procedure especially in relation to the aspect of sustainable use.

Objective 7.

Can recreationists and/or their vehicles or equipment be detected on airphotos with a sufficient level of accuracy, and if so, will this contribute to information that is relevant to land evaluation for recreation?

Most experiences have been obtained for watersports. There have been so many different approaches that it is difficult to come to a general conclusion. The level of accuracy with which recreational boats can be detected on airphotos may not always satisfy the purpose of statistical inventory, but usually is high enough to give a good impression of the spatial distribution. This spatial pattern again can give indications of the relation between this specific type of recreation and its resources in more detail than a mere inventory of facilities could. The spatial pattern can be analyzed from single airphoto coverages, when these are properly timed. But the use of sequences of airphotos, or of visual reconnaissance flights, during one day, during one season, or after several years, can significantly increase not only the amount of information, but also its value by adding the temporal aspect of the behaviour pattern.

Also cars can be easily detected on most types of aerial photos, and can be used as an indication of spatial concentrations of recreationists under conditions in which the non-recreational use of cars can be considered to be negligible.

For the identification of persons airphotos of a large scale are required. This type of survey can only be done with photos made on special purpose flights, in which case good results can be obtained. In the case of shoreline recreation good results have been obtained with respect to the identification and analysis of the spatial distribution pattern. Also in this application sequences of airphotos can add the temporal aspect and thus contribute to the information value. An alternative for special purpose flights in this case can be the use of a ground-based time-lapse camera, but then only relative small areas can be covered.

The information on the behaviour pattern of recreationists in space and time can be of help in designing an optimal management for a recreation area.

Objective 8.

Can the use of sequences of airphotos or other remote sensing images contribute significantly to the information aimed at in the previous objectives?

The answer on this question has already been partly incorporated in the conclusions for these previous objectives.

The use of older sets of airphotos in addition to the most recent one in a procedure of retrospective monitoring can be very useful in revealing distinct patterns of development in space and time. It can give indications about the factors that are of influence, and can also reveal which land uses or cover type are apparently more susceptible to or attractive for being taken over by recreational use.

Thus, the relation between recreational facilities and their resources may become more clear when analyzing sequences of airphotos than when only interpreting single situations.

Though the resolution of the SPOT satellite images is not suitable for identification of recreational facilities or land uses, it is possible to locate major changes in cover type that may indicate new developments. As such the contribution of SPOT may still be valuable, but it is doubtful whether this will justify the purchase of an image for this purpose alone.

In the analysis of the impact of recreation the use of sequences of airphotos can be very essential in revealing the results of a gradual process that is hard to notice otherwise.

In the direct monitoring approach the use of sequences of airphotos, during one single day or season, can add valuable information on the temporal aspect of the behaviour of recreationists.

Overall conclusion.

Summing up these conclusions, it appears that there are not only remote sensing approaches directly focused on recreational features that are very useful, but that a lot of remote sensing approaches primarily aimed at other features can indirectly contribute to land evaluation for recreation.

The application of remote sensing techniques to land evaluation for recreation in many cases can contribute to more efficient data collection and analysis, and in some cases allow the collection of information and a type of analysis that would otherwise not be possible.

Some of the methods discussed may be rather new, unconventional, still a bit experimental, and need further research to be made really operational, but many belong already to the realm of routine practice.

Still, it is clear that remote sensing can only give part of the answers. The rest has to be obtained by other means. But, the interpretation of airphotos and in some cases even of satellite images, can help to point out which other ways best to explore.

Especially in areas for which recreation related data are scarce or non-existent, which is the case in many developing countries, remote sensing therefore can be the most efficient tool to start with.

To fulfill the aim of this study, the full exploration of the possibilities of remote sensing as an input into land evaluation for recreation, the various application possibilities are presented in the following scheme, related to the type of remote sensing that is most appropriate and the results that can be expected.

Table 6.1. *Overview of applications of remote sensing as input into land evaluation for recreation.*

Type of remote sensing	Application	Results to be expected
single coverage vertical airphoto *) 1:10000/1:20000	inventory of facilities	strongly dependent on the type of facilities
"	analysis of the impact of facilities on the landscape	"
"	inventory of recreational resources	in general successful
"	analysis of relation of recreation types to their resources	"
"	inventory of landscape elements determining the visual structure	"
"	analysis of impact of recreation on animals	inventory and analysis of habitats possible
"	analysis of spatial behaviour	relative position of boats and cars can be indicated
1:10000	analysis of recreational impact on vegetation	identification and analysis of path patterns possible, absolute accuracy low
1:2000/1:5000	"	possible in more detail than in smaller scales

(continued on next page)

Table 6.1. *(continued)*

Type of remote sensing	Application	Results to be expected
sequences of vertical airphotos of different years		
1:10000/1:20000	analysis of development processes	in general very good
"	analysis of relation of type of recreation to resources	in general better than with single coverage
"	analysis of impact by facilities	time dimension adds value
1:10000	analysis of recreational impact on vegetation	the only way to reveal results of a gradual process
sequences of airphotos of different dates within a year		
1:10000/1:20000	analysis of spatial behaviour	differences in spatial distribution of boats or cars over the area in different seasons can be compared
1:2000/1:5000	"	differences in spatial distribution of persons over the area in different seasons can be compared
sequences of airphotos on different times of the day		
1:10000/1:20000 1:2000/1:5000	" "	the time dimension of the spatial behaviour during one day can be analyzed for boats or cars and for persons respectively
oblique airphotos #)		
once a year	analysis of development processes	revealing changes in the landscape
different dates in one year or different times on one day	analysis of spatial behaviour	the relative location of boats, cars and/or persons can be identified
aerial reconnaissance		
once a year	analysis of development processes	revealing changes in the landscape when in low concentrations
different dates in one year or different times on one day	analysis of spatial behaviour	the relative location of boats, cars and/or persons can be identified when in low concentrations @).
SPOT and/or TM images	analysis of development processes	identification of major changes in the landscape possible
	analysis of visual structure of the landscape	inventory of the main landscape structuring elements is possible

*) In vertical aerial photography usually panchromatic photos will suffice; the high expenses for full colour or false colour seldom is justified by better results that can be obtained.

#) at present often normal colour slides taken with a hand-held small format camera are used.

@) In the case of occurrence of large concentrations a combination with oblique aerial photography is often used.

7. SAMENVATTING EN CONCLUSIES.

7.1. SAMENVATTING.

De context van het onderzoek.

Het doel van dit onderzoek is de mogelijkheden van remote sensing als inbreng in landwaardering voor recreatie volledig te verkennen. Recreatie en toerisme zijn een niet meer weg te denken onderdeel van de moderne manier van leven geworden en nemen nog steeds in betekenis toe. Recreatie wordt door velen erkend als een bron van economische ontwikkeling en vormt voor veel landen of regio's een belangrijke sector van de economie. Zo kan het vooral een belangrijke rol spelen in economisch zwakke gebieden. Dit geldt ook voor ontwikkelingslanden.

Met toenemende bevolking, mobiliteit en deelname aan recreatie activiteiten neemt ook de vraag naar land voor recreatie toe en dit leidt bijna overal ter wereld tot grotere druk op de eindige hulpbronnen land en water. Hierdoor wordt niet alleen de natuur maar ook de kwaliteit van de recreatie zelf bedreigd. Deze bijna explosieve groei van de recreatie heeft een toegenomen aandacht voor een juiste planning van recreatievoorzieningen en hulpbronnen tot gevolg gehad. Meer kennis is nodig om zulke planning te bereiken.

Het ingewikkelde geheel van betrekkingen tussen recreatie en het landschap kan heel geschikt worden gepresenteerd in een procedure voor landwaardering. De gewone methoden om genoeg en voldoende betrouwbare gegevens te verschaffen voor zo'n procedure zijn arbeidsintensief, duur, tijdrovend en dus onpraktisch. Daarom is onderzocht of luchtfoto-interpretatie een bruikbaar hulpmiddel kan zijn, met name in de inventarisatie- en analysefase.

Enkele begrippen.

Recreatie is gedefinieerd als: verkwikking van lichaam of geest door activiteiten (of geplande in-activiteit) ondernomen uit vrije wil, zonder enige morele, economische, sociale of andere druk. Voor concrete onderzoeken kan deze veelomvattende definitie door zekere beperkingen operationeel gemaakt worden.

Toerisme kan op twee verschillende manieren worden gedefinieerd:

1. toerisme als een speciale (reizende) soort van recreatie;
2. toerisme als een economische activiteit, het leveren van goederen en diensten aan toeristen.

Wanneer gesproken wordt over de hulpbronnen van recreatie, heeft dit gewoonlijk slechts betrekking op de recreatie buiten de woonplaats. Hulpbronnen zijn alleen maar hulpbronnen wanneer de mens ze als zodanig herkent en waardeert en in staat is ze te gebruiken. Dit geldt ook voor de recreatie-hulpbronnen. Ze kunnen oorspronkelijke recreatie-hulpbronnen worden genoemd als ze niet in de eerste plaats zijn gemaakt of worden onderhouden ten behoeve van recreatief gebruik. De recreatievoorzieningen kunnen dan als daarvan afgeleid worden beschouwd.

Recreatievoorzieningen kunnen zo worden onderscheiden in voorzieningen die op de hulpbronnen berusten, meestal voorkomend in landelijke gebieden, en de op de gebruikers gerichte voorzieningen, overwegend in of nabij stedelijke agglomeraties.

Landwaardering is een methode of procedure, waarin bepaalde landgebruiken of landgebruikstypen, met hun behoeften, worden geconfronteerd met land (karterings) eenheden, met hun kenmerken en hoedanigheden, teneinde vast te stellen welke eenheden in welke mate geschikt zijn voor welke landgebruikstypen. Geschiktheid van land betekent daarbij geschiktheid voor duurzaam gebruik.

Onder *remote sensing* wordt gewoonlijk verstaan het opnemen en interpreteren van beelden van het aardoppervlak ten einde verschijnselen en processen op of bij dat oppervlak in kaart te brengen en in hun ontwikkeling te volgen. In die zin omvat remote sensing het hele scala van door multispectrale scanning tot stand gebrachte satellietbeelden tot aan foto's die vanuit een hoogspanningsmast zijn genomen.

Landwaardering ten behoeve van recreatie.

In landwaardering ten behoeve van recreatie zijn de landgebruikstypen verschillende vormen van recreatie waarvoor de landeenheden kunnen worden geïnterpreteerd op de aanwezigheid van hun recreatie-hulpbronnen. De recreatieve landgebruikstypen dienen te worden beschreven naar de activiteiten die plaats vinden. Deze activiteiten moeten zorgvuldig worden gedefinieerd en soms onderverdeeld in deel-activiteiten die elk hun eigen behoeften hebben met betrekking tot de hulpbronnen.

In de behoeften van de recreatieve landgebruikstypen kunnen drie verschillende aspecten worden onderscheiden: de *fysieke vereisten*, de *landschappelijke* kwaliteit en de *toegankelijkheid*. De betekenis die aan elk van deze drie aspecten kan worden toegekend zal per recreatievorm verschillen, en de vormen van recreatie kunnen dienovereenkomstig worden geclassificeerd. In een meer gedetailleerde classificatie worden nog twee andere aspecten betrokken: de vorm van ruimtegebruik: lineair, nodaal of oppervlakte dekkend; en het karakter van het gebruikte land: berg, bos, kust, water of landelijk. Daaraan kan nog een onderverdeling naar populariteit van de recreatie-activiteit worden toegevoegd.

De landeenheden dienen te worden beschreven naar hun kenmerken met betrekking tot fysieke geschiktheid, landschapsschoon en toegankelijkheid. Om de geschiktheid voor duurzaam gebruik te kunnen beoordelen moeten ook ecologische aspecten in de beschouwing worden opgenomen.

Om de behoeften van de landgebruikstypen te confronteren met de kenmerken en hoedanigheden van de landeenheden, moeten beide op dezelfde wijze met dezelfde parameters zo objectief mogelijk en bij voorkeur in kwantitatieve termen worden beschreven.

De "methode van de mogelijkheden".

Voor landwaardering ten behoeve van recreatie zou het logisch zijn om de vraag naar recreatie als uitgangspunt te nemen. Maar, het is moeilijk om deze vraag echt te bepalen en te meten. De vraag naar recreatie wordt beïnvloed door een aantal onderling verbonden factoren, die in drie groepen kunnen worden onderscheiden: gebruiker-gebonden, gebied-gebonden en gebruiker-gebied relaties. Bovendien kan een onderscheid gemaakt worden tussen werkelijke, verborgen en mogelijke vraag.

Er zijn verschillende manieren om de vraag naar recreatie te bepalen, maar de meeste zijn erg arbeidsintensief en tijdrovend en geven desondanks geen garantie dat ze volledig en alles omvattend zijn. Daarom wordt het de moeite waard geacht om te bekijken of het mogelijk is de vraag op indirecte wijze te benaderen door de aanbodzijde te onderzoeken. Dit is de "methode van de mogelijkheden", die begint met een inventarisatie van de recreatieve infrastructuur, het geheel van recreatievoorzieningen.

Doelstelling 1 is daarom geworden het beantwoorden van de vraag, of de recreatieve landgebruikstypen kunnen worden geïdentificeerd door middel van de voorzieningen. Daarvan is *doelstelling 2* afgeleid: het beantwoorden van de vraag of de recreatievoorzieningen met een voldoende mate van betrouwbaarheid kunnen worden geïdentificeerd met behulp van remote sensing.

Het bepalen van de nauwkeurigheid van luchtfoto-interpretatie.

Te bepalen hoe goed de verschillende categorieën recreatie- voorzieningen kunnen worden geïdentificeerd op luchtfoto's is op zichzelf niet gemakkelijk. Om te bepalen hoe nauwkeurig de interpretatie is moet deze vergeleken worden met andere bronnen van informatie over dezelfde categorie. Maar het is de vraag of deze bronnen zelf wel altijd nauwkeurig zijn. Zelfs met eenvoudige waarnemingen in het veld is het niet altijd gemakkelijk om de objecten van onderzoek duidelijk te identificeren. Het voorbeeld van de nauwkeurigheid waarmee boerderijen konden worden geïnterpreteerd in de omgeving rond Enschede is een illustratie van dit dilemma.

Daar komt bij dat er verschillen in nauwkeurigheid zullen optreden tussen individuele interpretatoren, afhankelijk van hun vaardigheid, ervaring en kennis van het onderzoeksthema en gebied. Dit wordt geïllustreerd aan de hand van tellingen van huizen in onderzoek gedaan in Italië en Spanje.

De luchtfoto-interpretatie van recreatievoorzieningen.

De recreatievoorzieningen zijn onderscheiden in primaire voorzieningen, de verblijfsaccommodatie en de infrastructuur voor de toegankelijkheid, en de secundaire voorzieningen of vermaaksvoorzieningen.

De interpretatie van verblijfsaccommodatie.

Van de verblijfsaccommodatie omvat de categorie hotels en restaurants een groot scala van typen gebouwen. Onderzoek in Nederland, Spanje, Thailand en Indonesië dient om de interpreteerbaarheid van deze categorie te bepalen.
Een andere categorie van verblijfsaccommodatie zijn de kampeerterreinen die uiteenlopen van heel eenvoudig tot zeer luxe. Voorbeelden uit Nederland en Spanje illustreren de mogelijkheden om kampeerterreinen met behulp van luchtfoto-interpretatie te inventariseren, hun gebied te omlijnen en hun bezettingsgraad te bepalen.
De derde categorie van verblijfsaccommodatie, de tweede woningen, kent ook een grote verscheidenheid. Ze kunnen in complexen gegroepeerd voorkomen, maar ook individueel in het landschap zijn verspreid. Voorbeelden uit Nederland, Spanje, Thailand en Indonesië dienen om de mogelijkheden voor betrouwbare luchtfoto-interpretatie van deze categorie te bepalen.

De interpretatie van secundaire voorzieningen.

Ook de secundaire voorzieningen omvatten een grote verscheidenheid. Er zijn voorbeelden uit Nederland, Groot-Brittannië en Spanje van de interpretatie van sportvelden. De interpreteerbaarheid van voorzieningen voor het zwemmen wordt geïllustreerd met voorbeelden uit Nederland en Spanje. Verder worden verscheidene voorbeelden van andere sportvoorzieningen besproken.
Met betrekking tot de interpretatie van voorzieningen voor informele activiteiten, zoals voorzieningen voor de watersport, voorzieningen voor het wandelen, attracties om te bezoeken, vermaaksvoorzieningen en volkstuinen worden de resultaten van verscheidene onderzoeken besproken.

De interpretatie van de ontsluitings-infrastructuur.

De infrastructuur voor de toegankelijkheid, of ontsluitings-infrastructuur, maakt deel uit van de primaire voorzieningen en het netwerk van wegen is de belangrijkste categorie ervan. Het onderzoek in de omgeving van Enschede dient om de nauwkeurigheid van luchtfoto-interpretatie voor deze categorie te bepalen.

De interpretatie van de relatie tussen voorzieningen en hulpbronnen.

Doelstelling 3 is antwoord te geven op de vraag of remote sensing kan onthullen met welke hulpbronnen de recreatievoorzieningen, en dus de daarmee samenhangende recreatieve landgebruikstypen, klaarblijkelijk zijn verbonden. Het is niet strikt noodzakelijk dat de voorzieningen daartoe met luchtfoto-interpretatie zijn geïdentificeerd. Wanneer de plaats van deze voorzieningen bekend is kunnen luchtfoto's worden gebruikt om hun verhouding tot de andere landschapselementen te onderzoeken.
Doelstelling 4 is te antwoorden op de vraag of de relaties bedoeld in doelstelling 3 gedefinieerd kunnen worden in parameters, die zowel met behulp van remote sensing kunnen worden geïdentificeerd, als van betekenis zijn voor de procedure van landwaardering.
Onderzoek van de relatie tussen voorzieningen en hulpbronnen en het bepalen van parameters wordt geïllustreerd met voorbeelden uit Nederland en Thailand.

Analyse van ontwikkelingsprocessen.

Doelstelling 8 is het beantwoorden van de vraag of het gebruik van opeenvolgende series van luchtfoto's of andere remote sensing beelden aanzienlijk kan bijdragen tot het verschaffen van de informatie waarop de overige doelstellingen gericht zijn.
Reeksen van luchtfoto's of satellietbeelden van verschillende tijd kunnen worden gebruikt voor *monitoring*, waarnemen om te waarschuwen. Echte monitoring, het op de voet volgen van

ontwikkelingen, op het gebied van recreatie gebeurt zeer weinig, omdat het oplossende vermogen van satellietbeelden te grof is en de kosten van het herhalen van luchtfotovluchten veelal te hoog. Meer gebruikelijk is het gebruik van bestaande series luchtfoto's voor het vergelijken van de huidige toestand met situaties in het verleden en de verschillen te onderzoeken in retrospectieve (=terugblikkende) monitoring. In zowel echte als retrospectieve monitoring wordt gewoonlijk slechts één fotobedekking gebruikt voor het maken van een volledige alles omvattende basiskaart. De andere bedekkingen worden dan slechts vergeleken op verschillen, die dan worden aangegeven op een kopie van die kaart. Veranderingen kunnen worden gepresenteerd in een speciale veranderingen-kaart en/of in een (kruis)tabel.
Op het gebied van recreatie worden de meest voor de hand liggende veranderingen veroorzaakt door de fysieke voorzieningen. Met name wanneer de ontwikkeling in een spontaan geleidelijk proces verloopt is dit moeilijk te herkennen. In zulke gevallen kan interpreteren van opeenvolgende series luchtfoto's het proces onthullen en mogelijk zelfs een patroon daarin duidelijk maken. De factoren die de geschiktheid en/of aantrekkingskracht van de recreatieve hulpbronnen bepalen kunnen uit zo'n analyse duidelijker naar voren komen. Maar, zelfs bij het gebruik van reeksen van verschillende tijd kan luchtfoto-interpretatie slechts een deel van de antwoorden geven.
De mogelijkheden van het interpreteren van reeksen luchtfoto's worden geïllustreerd met voorbeelden uit Zweden, USA, Spanje, Thailand en Nederland. De mogelijkheden van SPOT satelliet-beelden voor het analyseren van ontwikkelingen in de recreatie worden besproken aan de hand van een voorbeeld uit Thailand.

Onderzoek van het ruimtelijke gedrag van recreanten.

Recreatie activiteiten zijn niet gelijkmatig verspreid over ruimte noch tijd. Er zijn concentratiepunten naast gebieden die bijna ongebruikt zijn, en pieken in tijd naast perioden met haast geen gebruik. Recreatie-activiteiten zijn bovendien niet noodzakelijk beperkt tot de recreatievoorzieningen. Daarom is voor een goede beheersplanning van recreatie-hulpbronnen gedetailleerde informatie nodig over het ruimtelijke gedrag van recreanten binnen een landschap of landschapselement, alsmede van de tijdsdimensie in dat gedrag. Er zijn twee benaderingen onderscheiden van het gebruik van luchtfoto-interpretatie voor het verkrijgen van dergelijke informatie op een manier die in verhouding tot de kosten vrij doelmatig is. In *indirecte monitoring* wordt het ruimtelijke gedrag van recreanten onderzocht aan de hand van de zichtbare gevolgen daarvan op de omgeving. Dit leidt tot *doelstelling 6*, het antwoorden op de vraag of de invloed van recreatie op het landschap kan worden geïnventariseerd met behulp van remote sensing, en zo ja, welke informatie daaruit kan worden verkregen, die van belang is voor landwaardering ten behoeve van recreatie.
In *directe monitoring* worden de recreanten zelf en/of hun voer- of vaartuigen geïdentificeerd en hun ruimtelijke verspreiding over het terrein geanalyseerd, bij voorkeur op reeksen van luchtfoto's. Dit leidt tot *doelstelling 7*, het beantwoorden van de vraag of recreanten zelf, dan wel hun voertuigen of uitrusting, kunnen worden ontdekt op luchtfoto's met een voldoende mate van nauwkeurigheid, en zo ja, of dit bijdraagt tot informatie die van belang is voor landwaardering ten behoeve van recreatie.

Onderzoek van de invloed van recreatie.

Onderzoek van de invloed van recreatie op de omgeving kan niet alleen een indruk geven van het ruimtelijke gedrag van recreanten, maar is ook op zichzelf van belang. Het laat zien welke delen van het landschap meer schade ondervinden van recreatie en welke minder. Drie hoofdgroepen van invloed worden besproken. De mogelijkheden om met luchtfoto-interpretatie de *invloed van fysieke voorzieningen* te onderzoeken al eerder aan de orde gekomen. Het gebruik van luchtfoto-interpretatie voor het onderzoeken van de *invloed op dieren* is grotendeels beperkt tot het analyseren en monitoren van de verschillende soorten leefgebieden die beschikbaar zijn. Van de *invloed op vegetatie* is de meeste aandacht uitgegaan naar de invloed van betreding.

De invloed van betreding kan in verschillende fasen worden onderscheiden: van geringe onttakeling via zware aftakeling tot volledig verdwijnen van de vegetatie. Alleen deze laatste fase in het proces van recreatieve erosie kan meer of minder gemakkelijk worden onderzocht met luchtfoto-interpretatie. Deze door recreatie veroorzaakte erosie is een geleidelijk proces waarin zich per tijdseenheid talrijke kleine bijna onwaarneembare veranderingen voordoen. Vaak kan de omvang van die veranderingen en hun cumulatieve effect pas werkelijk beoordeeld worden door het vergelijken van reeksen van luchtfoto's.

Het interpreteren van recreatieve erosie.

Voorbeelden van het gebruik van luchtfoto-interpretatie voor onderzoek van recreatieve erosie uit Denemarken, Duitsland en Nederland worden besproken. Het subjectieve element in de interpretatie wordt geanalyseerd door twee interpretaties van één gebied op Schiermonnikoog te vergelijken.

Vergelijkingen van recreatieve erosie worden doorgaans uitgedrukt in pad-dichtheden en omvang van kale gebieden. Bovendien kan ook het patroon van de wilde paden worden geanalyseerd. Drie hoofd-typen zijn onderscheiden: het *evenwijdige padenpatroon*, het *straalsgewijze padenpatroon* en het *uitwaaierende padenpatroon*.

Deze patronen kunnen in verband worden gebracht met gedragskenmerken van de recreanten. Zodoende kan een inventarisatie en analyse van de effecten van recreatieve betreding een meer gedetailleerde aanwijzing geven van het verband tussen bepaalde vormen van recreatie en bepaalde landschapselementen en ook iets duidelijk maken over het ruimtelijke gedrag van de recreanten.

Ook water- en oevervegetatie kunnen worden beïnvloed door recreatie. Het onderzoeken van deze invloeden met behulp van luchtfoto-interpretatie wordt geïllustreerd met een aantal voorbeelden uit Nederland.

Onderzoek naar watersport vanuit de lucht.

In directe monitoring is in Nederland veel ervaring opgedaan vooral met onderzoek naar watersport. De groeiende betekenis van watersport leidt tot een toenemende druk op de hulpbronnen. Voor een optimaal beheer van deze hulpbronnen is informatie nodig over het aantal boten dat in een gebied aanwezig is, over hoeveel van deze boten daadwerkelijk uitvaart op een representatieve dag en wat het vaar-lig-gedrag van de watersporters is in ruimte en tijd. Met name om het laatste deel van die vraag te beantwoorden lijkt onderzoek vanuit de lucht een logische oplossing. De voordelen schijnen de nadelen te overtreffen. Natuurlijk moet beseft worden dat luchtfoto's als enige hulpmiddel niet voldoende zijn.

De keuzes tussen visuele waarneming, verticale of vogelvlucht luchtfoto's, en van het type camera, het fotografische materiaal, de vlieghoogte en de schaal hangen samen. De in Nederland uitgevoerde onderzoeken naar watersport zijn op deze aspecten met elkaar vergeleken. De interpreteerbaarheid van pleziervaartuigen wordt besproken, evenals de argumenten voor de keuze van dag(en) en tijd(en) waarop de vlucht moet worden uitgevoerd en de frequentie waarmee deze vlucht gedurende een dag of het seizoen moet worden herhaald. Er zijn onderzoeken met een hoge graad van herhaling, met verscheidene vluchten op één dag, maar ook met slechts één of twee vluchten per dag.

Dit speciale soort onderzoek vereist ook speciale interpretatie en uitwerkingsmethodes en -procedures. Boten worden geïdentificeerd en aangegeven op een kaart ongeveer of precies op de plaats waar ze zich tijdens het moment van de vlucht bevinden, onderscheiden naar type boot en naar varend en liggend of afgemeerd. De mogelijkheid om de nauwkeurigheid van tellingen op luchtfoto's te bepalen wordt besproken evenals het belang van deze nauwkeurigheid. Het spreidingspatroon van boten over het water geeft aan welke delen van het gebied klaarblijkelijk meer aantrekkingskracht hebben en welke minder. Dit kan een idee geven hoe een watersport gebied optimaal te beheren. Om die reden zijn in bijna alle onderzoeken naar watersport de dichtheden van boten per gebiedseenheid en/of per oeverlengte bepaald en zijn dichtheids-patronen geanalyseerd.

Niet alleen ruimtelijke patronen zijn op deze manier ontdekt, maar ook gedragspatronen in de tijd. Een groot deel van de boten dat op een zekere dag uitvaart kan gedurende het grootste deel van die dag liggend langs de oever worden aangetroffen. Dus wordt de capaciteit van een watersportgebied eerder door de lengte aan bruikbare oever dan door het oppervlak aan water bepaald.

Het monitoren van oever- en landrecreatie.
Soortgelijk onderzoek is uitgevoerd voor strand- en oever-recreatie. In dergelijk onderzoek moet de schaal van de luchtfoto's veel groter zijn omdat de voorwerpen die geïdentificeerd moeten worden veel kleiner zijn: personen, tenten, auto's, zeilplanken, rubberboten, enzovoort. Zowel verticale als vogelvlucht opnamen zijn gebruikt en twee Nederlandse onderzoeken zijn vergeleken. Ook in dit geval zijn de keuze van de juiste dag en tijd en van een zekere frequentie van herhaling van belang voor een optimaal resultaat. Absolute nauwkeurigheid en ruimtelijke spreidingspatronen in samenhang met verschillende sectoren van het strand en afstandszones tot de waterlijn worden besproken.
Onderzoeken vanuit de lucht voor direct monitoren van recreatie op het land zijn minder talrijk dan die voor recreatie op het water en langs de kust of oever. Toch zijn er enkele voorbeelden bekend. Vaak is het de auto waarop de interpretatie wordt gericht. Twee voorbeelden uit Groot-Brittannië van op auto's gericht onderzoek worden besproken. Voor een op personen gericht onderzoek is met redelijk resultaat een filmcamera, die met een bepaald tijdsinterval beelden opneemt, gebruikt in een stedelijke omgeving in de Verenigde Staten.

Verband leggen tussen recreatie en zijn hulpbronnen.

Door inventarisatie van recreatievoorzieningen, onderzoek van de invloed van recreatie, of het direct monitoren van recreanten of hun voertuigen, kan het ruimtelijke patroon van de recreatie duidelijk gemaakt worden. Wanneer reeksen van luchtfoto's van verschillende tijd worden gebruikt kan ook het tijdsaspect van dat patroon worden bevat. Analyse van dat patroon kan duidelijk maken met welk element in het landschap bepaalde vormen van recreatie verbonden zijn en een aanwijzing geven van hun behoeften met betrekking tot de hoedanigheden van het land. De kenmerken van de hulpbronnen, die klaarblijkelijk die hoedanigheden bevatten, kunnen dan vergeleken worden met die van andere landschapselementen in hetzelfde gebied of met gelijksoortige elementen in andere gebieden om inzicht te krijgen in de factoren die bepalen of een landschapselement een recreatieve hulpbron wordt of niet. Alle drie aspecten van geschiktheid voor recreatie moeten natuurlijk in deze beschouwing betrokken worden.
Wanneer uit dit onderzoek van werkelijk recreatief gebruik de hulpbronnen eenmaal bekend zijn geworden, kunnen landschapselementen, die dezelfde parameters hebben in alle drie geschiktheidsaspecten, geïnventariseerd worden ook in gebieden waar geen werkelijk gebruik is waargenomen. Dit kan een idee geven van het beschikbare potentieel dat ontwikkeld kan worden. De redenen voor het ontbreken van gebruik moeten worden onderzocht. Vergelijking van werkelijke recreatieve hulpbronnen met potentiële hulpbronnen kan laten zien welke factoren het gebruik of niet-gebruik door recreatie bepalen en zou gebruikt kunnen worden om de definitie van parameters te verfijnen.
De mate, waarin men moet ingrijpen in een bestaande situatie om een optimaal functioneren te benaderen, kan als maat voor geschiktheid genomen worden. Het is beter om niet alle geschiktheidsfactoren in één formule samen te vatten. Naast de fysieke geschiktheid, het landschapsschoon en de toegankelijkheid dient ook de draagkracht te worden beoordeeld. Drie soorten draagkracht voor recreatief gebruik kunnen worden onderscheiden: fysieke, ecologische en psychologische.

Drie benaderingen van landwaardering ten behoeve van recreatie.

In landwaardering ten behoeve van recreatie zijn in hoofdlijnen drie benaderingen onderscheiden: de *recreatie-benadering*, die min of meer op de gebruiker is gericht; de *toerisme-benadering*, die meer met de hulpbronnen verbonden is; en de *natuurbehouds-benadering*, waarin prioriteit wordt gegeven aan de belangen van natuur en milieu. Elk van deze benaderingen kan worden uitgevoerd of verkennend, half-gedetailleerd of gedetailleerd niveau, behalve de natuurbehoudsbenadering die misschien meteen op half-gedetailleerd niveau zou moeten beginnen.

Amerikaanse, Britse en Duitse voorbeelden van de recreatie- benadering worden besproken. De toerisme-benadering wordt geïllustreerd aan de hand van het voorbeeld van Botswana. Verscheidene voorbeelden van de natuurbehoudsbenadering worden genoemd.

Remote sensing van recreatie-hulpbronnen.

Doelstelling 5 is het beantwoorden van de vraag of de recreatie- hulpbronnen met betrouwbaarheid kunnen worden geïnventariseerd met behulp van remote sensing, met name wanneer parameters als genoemd in doelstelling 4 worden toegepast.

Interpreteerbaarheid van fysieke geschiktheid en toegankelijkheid.

De vraag van doelstelling 5 kan niet in zijn algemeenheid worden beantwoord. Voor de verschillende categorieën hulpbronnen die verbonden zijn met fysieke geschiktheid: wateroppervlaktes, stromen en watervallen, oevers en bos, alsmede voor wegen, de voornaamste ontsluitings-infrastructuur categorie, wordt de interpreteerbaarheid afzonderlijk in meer detail besproken.

Interpreteerbaarheid van landschapsschoon.

Er zijn gebieden die niet of weinig gebruikt worden door recreatie maar er toch van grote betekenis voor zijn, omdat ze het landschappelijke decor voor de recreatie-activiteiten vormen.
Het analyseren en bepalen van landschapsschoon is het onderwerp van landschapswaardering. Het landschapsschoon of de esthetische waarde van het landschap wordt bepaald door de visuele structuur ervan. In de waardering van landschapsschoon speelt subjectiviteit een grote rol. Methoden waarin beroepsdeskundigen en publiek worden betrokken om deze subjectiviteit verstandelijk te verklaren en begrijpen worden aangegeven. Ook het werkelijke ruimtelijke gedrag van recreanten kan als een aanwijzing worden beschouwd. De landschapselementen, waarvan uit onderzoek van het gedrag van recreanten blijkt, dat ze klaarblijkelijk de voorkeur genieten, kunnen geïnventariseerd worden. Deze landschaps-elementen kunnen beschouwd worden als bepalend voor de visuele structuur van het landschap. De analyse van deze visuele structuur kan een eerste, objectieve stap zijn in de landschaps-waardering. Verwezen wordt naar de benadering die in Duitsland is ontwikkeld door Kiemstedt en naar verscheidene Nederlandse methodes. Voor de inventarisatie- en analysefase in deze methodes zijn aanvankelijk topografische kaarten als voornaamste bron van informatie gebruikt naast veldwaarnemingen. Waarden worden vaak uitgedrukt ver vierkant. Latere methoden berusten in sterkere mate op luchtfoto-interpretatie en ook satellietbeelden zijn de laatste tijd gebruikt.
De visuele structuur van het landschap bepaalt welk deel ervan kan worden gezien vanuit een bepaald punt, en ook wat de inhoud en samenstelling van de aanwezige uitzichten is. Daarom neemt het bepalen van zichtlijnen en uitzichtsgebieden een centrale plaats in de meeste onderzoeken naar landschapsschoon.
Het waarderen van landschapsschoon zal altijd afhangen van de persoon of groep die het landschap ervaart en kan bovendien onderhevig zijn aan veranderingen in de loop van de tijd.

De nauwkeurigheid van landwaardering voor recreatie.

De vraag, hoe nauwkeurig de landwaardering voor recreatie is of kan zijn kan niet eenvoudig worden beantwoord. In de eerste plaats is het moeilijk om te bepalen wat eigenlijk de nauwkeurigheid van landwaardering is. Twee belangrijke aspecten van nauwkeurigheid kunnen worden onderscheiden: de betrouwbaarheid van de identificatie, die samenhangt met de volledigheid van de inventarisatie, en de betrouwbaarheid van de omlijning, die de resultaten van metingen beïnvloedt van zowel de recreatieve landgebruikstypen als van de recreatieve hulpbronnen. Bovendien is er nog een nauwkeurigheidsaspect verbonden aan het koppelen van deze beide in de bepaling van de geschiktheid, maar het blijkt onmogelijk om daarvan een duidelijke definitie te geven.

Het is niet alleen moeilijk om goed te definiëren wat beschouwd moet worden als de nauwkeurigheid van landwaardering voor recreatie, maar het is bijna, zo niet helemaal onmogelijk om die nauwkeurigheid te bepalen. Er schijnt geen mogelijkheid te zijn voor een objectieve kwaliteitscontrole. Dit maakt het des te noodzakelijker om de procedure helder en doorzichtig te maken en alle stappen, aannames en criteria te documenteren. Op deze manier zou iemand anders, die de procedure herhaalt met dezelfde gegevens, aannames en criteria dezelfde resultaten moeten verkrijgen. Het maakt het ook mogelijk, dat anderen de procedure kritisch kunnen onderzoeken en van commentaar voorzien en zo bijdragen tot verbeteringen, zodat tenslotte de methode algemeen aanvaard kan worden als een betrouwbaar hulpmiddel, zelfs als geen precieze nauwkeurigheid kan worden gemeten.

7.2. CONCLUSIES.

Vanuit het algemene doel van het onderzoek zijn doelstellingen afgeleid, geformuleerd als te beantwoorden vragen. De conclusies zullen per doelstelling gepresenteerd worden.

Doelstelling 1.

Kunnen de recreatieve landgebruikstypen via de voorzieningen worden geïdentificeerd?
Deze vraag kan niet in zijn algemeenheid positief worden beantwoord. Met de 'methode van de mogelijkheden' kan geen volledig alles omvattend overzicht worden verkregen van het recreatiepatroon in een gebied. Noch bestaat er altijd een duidelijke betrekking tussen een soort voorziening en een bepaalde vorm van recreatief landgebruik. Toch kan op deze manier een globale indruk van het ruimtelijke patroon van de recreatie worden verkregen, naast een meer gedetailleerd overzicht van een beperkt aantal bijzondere recreatieve landgebruikstypen. Het maakt deze benadering een bruikbaar instrument voor een snelle algehele verkenning.
En omdat het erg moeilijk is om zelfs op verkenningsniveau uit bestaande bronnen of gegevens-bestanden een alles omvattend bij-de-tijds overzicht van recreatievoorzieningen te krijgen, blijft het de moeite waard om te onderzoeken of het mogelijk is deze voorzieningen met behulp van remote sensing te inventariseren.

Doelstelling 2.

Kunnen de recreatievoorzieningen met behulp van remote sensing worden geïdentificeerd met een voldoende mate van betrouwbaarheid?
Het antwoord op deze vraag is beperkt tot voorzieningen die in landelijke gebieden voorkomen en verschilt naar gelang van het soort voorziening.
Hotels en restaurants kunnen niet met hoge graad van nauwkeurigheid worden geïdentificeerd op luchtfoto's. Maar het is met name in een landelijke omgeving mogelijk aan te geven welke gebouwen tot deze categorie zouden kunnen horen, de veld-waarnemingen alleen op deze punten te concentreren en zo te komen tot een min of meer volledige inventarisatie met een minimum aan inspanning. Zo kan luchtfoto-interpretatie toch nuttig zijn, met name in omstandigheden waar andere bronnen van gegevens schaars of verre van volledig zijn.
Een inventarisatie van kampeerterreinen kan met luchtfoto-interpretatie nagenoeg volledig en betrouwbaar worden gemaakt, hoewel niet overal met 100% nauwkeurigheid. Ook de omgrenzing van het gebied van een kampeerterrein kan vrij nauwkeurig worden gedaan. Om de bezettingsgraad van kampeerterreinen vast te stellen moeten veldwaarnemingen gelijktijdig met de fotovlucht worden gedaan en dat is alleen maar mogelijk in speciale onderzoeken.
Voor een inventarisatie van tweede woningen kan luchtfoto-interpretatie geen volledige en betrouwbare resultaten leveren. Wanneer ze in complexen bijelkaar voorkomen is interpretatie niet zo'n groot probleem, maar interpreteren van de tweede woningen die individueel verspreid in het landschap voorkomen is nagenoeg onmogelijk. Zelfs met eenvoudige veldwaarnemingen is het dan niet gemakkelijk om tweede woningen als zodanig zonder twijfel

te identificeren. Maar het is mogelijk om met luchtfoto-interpretatie alle gebouwen en voorwerpen, die tweede woningen zouden kunnen zijn, te markeren en zo een efficiënter veldwerk programma mogelijk te maken. Op deze manier kan luchtfoto-interpretatie toch nuttig zijn, zeker omdat gegevens over deze categorie zelden beschikbaar zijn.
De verscheidenheid aan sportvoorzieningen is zo groot dat geen algemene conclusie kan worden getrokken. Sommige soorten voorzieningen kunnen met bijna 100% nauwkeurigheid worden geïdentificeerd, andere zijn veel minder gemakkelijk te identificeren of zijn in het geheel niet identificeerbaar. Hetzelfde geldt voor attracties voor bezoek en vermaaksvoorzieningen. De meeste soorten watersportvoorzieningen kunnen worden geïnterpreteerd met voldoende betrouwbaarheid en volledigheid. Toch zijn ook hieronder bepaalde voorzieningen die moeilijk te ontdekken zijn.
Een consistente interpretatie van het netwerk van voetpaden, de belangrijkste voorziening voor wandelen, is niet mogelijk. Maar in de interpretatie van volkstuinen kan een nauwkeurigheid van bijna 100% worden bereikt.
Met betrekking tot de ontsluitings-infrastructuur, behalve de voetpaden, is de conclusie dat luchtfoto-interpretatie een bij de tijd gebrachte indruk van het gehele netwerk van wegen kan verschaffen, met goede nauwkeurigheid van de totale lengte aan wegen. Dit is met name van betekenis voor situaties waarvan geen grootschalige recente topografische kaarten beschikbaar zijn.
Voor een gedetailleerde onderverdeling in verschillende categorieën van wegen is de nauwkeurigheid niet groot genoeg in de meeste Europese situaties. Maar in veel gevallen zijn in ontwikkelingslanden dergelijke gedetailleerde onderverdelingen niet van toepassing en kan de interpretatie-nauwkeurigheid dus groter zijn. Luchtfoto's kunnen niets zeggen over de mate van recreatief gebruik van wegen, noch over de juridische, sociale en economische aspecten van toegankelijkheid.

Dus, luchtfoto-interpretatie kan slechts voor een beperkt aantal soorten voorzieningen een redelijk volledige en nauwkeurige inventarisatie leveren, maar geen algehele inventarisatie van alle typen. Desondanks wordt het toch een nuttig instrument geacht voor het verkrijgen van een eerste indruk van de beschikbaarheid en met name de ruimtelijke spreiding van verschillende soorten voorzieningen. Het kan helpen vast te stellen welke andere manieren om informatie te verkrijgen gebruikt moeten worden voor welke voorzieningen. Het gebruik van luchtfoto-interpretatie is vooral van belang, waar andere bronnen van gegevens onvolledig zijn of zelfs geheel ontbreken. Satellietbeelden zijn in het geheel niet geschikt voor de interpretatie van recreatievoorzieningen.

Doelstelling 3.

Kan remote sensing onthullen met welke hulpbronnen de recreatievoorzieningen, en dus de daarmee samenhangende landgebruikstypen, klaarblijkelijk zijn verbonden?
Voor dit soort analyse is het van geen betekenis of de voorzieningen zelf geïnventariseerd zijn met behulp van luchtfoto-interpretatie of op andere wijze. Hoewel aan luchtfoto-interpretatie een aantal beperkingen verbonden is, biedt het toch een beter en vollediger overzicht van het landschap dan menig andere benadering en dus een unieke gelegenheid om de betrekkingen tussen recreatievoorzieningen en hun hulpbronnen
te onderzoeken. Het gebruik van reeksen van luchtfoto's van verschillende tijd kan dit zelfs versterken. De benadering is met name van belang voor gebieden waar de betrekkingen tussen recreatie en zijn hulpbronnen nog niet of nauwelijks zijn onderzocht.

Doelstelling 4.

Kunnen de betrekkingen bedoeld in doelstelling 3 worden gedefinieerd in parameters die zowel identificeerbaar zijn met remote sensing als van betekenis voor de procedure van landwaardering?
De conclusie moet zijn, dat dit in het algemeen niet mogelijk is, omdat ofwel geen parameters kunnen worden gedefinieerd, ofwel deze niet op consistente wijze kunnen worden

geïdentificeerd met behulp van remote sensing. Het gebruik van reeksen van luchtfoto's van verschillende tijd helpt slechts in een aantal gevallen.

Doelstelling 5.

Kunnen de hulpbronnen voor recreatie consistent geïnventariseerd worden met behulp van remote sensing, met name bij toepassing van de parameters genoemd in doelstelling 4?

Wanneer is vastgesteld, welke elementen in het landschap als hulpbronnen voor recreatie moeten worden beschouwd, en parameters om hun mate van geschiktheid te meten zijn gedefinieerd, kan in de meeste gevallen de identificatie van deze hulpbronnen met behulp van luchtfoto-interpretatie routine-matig gedaan worden. Maar, er zijn ook parameters die moeilijk te identificeren zijn, en niet alle informatie kan worden verzameld met luchtfoto-interpretatie. Dus, vele hulpbronnen voor recreatie kunnen consistent worden geïnventariseerd met behulp van remote sensing, maar niet alle. Noch kunnen alle aspecten van de hulpbronnen voor recreatie uit luchtfoto's worden afgeleid.

Met name met betrekking tot het landschapsschoon zijn de mogelijkheden van remote sensing ernstig beperkt. Hoewel, vele benaderingen gaan uit van een inventarisatie van talrijke gegevens over landschapselementen en luchtfoto-interpretatie kan daartoe dikwijls het meest gedetailleerde resultaat op een efficiënte manier leveren. Zelfs SPOT satellietbeelden zijn in een aantal gevallen met succes gebruikt.

Toepassen van luchtfoto-interpretatie en andere remote sensing technieken op de vele aspecten, die kunnen worden geïdentificeerd, en het reserveren van andere benaderingen voor die aspecten, die niet identificeerbaar zijn, kan bijdragen tot een efficiënte voorbereiding voor landwaardering ten behoeve van recreatie. Nogmaals, deze benadering is met name van belang voor gebieden waarvoor andere bronnen van informatie onvoldoende zijn.

Doelstelling 6.

Kan de invloed van recreatie op het landschap met behulp van remote sensing worden geïnventariseerd, en zo ja, kan dit informatie opleveren die van betekenis is voor landwaardering voor recreatie?

De invloed, die fysieke voorzieningen op hun omgeving hebben, kan met dezelfde nauwkeurigheid worden geïnventariseerd, als waarmee deze voorzieningen zelf kunnen worden geïnterpreteerd. Zie doelstelling 2.

De invloed van recreatie op de vegetatie kan slechts worden geïnterpreteerd van luchtfoto's, wanneer het uiterste stadium van het vertrappingsproces is bereikt: wilde paden en kale gebieden. Voor het vaststellen van absolute waarden en zeer nauwkeurige plaatsbepaling van de invloed is luchtfoto-interpretatie niet echt geschikt, vanwege de te hoge graad van subjectiviteit of het gebrek aan overeenstemming tussen individuele interpretatoren.

Maar luchtfoto-interpretatie is uitermate geschikt voor het vergelijken van verschillende situaties in ruimte en/of tijd, wanneer de interpretatie door dezelfde persoon wordt uitgevoerd.

Het is dan in feite de enige methode om de resultaten van een zeer geleidelijk proces te laten zien. De methode heeft het meeste succes in open terrein en is minder toepasbaar in gebieden met bos of hoogopgaande vegetatie.

De analyse van de patronen van wilde paden, waarvoor luchtfoto's ook zeer geschikt zijn, kan interessante informatie opleveren over het ruimtelijke gedrag van recreanten. Luchtfoto-interpretatie zou gecombineerd moeten worden met andere methoden van onderzoek om de informatie nog meer van betekenis te laten zijn voor landwaarderingsdoeleinden.

Het onderzoeken van de invloed van recreatie op water- en oevervegetatie met behulp van remote sensing is tot dusverre minder geslaagd.

De invloed van recreatie op dieren kan als zodanig niet worden geïnventariseerd met remote sensing. Toch kan remote sensing bijdragen aan onderzoek naar dit soort invloed. De inventarisatie en analyse van verschillende typen leefgebied en van veranderingen in hun omvang en karakter is in een aantal gevallen gedaan met behulp van remote sensing. Ook het tellen van dieren kan gedaan worden met remote sensing of met visuele waarnemingen vanuit de lucht.

Natuurlijk zijn er veel meer soorten invloed van recreatie op het milieu, maar de kansen om die met behulp van remote sensing te identificeren zijn klein, zo niet onmogelijk.
De toepassing van luchtfoto-interpretatie in onderzoek naar de invloed van recreatie is van belang voor zowel ontwikkelde als ontwikkelingslanden. Dergelijk onderzoek kan laten zien welke delen van het landschap het meest waarschijnlijk beïnvloed zullen worden en/of het meest gevoelig zijn voor beïnvloeding. Dit soort informatie is vooral van belang met betrekking tot het aspect van duurzaam gebruik in de procedure voor landwaardering.

Doelstelling 7.

Kunnen recreanten en/of hun voertuigen of uitrusting op luchtfoto's met voldoende nauwkeurigheid ontdekt worden, en zo ja, draagt dit bij tot informatie die van belang is voor landwaardering voor recreatie?
De meeste ervaring is opgedaan in onderzoek naar watersport. Er zijn zoveel verschillende benaderingen geweest, dat het moeilijk is tot een algemene conclusie te komen. De graad van nauwkeurigheid, waarmee pleziervaartuigen op luchtfoto's kunnen worden ontdekt, is misschien niet altijd goed genoeg voor statistische doeleinden, maar gewoonlijk wel om een goede indruk te geven van de ruimtelijke spreiding. Dit ruimtelijke patroon kan weer aanwijzingen geven over de betrekkingen tussen deze vorm van recreatie en zijn hulpbronnen in meer detail dan met een inventarisatie van voorzieningen mogelijk is. Het ruimtelijke patroon kan worden geanalyseerd op een enkele luchtfoto-bedekking, wanneer die op de juiste tijd is gevlogen. Maar het gebruik van reeksen van luchtfoto's, of van verkennings-vluchten met visuele waarneming, gedurende één dag, één seizoen of over verscheidene jaren, kan duidelijk bijdragen niet alleen aan de hoeveelheid informatie, maar ook aan de waarde ervan, door de tijdsdimensie van het gedragspatroon er aan toe te voegen.
Ook auto's kunnen gemakkelijk op de meeste luchtfoto's worden waargenomen en worden gebruikt als aanwijzing van ruimtelijke concentraties van recreanten in omstandigheden waarin het niet-recreatieve gebruik van auto's verwaarloosbaar geacht mag worden.
Voor het identificeren van personen zijn luchtfoto's van grote schaal nodig. Dit soort onderzoek kan alleen maar met goed gevolg worden uitgevoerd met foto's, die speciaal voor dat doel gemaakt zijn. Voor oever-recreatie zijn goede resultaten verkregen met betrekking tot het herkennen en analyseren van het ruimtelijke spreidingspatroon. Ook in deze toepassing kunnen reeksen van foto's de tijdsdimensie toevoegen en dus bijdragen tot de informatiewaarde. Een alternatief voor speciale fotovluchten kan in dit geval zijn het gebruik van een op een hoog punt in het terrein geplaatste camera, die met een bepaalde interval opnames maakt. Maar dan kunnen slechts betrekkelijk kleine gebieden worden bestreken.
De informatie over het gedragspatroon van recreanten in ruimte en tijd kan helpen een optimaal beheersplan voor een recreatie- gebied te ontwerpen.

Doelstelling 8.

Kan het gebruik van reeksen van luchtfoto's of andere remote sensing beelden van verschillende tijd in belangrijke mate bijdragen tot de informatie bedoeld in de voorgaande doelstellingen?
Het antwoord op deze vraag is al voor een deel inbegrepen in de conclusies bij de voorgaande doelstellingen.
Het gebruik van oudere series luchtfoto's naast de meest recente bedekking, in een procedure van retrospectieve monitoring, kan erg nuttig zijn om bepaalde patronen van ontwikkeling in ruimte en tijd aan te tonen. Het kan een aanwijzing geven over de factoren, die van invloed zijn, en ook laten zien welke landgebruiken of bodembedekkingsvormen klaarblijkelijk meer gevoelig of meer aantrekkelijk zijn om door recreatief gebruik te worden overgenomen.
Zo kunnen de betrekkingen tussen recreatievoorzieningen en hun hulpbronnen duidelijker naar voren komen bij het bestuderen van reeksen van luchtfoto's van verschillende momenten, dan wanneer alleen maar enkelvoudige situaties bekeken kunnen worden.
Het oplossend vermogen van SPOT satellietbeelden is niet voldoende om recreatievoorzieningen of recreatief landgebruik te identificeren. Maar het is wel mogelijk op die

beelden de plaats aan te geven van grote veranderingen in bodembedekking die nieuwe ontwikkelingen kunnen aanduiden. Op die manier kan de bijdrage van SPOT toch van waarde zijn, al moet worden betwijfeld of dit de aanschaf van een beeld voor alleen dit doel kan rechtvaardigen.
In de analyse van de invloed van recreatie kan het gebruik van reeksen van luchtfoto's van verschillende tijd essentieel zijn om de gevolgen van een geleidelijk proces dat op andere wijze nauwelijks waarneembaar is aan te tonen.
In de directe monitoring kan het gebruik van reeksen van luchtfoto's, gedurende één dag of één seizoen, waardevolle informatie toevoegen over het tijdsaspect van het gedrag van recreanten.

Algehele conclusie.

Wanneer alle conclusies nog eens worden nagelopen, blijkt dat niet alleen remote sensing, die rechtstreeks op recreatie verschijnselen is gericht, erg nuttig is, maar dat ook een groot aantal toepassingen van remote sensing, die in de eerste plaats op andere verschijnselen is gericht, indirect kan bijdragen tot landwaardering voor recreatie.
De toepassing van remote sensing technieken op landwaardering voor recreatie kan in veel gevallen bijdragen tot efficiëntere verzameling en analyse van gegevens en het in sommige gevallen zelfs mogelijk maken informatie te verzamelen en vormen van analyse toe te passen die anders niet mogelijk zouden zijn.
Sommige van de besproken methodes zijn tamelijk nieuw, ongebruikelijk, nog een beetje experimenteel, en behoeven verder onderzoek teneinde ze werkelijk operationeel te maken. Maar vele andere methoden behoren reeds tot de routine-matige praktijk.
Het blijft duidelijk, dat remote sensing slechts een deel van de antwoorden kan geven en dat de rest langs andere wegen moet worden verkregen. Maar de interpretatie van luchtfoto's, en in sommige gevallen zelfs van satellietbeelden, kan helpen om aan te geven welke ander wegen het best verkend kunnen worden. Met name voor gebieden waarvoor op recreatie betrekking hebbende gegevens schaars zijn of niet bestaan, hetgeen in vele ontwikkelingslanden het geval is, kan remote sensing daarom het meest efficiënte instrument zijn om mee te beginnen.
Teneinde aan het algehele doel van dit onderzoek te voldoen, de volledige verkenning van de mogelijkheden van remote sensing als inbreng in landwaardering ten behoeve van recreatie, worden de verschillende toepassingsmogelijkheden in het volgende schema gepresenteerd in betrekking tot het type remote sensing dat daarvoor het meest geschikt is en de resultaten die verwacht kunnen worden.

Tabel 7.1. *Overzicht van toepassingen van remote sensing als inbreng in land- waardering voor recreation.*

Type van remote sensing	Toepassing	Te verwachten resultaten
enkelvoudige bedekking verticale luchtfoto's *) 1:10000/1:20000	inventarisatie van voorzieningen	sterk afhankelijk van de soort voorziening
"	analyse van de invloed van voorzieningen op het landschap	"
"	inventarisatie van recreatie-hulpbronnen	in het algemeen goede resultaten
"	analyse van de relatie van recreatie vormen tot hun hulpbronnen	"
"	inventarisatie van landschaps elementen die de visuele structuur bepalen	"
"	analyse van de invloed van recreatie op dieren	inventarisatie en analyse van leefgebieden mogelijk
"	analyse van ruimtelijk gedrag	relatieve plaats van boten en auto's kan worden aangegeven
1:10000	analyse van de invloed van recreatie op de vegetatie	identificatie an analyse van paden-patronen mogelijk, absolute nauwkeurigheid laag
1:2000/1:5000	"	mogelijk in meer detail dan op kleinere schaal
series van verticale luchtfoto's van verschillende jaren 1:10000/1:20000	analyse van ontwikkelingsprocessen	in het algemeen goed
"	analyse van de relatie tussen vormen van recreatie en hun hulp-bronnen	in het algemeen beter dan met een enkele foto-bedekking
"	analyse van de invloed van voorzieningen	tijdsdimensie voegt waarde toe
1:10000	analyse van de invloed van recreatie op de vegetatie	de enige manier om de gevolgen van een geleidelijk proces aan te tonen
series luchtfoto's van verschillende data binnen a één jaar 1:10000/1:20000	analyse van ruimtelijk gedrag	verschillen in ruimtelijke spreiding van auto's en boten over een gebied in verschillende seizoenen kunnen worden vergeleken
1:2000/1:5000	"	verschillen in ruimtelijke spreiding van personen over een gebied in verschillende seizoenen kan worden vergeleken
series luchtfoto's van verschillende tijden op één dag 1:10000/1:20000	"	de tijdsdimensie van het ruimtelijke gedrag gedurende een dag kan worden geanalyseerd voor boten en auto's,
1:2000/1:5000	"	respectievelijk voor personen.

(wordt vervolgd op volgende bladzijde)

Tabel 7.1. *(vervolg)*

Type van remote sensing	Toepassing	Te verwachten resultaten
vogelvlucht opnamen #) eens per jaar	analyse van ontwikkelingsprocessen	aantonen van veranderingen in het landschap
verschillende data in één jaar of tijden op één dag	analyse van ruimtelijk gedrag	de relatieve plaats van boten, auto's en/of personen kan worden vastgesteld
visuele waarneming vanuit de lucht eens per jaar	analyse van ontwikkelingsprocessen	aantonen van veranderingen in het landschap bij lage concentraties
verschillende data in één jaar of tijden op één dag	analyse van ruimtelijk gedrag	de relatieve plaats van boten, auto's en/of personen kan worden vastgesteld indien in lage concentraties @)
SPOT en/of TM beelden	analyse van ontwikkelingsprocessen	vaststellen van grote veranderingen in het landschap is mogelijk
	analyse van de visuele structuur van het landschap	inventarisatie van de belangrijkste landschaps structurerende elementen is mogelijk

*) In verticale luchtfotografie zijn panchromatische foto's gewoonlijk voldoende; de hoge kosten voor kleuren of kleuren-infrarood worden zelden gerechtvaardigd doordat betere resultaten kunnen worden behaald.

#) tegenwoordig worden vaak gewone kleurendia's met een kleinbeeldcamera uit de hand genomen.

@) wanneer zich grotere concentraties voordoen wordt deze methode vaak gebruikt in combinatie met vogelvlucht opnamen.

References.

According to Dutch usage composite names such as Van Lier, Van der Zee, De Jong, etcetera, will be listed as: Lier, H.N.van; Zee, D.van der; Jong, H.de.
The IJ will be listed together with the Y, rather than under the I.
Institutions that have been referred to in the text by abbreviations, for example BM&RIN, are listed according to these abbreviations, to which now the full name will be added.
When more persons with the same name appear, for example Zonneveld, in the references in the text one or more initials will be added.

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Adrian Aria Kusumah, 1991 The environmental impact of tourism and recreation on part of Cibodas Biosphere Reserve, West Java, Indonesia. MSc thesis, ITC, Enschede.

Agullo, M. & Ramos, A. 1981 Viewshed and Landscape Morphology. In: Proceedings of the International Congress of the Netherlands Society for Landscape Ecology, Veldhoven, the Netherlands. Pudoc, Wageningen. pp 310-311.

Alonso, S.G., Agullo, M. & Ramos, A. 1986 Visual impact assessment methodology for industrial development site review in Spain. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 277-305.

An, R.L. 1980 A report on settlements interpretation and population estimates. Rural Survey course fieldwork report, ITC, Enschede.

Ashton, P.G. & Chubb, M. 1971 Recreational boating carrying capacity of lakes: a case study in South-eastern Michigan. Recreation research and planning unit. Department of park and recreation resources.

Ashworth, G.J. 1985 The evaluation of urban recreation resources in tourist development regions. In: Ashworth, G.J. & Goodall, B. (eds), The impact of tourist development on disadvantaged regions. pp 37-44. Sociaal-Geografische Reeks, aflevering 35. Geografisch Instituut, Rijksuniversiteit Groningen.

Ashworth, G.J. & Goodall, B. 1985 A framework for integrated research into tourist development. In: Ashworth, G.J. & Goodall, B. (eds), The impact of tourist development on disadvantaged regions. pp 3-5. Sociaal-Geografische Reeks, aflevering 35. Geografisch Instituut, Rijksuniversiteit Groningen.

Backhouse, D.G. 1974 Fundamentals of aerial photography. Lecture note PHM 89, ITC, Enschede.

Bakker, J.G. & Thewesen, Th.J.M. 1986 Inventariserend onderzoek naar het gebruik van luchtfoto's. In: Recreatie & Toerisme, no 4, pp 186-189.

Bakker, J.G. & Hell, A.E. 1988 Veerse Meer: Bijsturing van beleid noodzakelijk. In: Recreatie & Toerisme, no 5, pp 148-151.

Barkhof, J. 1988 Toerisme, vriend of vijand van de World Conservation Strategy? In: Recreatie & Toerisme, no 1, pp 6-8.

Bartkowski, T. 1985 The concept of physiognomic landscape as a tool for spatial ecological planning. In: VIIth International Symposium on problems of Landscape Ecological Research. Panel 1, volume 1, part 1.1; 21-26 October 1985, Pezinok, Czechoslovakia.

Baumgartner, R. 1981 Inventory and Evaluation from the Visual/Aesthetic Perspective. In: Proceedings of the International Congress of the Netherlands Society for Landscape Ecology, Veldhoven, the Netherlands. Pudoc, Wageningen. pp 318-319.

Bayfield, N. 1979 Some effects of trampling on Molophilus Ater (Meigen) (Diptera, Tipulidae). In: Biological Conservation, 16, pp 219-232.

Beckers, Th.A.M. 1974 Rekreatiegeografie in theorie en praktijk. In: Recreatie, no 7, pp 10-15.

Beckers, Th.A.M. 1983 Planning voor vrijheid. Een historisch-sociologische studie van de overheidsinterventie in rekreatie en vrije tijd. Dissertation. Mededelingen van de vakgroepen voor Sociologie, Landbouw Hogeschool Wageningen.

Beckers, Th.A.M. 1985 The concept of need in Dutch recreation planning. In: Ashworth, G.J. & Goodall, B. (eds), The impact of tourist development on disadvantaged regions. pp 6-9. Sociaal-Geografische Reeks, aflevering 35. Geografisch Instituut, Rijksuniversiteit Groningen.

Beckers, Th.A.M. 1988a Over de waarde en waardering van vrije tijd. In: Vrije tijd en samenleving, vol 6, no 1, pp 7-29.

Beckers, Th.A.M. 1988b Op zoek naar de verloren tijd. In: Vrije tijd en samenleving, vol 6, no 2, pp 111-116.

Beckers, Th.A.M. & Slettenaar, J. 1986 Dicht bij huis, ver van huis? Een experiment in rekreatie-onderzoek. In: Groen, vol 42, no 4, pp 34-38.

Beek, K.J. 1978 Land evaluation for agricultural development. International Institute for Land Reclamation and Improvement (ILRI), publication 23. Wageningen.

Bergsma, J.R. 1985 Locational aspects of the tourist enterprise. In: Ashworth, G.J. & Goodall, B. (eds), The impact of tourist development on disadvantaged regions. pp 79-83. Sociaal-Geografische Reeks, aflevering 35. Geografisch Instituut, Rijksuniversiteit Groningen.

Bergstrom, J.C., Cordell, H.K., Ashley, G.A., English, D.B.K. & Watson, A.E. 1989 Rural economic development impacts of outdoor recreation in Georgia. In: Research Report of the University of Georgia, Agricultural Experiment Station, pp 1-10.

Berkel, C.J.M.van 1983 Invloeden van recreatie-activiteiten op het natuurlijk milieu, een literatuuronderzoek. Provinciale Planologische Dienst Zuid-Holland.

Bernelot Moens, W.C. 1985 Kerncijfers en cijferbronnen vrijetijdsbesteding, cultuurdeelname, recreatie en toerisme en de aanwezigheid van accomodatie ten behoeve van de vrijetijdsbesteding. In: Sociaal Cultureel Kwartaal Bericht, nr 3, pp 42-54.

Bernelot Moens, W.E. 1990 Bezettingsgraad van logiescapaciteit hoger, verblijfsduur lager. In: Recreatie & Toerisme, no 3, pp 68-71.

Bernelot Moens, W.E. 1990 Bezettingsgraad van logiescapaciteit hoger, verblijfsduur lager. In: Recreatie & Toerisme, no 3, pp 68-71.

Blok, A.P., Elzakker, C.P.J.M.van and Zeeuw, J.G.de 1986 Recreatie. Part 7 of Atlas van Nederland in 20 delen. Staatsuitgeverij, 's-Gravenhage.

BM&RIN (Buro Maas & Rijks Instituut voor Natuurbeheer) 1984 Behouden vaart. Onderzoek naar waterrecreatie en natuur in de Nieuwkoopsche Plassen en de Kagerplassen. I.o.v. Ministerie van Landbouw en Visserij en de Provincie Zuid Holland.

Boonstra, H.J. & Herfkens, A.J.J. 1985 Basisrecreatie-plannen en TROP's te eenzijdig. In: Recreatie & Toerisme, no 12, pp 574-578.

Bowden, L.W. & Pruitt, E.L. (eds.) 1975 Manual of Remote Sensing. Volume II. Interpretation and applications. American Society of Photogrammetry.

Broekhuizen, S. & Wolf, M.de 1979 Grintgaten, openluchtrecreatie, luchtfotografie (2). De watersport in Midden-Limburg. In: Recreatie-voorzieningen, no 3, pp 117-121.

Büchli, H. 1962 Zur Terminologie des Fremdenverkehrs und der Fremdenverkehrswerbung. In: Zeitschrift für Fremdenverkehr, no 1, pp 23-28.

Campbell, A.C. 1971 The development of the wildlife industry in the Kalahari. In: Botswana Notes and Records, special edition no 1, pp 270-275.

Campbell, J.B. 1987 Introduction to remote sensing. The Guilford Press, New York, London.

Carter, D.J. 1986 The remote sensing sourcebook. A guide to remote sensing products, services, facilities, publications and other materials. McCarta Ltd, London.

CD&PW: Cultuurtechnische Dienst & Provinciale Waterstaat Friesland 1970 Luchtfototellingen op een aantal Friese meren. Leeuwarden.

Chenoweth, R.E. & Gobster, P.H. 1986 Wildland description and analysis. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 81-101.

Christaller, W. 1955 Beiträge zu einer Geographie des Fremdenverkehrs. In: Erdkunde, Band IX, Heft 1, pp 1-19.

Christaller, W. 1964 Some considerations on tourism location in Europe: the peripheral regions -under-developed countries- recreation areas. In: Regional Science Association; Papers vol. XII, European Congress, Lund, 1963, pp 95-105.

Clawson, M. & Knetsch,J.L. 1966 Economics of outdoor recreation. Resources for the future, Inc., Washington D.C. (2nd edition 1969).

Clout, H.D. 1976 Rural Geography, an introductory survey. Pergamon Press, Oxford etc., second reprint.

Cox, J.A., 1985. Landscape ecological survey and land evaluation in South-eastern Sri Lanka. Msc thesis, ITC, Enschede.

Cox, J.A., 1988. Remote sensing and land evaluation for planning elephant corridors in Sri Lanka. In: ITC Journal 1988-2: pp 172-177.

Cole, D.N. 1989 Recreation ecology: what we know, what geographers can contribute. In: Professional Geographer, 41 (2), pp 143-148.

Coleman, R. 1981 Footpath erosion in the English Lake District. In: Applied Geography, 1, pp 121-131.

Collins, W.G. & El-Beik, A.H.A. 1971a The acquisition of urban land use information from aerial photographs of the City of Leeds, Great Britain. In: Photogrammetria, 27(2).

Collins, W.G. & El-Beik, A.H.A. 1971b Population census with the aid of aerial photographs: an experiment in the city of Leeds. In: Photogrammetric Record, 7(37), pp 16-25.

Colwell, R.N. 1950 Uses of aerial photographs in forest recreation. In: Photogrammetric Engineering, vol XVI, pp 21-31.

Colwell, R.N. 1975 Introduction. In: Manual of Remote Sensing. Volume I. Theory, instruments and techniques. American Society of Photogrammetry.

Coppock, J.T. 1966 The recreational use of land and water in rural Britain. In: Tijdschrift voor Economische en Sociale Geografie, 57, pp 81-96.

Coppock, J.T. 1982 Geographical contributions to the study of leisure. In: Leisure Studies, 1, pp 1-27.

Cosgrove, I. & Jackson, R. 1972 The geography of recreation and leisure. Hutchinson University Library, London.

Culpan, R. 1987 International tourism model for developing economies. In: Annals of tourism research, vol 14, no 4.

Cracknell, A.P. & Hayes, L.W.B. 1991 Introduction to Remote sensing. Taylor & Francis Ltd, London.

Danz, W. 1984 Die Alpen und der modernen Tourismus. In: Das große ADAC Alpenbuch, pp 204-209. ADAC Verlag GmbH, München.

Defert, P. 1952 Les fondements géographiques du tourisme. In: Zeitschrift für Fremdenverkehr, no 4, pp 126-132.

Defert, P. 1954 Essai de localisation touristique. In: Zeitschrift für Fremdenverkehr, no 3, pp 110-118.

Defert, P. 1966 Der touristische Standort - Theoretische und praktische Probleme. In: Zeitschrift für Fremdenverkehr, no 3, pp 99-108.

Dietvorst, A.G.J. 1982 Theoretische aspecten van de recreatie-geografie: een verkenning. In: De relatie theorie-praktijk in recreatie-geografisch onderzoek. Nijmeegse geografische cahiers, no 19. pp 17-34.

Dietvorst, A.G.J. 1987 Neue Perspektiven der Freizeitforschung. In: Freizeitpädagogik, vol 9, no 3-4, pp 141-147.

Dietvorst, A.G.J. 1989a Complexen en netwerken: hun betekenis voor de toeristisch-recreatieve sector. Inaugurele rede, 21-7-1989, Landbouwuniversiteit Wageningen.

Dietvorst, A.G.J. 1989b Complexen en netwerken: hun betekenis voor de toeristisch-recreatieve sector. In: Vrije tijd en samenleving, vol 7, no 2, pp 95-113.

Dietvorst, A.G.J. 1989c Geïntegreerd beleid van recreatie en toerisme noodzakelijk. In: Recreatie & Toerisme, no 11, pp 350-354.

Dietvorst, A.G.J. 1989d Ontwikkelingen in de waterrecreatie. In: Recreatie, 27 no 3, pp 18-24.

Dietvorst, A.G.J. 1989e Gecompliceerde processen vraag en aanbod beter hanteerbaar maken. In: Recreatie & Toerisme, no 5, pp 171-174.

Dietvorst, A.G.J. 1989f Recreatieve voorzieningen in landinrichtingsgebieden. In: Landinrichting, Juni 1989, pp 31-37.

Dietvorst, A.G.J. 1990a Recreatie en toerisme: bron van tegenstellingen. In: Recreatie & Toerisme, no 7/8, pp 203-206.

Dietvorst, A.G.J. 1990b Changing planning strategies for recreation and tourism: Dutch experiences. In: New developments and concepts in planning for tourism and recreation. Papers of the international symposium at the CELA conference, Denver, USA, October 5.

Dietvorst, A.G.J. 1991 Maatschappelijke veranderingen en hun gevolgen voor de ontwikkeling van het toeristisch-recreatief produkt op regionaal niveau. In: H.N. van Lier (ed), Economisering in planning en beleid voor openluchtrecreatie en toerisme. Mededelingen van de Werkgroep Recreatie, no 18. Landbouwuniversiteit Wageningen.

Dietvorst, A.G.J. & Jansen-Verbeke, M. 1986 Een geografische visie op de interrelatie Vrijetijd, Recreatie en Toerisme. In: Vrije Tijd en Samenleving, vol 5, no 3, pp 241-256.

Dietvorst, A.G.J. & Pater, B.de 1988 A Leisure Society? In: Dietvorst, A.G.J. & Kwaad, F.J.P.M. (eds), Geographical Research in the Netherlands 1978-1987. Nederlandse Geografische Studies, no 64, pp 128-133.

Dill, H.W. 1963 Airphoto Analysis in Outdoor Recreation: Site Inventory and Planning. In: Photogrammetric Engineering, vol XXIX, pp 67-70.

Dodt, J. 1974 Luftbildauswertung durch "Indikatoren". Möglichkeiten und Grenzen der Datengewinnung für die Raumplanung. In: Vermessungswesen und Raumordnung, Vermessungstechnische Rundschau, Jahrgang 36, Heft 12, pp 433-444.

Dodt, J. & Zee, D.van der 1974 Identification of rural land-use types. (A method of teaching in, and data acquisition by, photo-interpretation). In: ITC Journal, no 5, pp 599-616.

Dodt, J. & Zee, D.van der 1984 Möglichkeiten der Anwendung von Luftbildinterpretation in der räumlichen Freizeit- und Erholungsplanung. In: Angewandte Fernerkundung. Methoden und Beispiele. Akademie für Raumforschung und Landesplanung. Vincentz, Hannover, pp 65-70.

Doorn, J.W.M.van 1980 Toerisme: begrip voor een begripsontwikkeling. In: Recreatievoorzieningen, no 11, pp 544-549.

Doren, C.S.van & Lollar, S.A. 1985 The consequences of forty years of tourism growth. In: Annals of Tourism Research, vol 12, pp 467-489.

Dorp, C.T.van & Dijk, H.W.J.van 1982 Rekreatie en duinvegetatie. Een momentopname in een deel van Berkheide. In: Duin, no 4, pp 3-11.

Driebergen, J. 1981a Luchtfoto onderzoek op de Randmeren. (1) De watersport: een confrontatie van visie en werkelijkheid. In: Recreatievoorzieningen, no 10, pp 470-474.

Driebergen, J. 1981b Luchtfoto onderzoek op de Randmeren. (2) De stranden: minder mensen en meer zeilplanken. In: Recreatievoorzieningen, no 11, pp 519-523.

Droogers, J.A.G.W. 1990 BRTN aanzet ontwikkeling mobiliteit te water. In: Recreatie & Toerisme, no 6, pp 163-167.

Duin, R.H.A.van & Loos, P. 1969 Water- en oeverrecreatie in het IJsselmeergebied. In: Stedebouw en Volkshuisvesting, jrg 50, no 4, p 151-171.

Duminy, J. 1967 Espace de loisirs. In: Urbanisme, no 100, pp 26-31.

Dijkema, K.S. 1990a A Habitat Map of the entire International Wadden Sea. In: Wadden Sea Newsletter, no 3/4, pp 27-32.

Dijkema, K.S. 1990b Habitatkaart van de internationale Waddenzee. In: Waddenbulletin, vol 25, no 2, p 100.

Edington, J.M. & Edington, M.A. 1977 Ecology and environmental planning. Chapman & Hall, London.

Estes, J.E. & Simonett, D.S. (eds), 1975 Fundamentals of image interpretation. In: Bowden, L.W. & Pruitt, E.L. (eds), Manual of Remote Sensing. Volume II, pp 869-1076.

Fagerholm, P.O. 1959 The application of photogrammetry to land use planning. In: Photogrammetric Engineering, vol 25, pp 523-529.

FAO (Food and Agriculture Organisation of the United Nations) 1977 A framework for land evaluation. ILRI Publication no 22, Wageningen.

FAO (Food and Agriculture Organisation of the United Nations) 1983 Guidelines in land evaluation for rainfed agriculture. FAO Soils Bulletin 52. Rome.

Felleman, J.P. 1986 Landscape visibility. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 47-62.

Ferrario, F. 1979 The evaluation of tourist resources: an applied methodology. In: Journal of travel research, pp 18-22; pp 23-30.

Florence, G.R. 1980 Survey and evaluation of rangelands in the Hukuntsi-Ngwatle pan area, Kalahari, Botswana. MSc thesis, ITC, Enschede.

Frederiksen, P. 1977 Turistslitage I et klitlandskab, Skallingen 1976. In: Geografisk Tidsskrift, Bd 76, pp 68-77.

Fowkes, J.D. 1985 The contribution of the tourist industry to the economy of the republic of Botswana. Kalahari Conservation Society, Botswana.

Funke, T. 1977 Bewertungsverfahren Landschaftsplan Altenahr. Untersuchung des Verfahrenansatzes zur ordinalen Messung des Freizeitspotentials. II Projektarbeit am Institut für Landschaftspflege und Naturschutz der Technischen Universität Hannover.

Furmidge, J. 1969 Planning for recreation in the countryside. In: Journal of the Town Planning Institute, 55, pp 62-67.

Geigant, F. 1962 Die Standorte des Fremdenverkehrs. Eine sozialökonomische Studie über die Bedingungen und Formen der räumlichen Entfaltung des Fremdenverkehrs. Dissertation, Ludwig-Maximilians Universität, München.

Gerasimov, I.P., Mints, A.A. & Preobrazhensky, V.S. 1970 Current geographical problems in recreation planning. In: Soviet Geography, 1970, pp 189-198.

Ginkel, C.J.van 1980 Resultaten sportvisserstellingen en -enquêtes op het IJsselmeer. In: Recreatievoorzieningen, no 3, pp 119-123.

Goderie, R. 1986 Recreatie en natuurbehoud in natuurbos: controverse of synthese? In: Recreatie & Toerisme, no 12, pp 524-529.

Goodall, B. 1985 Identification and evaluation of tourism and recreation resources - a review. In: Ashworth, G.J. & Goodall, B. (eds), The impact of tourist development on disadvantaged regions. pp 24-36. Sociaal-Geografische Reeks, aflevering 35, Geografisch Instituut, Rijksuniversiteit Groningen.

Goosen, D. 1967 Aerial photo interpretation in soil survey. Soils Bulletin no 6. FAO, Rome.

Graham, R. & Read, R.E. 1986 Manual of aerial photography. Butterworth & Co (Publishers) Ltd.
Grinde, K. & Kopf, A. 1986 Illustrated glossary. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 308-333.
Grontmij NV, afdeling recreatie en landschapsarchitectuur, 1975 Midden Holland - het landschap en zijn bebouwing. I. De ruimtelijke opbouw van het landschap. Intergemeentelijk overlegorgaan Midden Holland, Gouda.
Gunn, C.A. 1988 Tourism planning. Second edition, revised and expanded. Taylor & Francis.
Haaften, J.L.van 1976 Zeehonden. In: Abrahamse, J., Joenje,W. & Leeuwen-Seelt, N.van (eds), Waddenzee, natuurgebied van Nederland, Duitsland en Denemarken. Landelijke Vereniging tot Behoud van de Waddenzee, Harlingen. pp 143-147.
Hagoort, E.F. 1986a Toename gebruik IJsselmeer en Markermeer. In: Recreatie & Toerisme, no 10, pp 424-427.
Hagoort, E.F. 1986b Plaatsmaken voor nog 11000 boten. Watersportonderzoek IJsselmeer en Markermeer. In: Cultuurrijp 22(3), pp 3-5.
Ham, R.J.I.M.van der & Iding, J.A.M.E. 1971 De landschaps-typologie naar visuele kenmerken. Methodiek en gebruik. Afdeling landschapsarchitectuur, Landbouwhogeschool, Wageningen.
Heeley,J. 1980 The definition of tourism in Great Britain: Does terminological confusion have to rule? In: Revue de tourisme, no 2, pp 11-14.
Hempenius, S.A. 1978 Teledetectie: Hoe ver en hoe fijn? Public Lecture 2-11-1978 Agricultural University Wageningen.
Hendriks, H. & Zom, J.A.M. 1976a Definiering van begrippen op het gebied van het toerisme en de recreatie (1). In: Recreatievoorzieningen, no 10, pp 438-422.
Hendriks, H. & Zom, J.A.M. 1976b Definiering van begrippen op het gebied van het toerisme en de recreatie (2). In: Recreatievoorzieningen, no 11, pp 467-470.
Hendriksen, J. 1970 Recreatiecapaciteit van watersportplassen. In: Recreatievoorzieningen, no 6, pp 99-102.
Hendriksen, J. 1971 Luchtfototellingen op een aantal Friese meren. In: Recreatievoorzieningen, no 1, pp 5-17.
Heijens-Lijnse, P.L. & Bernelot-Moens, W.E. 1988 Directe woonomgeving van groot belang voor alledaagse recreatievormen. In: Recreatie & Toerisme, no 6, pp 185-188.
Hoeve, H.van der 1985 Invloed van de waterrecreatie op de broedvogels in het Nieuwkoopsche Plassen gebied. In: Recreatie & Toerisme, no 5, pp 241-243.
Holz, R.K. 1985 The surveillant science: remote sensing of the environment. John Wiley & Sons.
Hommel, P.W.F.M. 1990 Ujung Kulon: landscape survey and land evaluation as a habitat for the Javan Rhinoceros. In: ITC Journal, no 1, pp 1-15.
Hoorn, A.van, Bruin, A.H.de & Jaarsma, C.F. 1988a Ontwikkeling methode voor bepaling gebruik openluchtrecreatieprojecten (1). In: Recreatie & Toerisme, no 4, pp 124-128.
Hoorn, A.van, Bruin, A.H.de & Jaarsma, C.F. 1988b Ontwikkeling methode voor bepaling gebruik openluchtrecreatieprojecten (2). In: Recreatie & Toerisme, no 5, pp 158-162.
Houten de Lange, S.M.ten 1978 Resultaten van onderzoek naar de gevolgen van rekreatie in natuurgebieden. In: Ittersum, G.van, Kwakernaak, K. & Zee, D.van der (eds), Verslag van de studiedag rekreatie op 4 november 1977 te Leeuwarden. pp 6-8. Werkgroep Rekreatie van de Landelijke Vereniging tot Behoud van de Waddenzee, Harlingen.
Hyatt, E. 1988 Keyguide to information sources in remote sensing. Mansell Publishing Ltd, London & New York.
Hylgård, T. 1977 Turistsitage på Skallingen. En undersøgelse over besogstal og rekreative aktiviteter sommeren 1976, specielt med henblik på en vurdering af disses påvirkning af klitvegetationen. Botanisk Institut, Okologisk Afd. Århus Universitet.
Ittersum, G.van & Kwakernaak, C. 1977 Gevolgen van de recreatie voor het natuurlijk milieu. In: Eilanden onder de voet, pp 59-103. Werkgroep Recreatie van de Landelijke Vereniging tot Behoud van de Waddenzee. Harlingen.
Jacsman, J., Schilter, R.Ch. & Schmid, W.A. 1990 New developments and concepts in tourism and recreation planning in Switzerland. In: New developments and concepts in planning for tourism and recreation. Papers of the International symposium at the CELA conference, Denver, USA, October 5.
Jansen-Verbeke, M.C. 1982 De binnenstad als recreatie-omgeving: potenties en knelpunten vanuit empirische verkenningen bekeken. In: De relatie theorie-praktijk in recreatie-geografisch onderzoek. Nijmeegse geografische cahiers, no 19. pp 37-57.
Jansen-Verbeke, M. 1987 Freizeit, Fremdenverkehr und Erholung: zwischen Raumforschung und Raumplanung. In: Zeitschrift für Freizeitpädagogik, vol 9, no 3-4, pp 148-158.
Jansen-Verbeke, M.C. & Dietvorst, A.G.J. 1987 Leisure, Recreation, Tourism. A geographic view on integration. In: Annals of Tourism Research, vol 14, pp 361-375.
Jansen-Verbeke, M.C. & Klein, P.de 1990 Met de trein er-op-uit: het kan wel, maar... In: Recreatie & Toerisme, no 3, pp 63-67.
Janssen, J. 1990 Toerisme groeisector met groot potentieel. In: Recreatie & Toerisme, no 9, p 249.
Janssens, P & Gulink, H. 1988 Image analysis of remote sensing data (SPOT) for landscape typology. In: Proceedings of the VIIIth International Symposium on Problems of Landscape Ecological Research, October 3-7 1988, Zemplinska Širava, Czechoslovakia. Volume I: Spatial and functional relationships in landscape ecology, pp 31-37.
Jassies, A. 1985 Vette jaren zijn voorbij voor luxe bungalow parken. In: Tubantia, weekuit, 14-12-1985, p 5.
Jerie, H.G. 1976 The establishment of cost models in photogrammetry. In: ITC Journal 1976-2, pp 139-158.
Joint Schools Survey 1970 People at play in Dartmoor National Park. In: the Geographical Magazine, vol XLII, no 4, pp 266-278.
Jong, H.de 1986 Openluchtrecreatie: onverwachte wendingen. In: Recreatie & Toerisme, no 2, p 60-63.

Jong, M.A.de, Kaiff, P.J. & Verroen, E.J. 1990 Toekomst van de recreatie: auto in de klem? In: Recreatie & Toerisme, no 9, pp 260-263.

Jonge, D.de 1968 Plaatskeuze in recreatiegebieden. In: Bouw, no 1, pp 13-15.

Jurgens, C.R. & Voet, J.L.M.van der 1989 Computer hulpmiddel op weg naar samenhang in toeristisch/recreatieve infrastructuur? In: Recreatie & Toerisme, no 5, pp VI-VII.

Kannegieter, A. 1987 Remote sensing for land ecology and land use survey. Lecture series N9. ITC, Enschede.

Kannegieter, A. 1988 Mapping land-use. In: Küchler, A.W. & Zonneveld, I.S. (eds), Vegetation mapping. Kluwer Academic Publishers, Dordrecht, the Netherlands. pp 335-374.

Karssen, A.(red) 1986 De Vakantie-atlas van Nederland. Intermap bv, Enschede.

KCS (Kalahari Conservation Society) 1985 Newsletter, no 8.

Kiemstedt, H. 1967 Zur Bewertung der Landschaft für die Erholung. Beiträge zur Landespflege, Sonderheft 1. Institut für Landesplanung und Raumforschung der TH Hannover.

Kiemstedt, H. 1972 Erfahrungen und Tendenzen in der Landschaftsbewertung. In: Zur Landschaftsbewertung für die Erholung. Forschungsberichte des Forschungsausschusses "Raum und Fremdenverkehr" der Akademie für Raumforschung und Landesplanung. Forschungs- und Sitzungsberichte, Band 76. Raum und Fremdenverkehr 3, Hannover. pp 33-44.

Kiemstedt, H. et al. 1975 Landschaftsbewertung für Erholung im Sauerland. Schriftenreihe Landes- und Stadtentwicklungs-forschung des Landes Nordrhein-Westfalen, Landesentwicklung, Band 1-008/I.

Killmayer, A. & Epp, H. 1983 Use of small format aerial photography for land use planning. In: ITC Journal 1983-4, pp 285-290.

Kingo Jacobsen, N. 1977 Investigations of tourist wear on the peninsula of Skallingen, 1975 and 1976. Summary. In: Geografisk Tidsskrift, Bd 76, pp 82-83.

Kloosterman, M.; Nuland, E.van; Olde Loohuis, E. & Oort, G.van 1985 Werkgelegenheidsaspecten van toerisme en recreatie. In: Recreatie, 1985, no 4/5, pp 30-37.

Klöpper,R. 1972 Einführung. In: Zur Landschaftsbewertung für die Erholung. Forschungsberichte des Forschungsausschusses "Raum und Fremdenverkehr" der Akademie für Raumforschung und Landesplanung. Forschungs- und Sitzungsberichte, Band 76. Raum und Fremdenverkehr 3, Hannover. pp 1-8.

Koetsier, J.A. 1982 Stedelijke recreatie. Methodisch-technische problemen bij onderzoek. In: De relatie theorie-praktijk in recreatie-geografisch onderzoek. Nijmeegse geografische cahiers, no 19. pp 59-68.

Konecny, G. 1987 The development and state of art of remote sensing. In: ITC Journal, 1987-2, pp 153-156.

Kontturi, O. & Lyytikainen, A. 1985 Assessment of glaciofluvial landscapes in Finland for nature conservation and other multiple use purposes. The nation-wide esker investigation, report 32. Reprint from STRIAE, 22, pp 41-59.

Koroma, E., Layraman, T., Mundachitra, N. & Tongsa-ad, S. 1978 Socio-economic aspects of the rural environment by airphoto-interpretation. Basilicata - Southern Italy, a case study. (An ITC Rural Survey Course Final report).

Kosters, M.J. 1976 Op weg naar een toeristische politiek? In: Intermediair, vol 12, no 1/2.

Kosters, M.J. 1985 Slecht voorseizoen drukte de ontwikkeling van de pleziervaart in 1984. In: Recreatie & Toerisme, no 5, pp 244-249.

Kostrowicki, A.S. 1970 Application of geobotanical methods in appraising fitness of regions for purposes of recreation and rest. In: Przeglad Geograficzny, vol XLII, no 4, pp 644-645.

Krajčovič, R; Šteffek, J.; Hilbert, H. & Múdry, P. 1985 Möglichkeiten der Anwendung des Landep-Verfahrens für die Landschaftsschutz und Naturschutzplanung. (Die Nützung des Landep bei der Lösung von Problemen der Natur- und Landschaftsschutzes am Beispiel des Modellterritoriums CHKO Štiavnické Vrchy.) In: VIIth International Symposium on problems of Landscape Ecological Research. Panel 1, volume 2, part 1.6; 21-26 October 1985, Pezinok, Czechoslovakia.

Krapf, K. 1952 Fondements de la récherche scientifique du tourisme. In: Zeitschrift für Fremdenverkehr, no 1, pp 1-5.

Krapf, K. 1962 Le tourisme, facteur de l'économie moderne. In: Zeitschrift für Fremdenverkehr, no 3, pp 90-98.

Kromhout, H.C. 1986 Toeristische plannen bedreigend voor natuur en landschap. In: Recreatie & Toerisme, no 11, pp 476-478.

Kroon, H.J.J. 1986 Waardering van gebieden voor openluchtrecreatie. Over relaties tussen particuliere en politieke waarderingen. Proefschrift, Rijksuniversiteit Groningen.

Kwakernaak, K. & Ittersum, G.van 1978 Materiaal en methodiek voor de vergelijkende luchtfotokartering van de betredingsintensiteit op de waddeneilanden. Achtergrondinformatie voor hoofdstuk 4 van het rapport "Eilanden onder de voet". vit/oo8. Werkgroep Rekreatie van de Landelijke Vereniging tot Behoud van de Waddenzee, Harlingen.

Lansink, A. 1983 Skiën: samen met het landschap richting bergaf. In: Natuur en milieu, 83/1, pp 13-16.

Laursen, K., Pihl, S., Hansen, M. & Frikke, J. 1989 Landsdaekkende optaelling af vandfugle fra flyvemaskine, Januar/Februar 1989. Rapport fra Vildtbiologisk Station, Miljøministeriets Vildtforvaltning.

Leiper, Neil 1979 The framework of tourism. In: Annals of Tourism Research, vol VI, no 4, pp 390-406.

Lier, H.N.van 1973 determination of planning capacity and layout criteria of outdoor recreation projects. Proefschrift, Wageningen.

Lier, H.N.van 1987 De betekenis van de Engelse "access"-studie voor Nederland. In: Voet, J.L.M.van der & Burgers (eds), Toegang voor recreatie in het landelijk gebied. Mededelingen van de Werkgroep Recreatie, no 11. Wageningen. pp 23-36.

Lier, H.N.van 1988 Meervoudig grondgebruik. Doctoraal college. Cultuurtechniek, Landbouwuniversiteit Wageningen.

Lier, H.N.van 1990 Introduction to new challenges in tourism and recreation planning. In: New developments and concepts in planning for tourism and recreation. Papers of the International symposium at the CELA conference, Denver, USA, October 5.
Lier, H.N.van 1991 Wat wordt bedoeld met "economisering"? In: H.N. van Lier (ed), Economisering in planning en beleid voor openluchtrecreatie en toerisme. Mededelingen van de Werkgroep Recreatie, no 18. Landbouwuniversiteit Wageningen.
Liddle, M.J. 1975 A selective review of the ecological effects of human trampling on natural ecosystems. In: Biological Conservation, no 7, pp 17-36.
Liddle, M.J. & Greig-Smith, P. 1975 A survey of tracks and paths in a sand dune ecosystem. I. Soils. II. Vegetation. In: Journal of Applied Ecology, no 12, pp 893-930.
Liddle, M.J. & Scorgie, H.R.A. 1980 The effects of recreation on freshwater plants and animals, a review. In: Biological Conservation, 17, pp 183-206.
Linden, J.W.van der & Eijk, T.van 1984 Enquete waterrecreatie Biesbosch. In: Deelrapport "Recreatiegedrag en recreatiepatroon" van: Openluchtrecreatie en natuurlijk milieu in de Biesbosch. Instituut voor Milieuvraagstukken, VU Amsterdam, Studie- en Informatiecentrum voor Milieu-onderzoek, TNO, Delft.
Lo, C.P. 1986 Applied remote sensing. Longman Group UK Ltd.
Loedeman, J.H. & Voet, J.M.L.van der 1979 Grintgaten, openluchtrecreatie, luchtfotografie (1) Aanleiding, opzet en uitvoering. In: Recreatievoorzieningen, no 2, pp 55-58.
Loedeman, J.H. & Quaedflieg, P. 1979 Grintgaten, openluchtrecreatie, luchtfotografie (4). Techniek van de luchtfotografie. In: Recreatievoorzieningen, no 5, pp 255-261.
Loth, P.E., 1988. Vegetation and landscape of Kora National Reserve, Kenya. In: ITC Journal, 1988-2: pp 133-148.
Maas, F. 1980 Een plaatsje achter de geraniums. De recreatie en het behoud van de groene ruimte. In: Natuurbehoud, vol 11, no 2, pp 40-44.
Maas, F.M. 1971 Toekomstmodel voor natuur en landschap. Een bijdrage tot goed milieubeheer. Het wereldvenster, Baarn.
MacConnel, W.P. & Garvin, L.E. 1956 Cover mapping a state from aerial photographs. In: Photogrammetric Engineering, vol 22, pp 702-707.
MacConnel, W.P. & Stoll, P. 1969 Evaluating Recreational Resources of the Connecticut River. In: Photogrammetric Engineering, vol 35, pp 686-692.
Maier, J. 1972 Zur Bewertung de landschaftlichen Erholungspotentials aus der Sicht der Wirtschafts- und Sozialgeographie. In: Zur Landschaftsbewertung für die Erholung. Forschungsberichte des Forschungsausschusses "Raum und Fremdenverkehr" der Akademie für Raumforschung und Landesplanung. Forschungs- und Sitzungsberichte, Band 76. Raum und Fremdenverkehr 3, Hannover. pp 9-20.
Malan, O.G., Erasmus, P.F. & Fourie, C. 1988 Comparison of SPOT, TM and combined data for urban studies. In: SPOT 1, Image Utilization, Assessment, Results. Centre National d'Études Spatiales (CNES). Cepadues-Éditions, Toulouse.
Marsz, A.A. 1972 Calculation method of recreation capacity of health resorts in the lowland. In: Poznanskie towarzystwo przyrodniczy prace komisji geograficzno-geologicznej, tom XII, zesz 3, Poznan.
Mather, P.M. 1987 Computer processing of remotely-sensed images. An introduction. John Wiley and Sons.
Meulen, F.van der; Wanders, E.A.J. & Huis, J.C.van 1985 A landscape map for coastal dune management. Meyendel, the Netherlands. In: ITC Journal 1985-2, pp 85-92.
Meyboom, P. & Hellinga, P. 1977 IJsselmeer in beeld. Een onderzoek naar patronen en intensiteiten van de recreatievaart op het IJsselmeer, Markermeer en IJmeer aan de hand van luchtfoto kartering. In: Recreatievoorzieningen, no 11, pp 522-526.
Midaglia V., C.L., Prabowo, A.N. & Sundung, S. 1987 Analysis of the recreational resources of the Mae Sa valley. Fieldwork report, ITC, Enschede.
Middelkoop, H. 1990 Uncertainty in a GIS: a test for quantifying interpretation output. In: ITC Journal 1990-3, pp 225-232.
Mittman, H.J. 1990 Recreation management within the multiple use management concept of the United States Forest Service. In: New developments and concepts in planning for tourism and recreation. Papers of the International symposium at the CELA conference, Denver, USA. October 5.
Mpaphadzi, M. (ed) 1984 Botswana '84. An official handbook. Department of Information and Broadcasting. Gaborone.
Mukonyora, H. 1980 Keyhole freaks in Spain. A study of small rural Spanish settlements (around Mérida area) based on airphoto interpretation. Rural Survey course, ITC, Enschede.
Mulder, A.F. 1981 Watersport, marktontwikkeling en planologie. 1. Een profielschets. In: Recreatievoorzieningen, no 9, pp 440-444.
Mulder, A.F. 1982 De factor ruimte als geleider van maatschappelijke processen. Een verkenning van perspectieven ten dienste van de geografie van recreatie en toerisme. In: De relatie theorie-praktijk in recreatie-geografisch onderzoek. Nijmeegse geografische cahiers, no 19, pp 113-145.
Mulder, N.J. 1986 What, where, when ..., why? Extracting information from remote sensing data. In: ITC Journal 1986-2, pp 145-155.
Mulder, N.J. 1988 Digital image processing, computer-aided classification and mapping. In: Küchler, A.W. & Zonneveld, I.S. (eds), Vegetation mapping. Kluwer Academic Publishers, Dordrecht, the Netherlands. pp 269-316.
Mulder, N.J. 1991 Earth watch. Remote sensing & image analysis. Inaugural address, Universiteit Twente, Enschede.
Naithani, K.K. 1990 Can satellite images replace aerial photographs? A photogrammetrist's view. In: ITC Journal, no 1, pp 29-31.

Neef, E. 1984 Applied Landscape Research. Paper distributed at the First International Seminar of the International Association for Landscape Ecology (IALE), Roskilde University Centre, Denmark, October 1984.

Noor, R.A.W. 1989 Een landsdekkende inventarisatie recreatieve voorzieningen. STEC, Vereniging van Stads- en Economisch Geografen, Nijmegen, in opdracht van de Rijks Planologische Dienst (RPD).

Norton-Griffiths, M., Hart, T. and Parton, M. 1983 Sample surveys from light aircraft combining visual observation and very large scale colour photography. In: ITC-Journal 1983-1, pp 17-20.

NRIT (Nederlands Research Instituut voor Toerisme en recreatie) 1975 Definiering van begrippen op het gebied van het toerisme en de rekreatie. Breda.

Olson Jr, C.E., Tombaugh, L.W. & Davis, H.C. 1969 Inventory of Recreation Sites. In: Photogrammetric Engineering, vol 35, pp 561-568.

Oort, G.M.R.A.van & Jeekel, J.F. 1982 Openluchtrecreatie en het landschap. In: De relatie theorie-praktijk in recreatie-geografisch onderzoek. Nijmeegse geografische cahiers, no 19. pp 147-174.

Oosterhaven, J. & Verhek, M. 1985 Some research aspects of regional economic aspects of recreation and tourism. In: Ashworth, G.J. & Goodall, B. (eds), The impact of tourist development on disadvantaged regions. pp 67-77. Sociaal-Geografische Reeks, aflevering 35. Geografisch Instituut, Rijksuniversiteit Groningen.

Palmer, J.E. 1967 *Recreational planning*. A bibliographical review. In: Planning Outlook, new series vol 2. pp 19-69.

Patmore, J.A. 1972 Land and Leisure. Penguin Books Ltd, England.

Patmore, J.A. 1973 *Recreation*. In: Dawson, J.A. & Doornkamp, J.C. (eds), Evaluating the Human Environment. Edward Arnold Ltd. pp 224-248.

Patmore, J.A. 1983 Recreation and Resources. Leisure patterns and leisure places. Basil Blackwell publisher Ltd, Oxford, England.

Pavlicek, K.O. 1991 Impact of recreation on mountain ecosystems in a part of the Hohe Tauern National Park, Austria. MSc thesis, ITC, Enschede.

Pearson, R.N. 1961 The terminology of recreational geography. In: Papers of the Michigan Academy of Science, Arts and Letters, Vol XLVII, 1962, pp 447-451.

Peltzer, R.H.M. 1977 Het Zwarte Meer en de watersport. Een kwantificerend onderzoek naar recreatievaartuigen op het Zwarte Meer met behulp van luchtfoto's in 1976. Mededeling nr 1, afdeling recreatie-onderzoek, Staatsbosbeheer.

Peppelenbosch, P.N.G. & Tempelman, G.J. 1973a *Tourism and the developing countries*. In: Tijdschrift voor Economische en Sociale Geografie, 64, no 1, pp 52-58.

Peppelenbosch, P.N.G. & Tempelman, G.J. 1973b Toerisme en ontwikkelingslanden. In: Intermediair, vol 9, no 4.

Piotrowska, H. 1979 Natural resistance against mechanical destruction in plant communities on Baltic coast dunes. In: Biologia, no 1, pp 6-13.

Ploeg, S.W.F.van der (red) 1984a Openluchtrecreatie *en natuurlijk milieu in de Biesbosch. Hoofdrapport*. Instituut voor Milieuvraagstukken, VU Amsterdam, Studie- en Informatiecentrum voor Milieu-onderzoek, TNO, Delft.

Ploeg, S.W.F.van der (red) 1984b Recreatie patronen. In: Deelrapport 'Recreatiegedrag en recreatiepatroon' van: *Openluchtrecreatie en natuurlijk milieu* in de Biesbosch. Instituut voor Milieuvraagstukken, VU Amsterdam, Studie- en Informatiecentrum voor Milieu-onderzoek, TNO, Delft.

Ploeg, S.W.F.van der 1990 Outdoor recreation and *the multiple use management of natural resources*. Proefschrift. Instituut voor Milieuvraagstukken, Vrije Universiteit, Amsterdam.

Pollé, V.F.L. 1988 Monitoring and measuring human settlement changes by remote sensing methods. A case study with SPOT images of Bandung, Indonesia. ITC, Enschede.

Purnell, M.F. 1986 Application of the FAO Framework for landevaluation for conservation in sloping areas; potentials and constraints. In: Siderius, W. (ed), Landevaluation for land-use planning and conservation in sloping areas. ILRI publication 40, pp 17-31.

Putte, R.van de 1989 Land evaluation and project planning. In: ITC Journal, no 2, pp 139-142.

PWF: Provinciale Waterstaat Friesland 1977 Luchtfototellingen op een aantal Friese meren. Planologie, verkeer en recreatie onderzoek. Leeuwarden.

Quader, A.K.M.A. 1980 Keyhole peeping in Spain. Rural Survey course fieldwork report, ITC, Enschede.

Rambousková, H. 1981a Recreational impact on vegetation. In: Proceedings of the International Congress of the Netherlands Society for Landscape Ecology, Veldhoven, the Netherlands. Pudoc, Wageningen. pp 146-147.

Rambousková, H. 1981b A contribution to the application of some numerical indices in the evaluation of recreational impact on vegetation. In: Preslia, *Praha*, 53, pp 147-158.

Rambousková, H. 1982a Vliv Rekreace na Vegetaci. Summary: Impact of recreational activities on vegetation. Praha.

Rambousková, H. 1982b Recreation-induced changes in natural and semi-natural vegetation with a special respect to camping activities. In: Ekologia (CSSR), vol 1, no 3, pp 313-330.

Rambousková, H. 1982c A contribution to the stability of forest communities, particularly concerning recreational pressure. In: VI Medzinarodne sympozium o problematike ekologickeho vyskumu krajiny, 25-30 oktober 1982.

Rasmussen, G. 1962 From poor heath to flourishing seaside resort. A comparative airphotostudy of some land use changes on the Skanör peninsula, Sweden. In: Symposium Photointerpretation, Working Group 5, Delft 1962, pp 285-294.

Reijnders, P.J.H. 1976 Haalt onze zeehonden populatie 1984? In: Waddenbulletin, no 4, pp 179-181.

Reijnders, P.J.H., Drescher, H., Haaften, J.L.van, Bøgebjerg Hansen, E. & Tougaard, S. 1981 Population dynamics of the Harbour Seal in the Wadden Sea. In: Reijnders, P.J.H. & Wolff, W.J. (eds), Marine Mammals of the Wadden Sea. Report 7 of the Wadden Sea Working group. pp 19-32.

Richter, W.von & Butynski, T. 1973 Hunting in Botswana. In: *Botswana Notes and Records*, vol 5, pp 191-208.

Riezebos, H.Th. 1988 Land evaluation and land use planning. In: Dietvorst, A.G.J. & Kwaad, F.J.P.M. (eds), Geographical Research in the Netherlands 1978-1987. Nederlandse Geografische Studies, no 64, pp 128-133.

RMNO (Raad voor het Milieu en Natuur Onderzoek) 1983a RMNO meerjaren programma 1983. Publicatie RMNO, no 2.

RMNO (Raad voor het Milieu en Natuur Onderzoek) 1983b Agendapunten voor Natuur en Milieu. Publicatie RMNO, no 3.

RMNO (Raad voor het Milieu en Natuur Onderzoek) 1984 Bijdrage meerjarenplan 1984: dosis-effectrelaties; sturing van recreatie t.b.v. natuur. Publikatie no 3, Programmerings- en studiegroep recreatie en natuurlijk milieu.

RMNO (Raad voor het Milieu en Natuur Onderzoek) 1985 Bijdragen van de programmerings- en studiegroepen aan het RMNO jaaradvies 1984. Bijdrage van de PSG Recreatie en Natuurlijk Milieu. pp 77-95.

RMNO (Raad voor het Milieu en Natuur Onderzoek) 1988 RMNO-meerjaren visie 1987. Publikatie RMNO nr 29.

Robinson, G.W.S. 1972 The recreation geography of South Asia. In: The Geographical Review, vol LXII, no 4, pp 561-572.

Robinson, R.A. 1953 Methods of tourist market research. In: Zeitschrift für Fremdenverkehr, no 3, pp 89-96.

Rodgers, H.B. et al. 1973 Recreation and Resources. In: The Geographical Journal, vol 139, part 3, pp 467-497.

Roomer, M.G. 1974 Het begrip 'vrije tijd' heeft zijn tijd gehad. In: Recreatie, vol 12, no 4, p 22.

RWS: (Rijkswaterstaat, Dienst Zuiderzeewerken) 1977 IJsselmeer in beeld. Een onderzoek naar patronen en intensiteiten van de recreatievaart op het IJsselmeer, Markermeer en IJmeer aan de hand van luchtfoto kartering. ZZW-RFO, nota nr 291, Lelystad.

RWS: (Rijkswaterstaat, Dienst Zuiderzeewerken) 1979 Randmeren in beeld. De resultaten van een luchtfoto onderzoek naar de recreatie op de randmeren van Flevoland. Nota 318, Lelystad.

Sabins jr, F.F. 1987 Remote sensing, principles and interpretation. Second edition. W.H. Freeman and company, New York.

Saris, F.; Kwakernaak, C.; Heusden, W.van & Huls, J.van 1984 Vegetatie en oevers in de Biesbosch en de relatie met de recreatie. Deelrapport van: Openluchtrecreatie en natuurlijk milieu in de Biesbosch. Instituut voor Milieuvraagstukken, VU Amsterdam, Studie- en Informatiecentrum voor Milieu-onderzoek, TNO, Delft.

Sas, D. 1988 Geschiktheidsonderzoek recreatie. OPOL nota 14. Intern rapport vakgroep cultuurtechniek no 37, Wageningen.

Schauman, S. 1986 Countryside landscape visual assessment. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 103-114.

Schrauwen, R. & Terpstra, D. 1986 Van Bovenaf Bekeken. Een onderzoek naar de theoretische en praktische aspekten van het gebruik van luchtopname technieken bij rekreatie onderzoek. LH Wageningen, Vakgroep Cultuurtechniek.

Segeren, W.A. 1971 Cultuurtechnische aspecten bij het inrichten van gebieden met urbane en recreatieve bestemmingen. Intern rapport no 236. Rijksdienst voor de IJsselmeerpolders, Wetenschappelijke afdeling, Kampen.

Segers, A.J.A.M. 1970 Bepaling van de fysische geografische geschiktheid van plattelandsgebieden voor openluchtrecreatie. Nota 574, Instituut voor Cultuurtechniek en Waterhuishouding, Wageningen.

Sideway, R.M. 1987a Access to the countryside for recreation and sport. In: Voet, J.L.M.van der & Burgers, R.A.J.P. (eds), Toegang voor recreatie in het landelijk gebied. Mededelingen van de Werkgroep Recreatie, no 11. Wageningen. pp 11-22.

Sideway, R.M. 1987b Access to the countryside for *outdoor recreation: an Anglo-Dutch comparison*. In: Town Planning Review, vol 58, no 4, pp 401-409.

Smardon, R.C. 1986 Review of agency methodology for visual project analysis. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 141-166.

Smith-Romeijn, E. 1969 Een systeem van landschaps-waardering uit oogpunt van de recreatie. In: Recreatievoorzieningen, no 6, pp 83-86.

Smith-Romeijn, E. 1970 Landschapswaardering uit een oogpunt van de recreatie. Netschema's voor de recreatieve waarde. In: Recreatievoorzieningen, no 1, pp 7-8.

Sombat, M. 1980 Recreation and soil erosion analysis on Schiermonnikoog. Special project report, ITC, Enschede.

Stabler, M.J. 1985 Recreational resources: an economic evaluation with particular reference to methods of assessing demand. In: Ashworth, G.J. & Goodall, B. (eds) The impact of tourist development on disadvantaged regions. pp 10-23. Sociaal-Geografische Reeks, aflevering 35. Geografisch Instituut, Rijksuniversiteit Groningen.

Statham, D. 1972 Natural resources in the uplands. Capability analysis in the North York Moors. In: Journal of the Royal Town Planning Institute, vol 58, no 10, pp 468-478.

Stone, K.H. 1956 Airphoto Interpretation Procedures. In: Photogrammetric Engineering, vol. 2, pp 123-132.

Stroband, A.G. 1971 Het gebruik van luchtfoto's voor recreatie onderzoek. In: Recreatievoorzieningen, no 5, pp 141-146.

Stroband, A.G.; Dijkstra, H. & Wegner, J. 1970 Capaciteiten van watersportgebieden. In: Recreatievoorzieningen, no 2, pp 236-242.

Suwan, M. 1987 The development of recreation and its impact on the land. In: Geographical Journal, Geographical Association of Thailand, vol 12, no 1, pp 48-62.

Suwan, M. & Nurbaya, S. 1986 The development of recreation in the Mae Sa Valley, Northern Thailand. Fieldwork report ITC, Enschede.

Tarlet, J. 1990 The French experiment -today's problematics- and new prospects. In: New developements and concepts in planning for tourism and recreation. Papers of the International symposium at the CELA-conference, Denver, USA. October 5.

Tempelman, G.J. 1973 Sociale gevolgen van toerisme naar de Derde Wereld. In: Intermediair, vol 9, no 43.

Tempfli, K. & Kure, J. 1980 Large scale surveys: aerial versus ground survey methods. In: ITC Journal 1980-4, pp 696-717.
Thalen, D. 1977 Inleiding. In: Eilanden onder de voet. Werkgroep Rekreatie van de Landelijke Vereniging tot Behoud van de Waddenzee, Harlingen. pp 13-20.
Theuns, H.L. 1973a Internationaal toerisme. Omvang, spreiding en groei (1). In: Intermediair, vol 9, no 26.
Theuns, H.L. 1973b Internationaal toerisme. Omvang, spreiding en groei (2). In: Intermediair, vol 9, no 27.
Theuns, H.L. 1985 Ontstaan en ontwikkeling van het massatoerisme naar de derde wereld. In: Economische Statistische Berichten, vol 70, no 3516, pp 752-759.
Theuns, H.L. 1989a Toerisme in ontwikkelingslanden. Tilburg University Press.
Theuns, H.L. 1989b Multidisciplinary focus on leisure and tourism. In: Annals of Tourism Research, vol 16, pp 189-204.
Thewessen, Th.J.M. & Bakker, J.G. 1987 Het gebruik van luchtfoto's bij recreatie onderzoek. Mededelingen van de werkgroep recreatie, no 7, Agricultural University, Wageningen.
Thiesen, G. 1977 Studier af turistbesoget på Skallingen 1975-1976. *In: Geografisk Tidsskrift, Bd 76, pp 78-82.*
Tin Sein 1980 Estimation of rural population and settlement analysis by photo interpretation techniques completed by field checks. Rural Survey course fieldwork report, ITC, Enschede.
Usher, M.B. 1973 Biological management and conservation. Ecological theory, application and planning. Chapman & Hall, London.
Veer, A.A.de 1984 Landschapsbeeldkartering: een overzicht. In: Landschap. Tijdschrift voor landschapsecologie en milieukunde, vol 1, no 1, pp 23-32.
Vegt, W.D.C.van der; Eckhardt, W. & Steenbergen, A.A.C. 1979 Structuur van de watersport in Friesland.
Veld, C. & Dijkema, K.S. 1990 Ekologische kaarten van de Waddenzee. In: Waddenbulletin, vol 24, no 4, pp 172-176.
Veld, C. & Dijkema, K.S. 1990 Ecological maps for pollution control in the Dutch Wadden Sea. In: Wadden Sea Newsletter, no 3/4, pp 33- 36.
Venema, E. 1990 Papegaaien als vakbroeders of: wàt weet men van de toeristische aanbodkant? In: Recreatie & Toerisme, no 10, pp 296-298.
Vet, F.de 1979 Grintgaten, openluchtrecreatie, luchtfotografie (3) Oeverrecreatie in Midden- en Zuid-Limburg. In: Recreatievoorzieningen, no 4, pp 186-191.
Vining, J. & Stevens, J.J. 1986 The assessment of landscape quality: major methodological considerations. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 167-186.
Vink, G.de 1988 Inspelen op veranderende recreatiepatronen. In: Openluchtrecreatie en vrije tijd. Recreatie reeks nr 2. Stichting Recreatie, Den Haag. pp 13-18.
Vlas, J.de 1985 Waddenzee in matrixvorm. In: ROM. Magazine over ruimtelijke ordening en milieubeheer, no 4, pp 3-8.
Voet, J.M.L.van der 1984 Recreatief medegebruik. In: Recreatie, vol 22, no 3, pp 11-15.
Voet, J.M.L.van der (ed) 1985 Plussen en minnen voor de openluchtrecreatie? Contactcommissie Openluchtrecreatie NLRO, Wageningen.
Voet, J.L.M.van der 1986 Leemten in kennis over recreatieplanning vragen om oplossing. In: Recreatie & Toerisme, no 5, pp 232-237+240.
Voet, J.M.L.van der 1989 Recreatie en het landelijk gebied. In: De Landeigenaar, juni, pp 12-16.
Voet, J.L.M.van der & Dijkstra, H. 1971 Recreatie onderzoek rond Kagerplassen en Braassemermeer. In: Recreatievoorzieningen, no 6, pp 171-179.
Voet, J.M.L.van der & Haak, M.Th. 1989 Op weg naar een recreatief toegankelijk gebied? In: Landinrichting, vol 29, no 5, pp 31-40.
Voskens-Drijver, M.E. 1987 Effecten verblijfsrecreatie op het natuurlijk milieu (1). In: Recreatie & Toerisme, no 12, pp 487-492.
Voto, K.De, El Abd, R. & Srirath, W. 1979 Fieldwork Study of Mérida, S.W.Spain: Human Geography Team Survey and Report. ITC, Enschede (unpublished report).
Warner, W.S. 1990 Accuracy and small-format surveys: the influence of scale and object definition on photo measurements. In: ITC Journal, no 1, pp 24-28.
Weber, P. 1982 Wahrnemung und Bewertung von Raumnutzungskonkurrenzen im Naturschutzgebiet "Westruper Heide". In: Natur und Landschaft, Jg. 57, Heft 7/8, pp 235-238.
Weerstra, J.F. 1990 Nederland-Waterland: wie is de roerganger? In: Recreatie & Toerisme, no 6, pp 171-172.
Werf, S.van der 1972 Effecten van recreatie op de vegetatie in natuurterreinen. In: Natuur en Landschap, 1972/2, pp 210-220.
Werkgroep Helmond, 1974 Landschapsonderzoek Helmond. Hoofdstuk 7. Visuele aspecten. Afdeling landschapsarchitectuur, Landbouwhogeschool, Wageningen.
Wezenaar, J.A. 1982 Planologie als programma voor levensecht recreatie-onderzoek. In: De relatie theorie-praktijk in recreatie-geografisch onderzoek. Nijmeegse geografische cahiers, no 19, pp 207-245.
Whyte, W.H. 1980 The social life of small urban spaces. The Conservation Foundation, Washington D.C.
Wittig, R. 1979 Vegetation, Flora, Entwicklung, Schutzwürdigkeit und Probleme der Erhaltung des NSG "Westruper Heide" in Westfalen. In: Abh. Landesmus. Naturk., 42, pp 3-30.
Wolfe, R.I. 1966 Recreational Travel: the New Migration. In: Ekistics, pp 117-123.
WTO (World Tourism Organisation) 1983a Development of leisure time and the right to holidays. WTO, Madrid.
WTO (World Tourism Organisation) 1983b Workshop on environmental aspects of tourism. Organized jointly by WTO & UNEP, 5-8 July 1983, Madrid.
WTO (World Tourism Organisation) 1988 Yearbook Tourism Statistics. Vol I.
WTR (Werkgroep Typologie Recreatievormen) 1973 Definities en condities openluchtrecreatie. In: Recreatie, vol 11, no 7.
Wijngaarden, W.van, 1988 Low-level aerial survey techniques. In: Küchler, A.W. & Zonneveld, I.S. (eds), Vegetation mapping. Kluwer Academic Publishers, Dordrecht, the Netherlands, pp 209-213.

Yanchev, I.Y. 1988 On the possibilities to optimize recreational areas around Sofia. In: Proceedings of the VIIIth International Symposium on Problems of Landscape Ecological Research. Spatial and Functional Relationships in Landscape Ecology. October 3-7, 1988, Zemplinska Širava, CSSR. Vol. 3, pp 130-135.

Yeomans, W.C. 1986 Visual impact assessment: changes in natural and rural environment. In: Smardon, R.C., Palmer, J.F. & Felleman, J.P. (eds), Foundations for visual project analysis. John Wiley & Sons. pp 201-222.

IJkelenstam, G.F.P. 1988 Bijna kwart miljoen Nederlandse huishoudens heeft een volkstuin. In: Recreatie & Toerisme, no 6, pp 178-18.

Young, A. 1973 Rural land evaluation. In: Dawson, J.A. & Doornkamp, J.C. Evaluating the human environment. Essays in applied geography. Edward Arnold Ltd, London, pp 5-33.

Zee, D.van der 1971 Rekreatie in en vanuit vaste buitenverblijven in het Drie Provinciën Gebied. Planologisch Studiecentrum Rijksuniversiteit Groningen, 1974.

Zee, D.van der 1973 Sample Collection Geography. Volume 12: Various, (Fisheries, Recreation, etc.). Geography Department, ITC.

Zee, D.van der 1977 Worden de waddeneilanden onder de voet gelopen? In: Waddenbulletin 1977-4, pp 403-407.

Zee, D.van der 1978 De bescherming van dorpsgezichten. In: Waddenbulletin, no 4, pp 610-613.

Zee, D.van der 1981 The impact of recreation on the rural landscape. In: Perspectives in Landscape Ecology. Proceedings of the International Congress organized by the Netherlands Society for Landscape Ecology in Veldhoven, the Netherlands, April 6-11, 1981. Pudoc, Wageningen, 1982, pp 148-149.

Zee, D.van der 1982 An analysis of recreational development using sequential aerial photographs. In: ITC Journal 1982-3, pp 362-366.

Zee, D.van der 1983 Man's activities and their impact on the natural landscape of the islands. Part 8.1 of chapter 8: Man's interference. In: K.J.Dijkema & W.J.Wolff (eds): Flora and vegetation of the Waddensea islands and coastal areas. Balkema, Rotterdam. pp 270-279.

Zee, D.van der 1985a Tourism and Environmental Conservation. Aid or Threat? Public lecture given for the Botswana Society on June 20th, 1985 at the National Museum, Gaborone, 8 pp.

Zee, D.van der 1985b Remote sensing en geografische informatie systemen. In: Landschap, 1985, no 4, pp 306-316.

Zee, D.van der 1986 Analysis and evaluation of recreational resources with the aid of remote sensing. In: Remote sensing for resources development and environmental managment. Proceedings of the 7th International Symposium of the ISPRS, Enschede, 25-29 August 1986. Commission VII: Interpretation of photographic and remote sensing data. International archives of photogrammetry and remote sensing, volume 26, part 7/2, pp 887-892.

Zee, D.van der 1987 The recreational resources of the Mae Sa Valley viewed in some theoretical context. (A challenge for further research and reflection). In: Proceedings of the seminar on "The role of geography in the tourism development", pp 66-88. Geographical Association of Thailand, Kanchanaburi, 26-29 October 2530.

Zee, D.van der 1988a Down by the waterfall. The waterfall-sites of the Mae Sa valley area analysed and evaluated as recreational resources. ITC, Enschede, May 1988.

Zee, D.van der 1988b Rekreatie in het waddengebied, zorg en zegen. In: Waddenbulletin, 1988, nr 3, pp 119-123.

Zee, D.van der 1988c The importance of the spatial aspect in the evaluation of recreational resources in the landscape. In: Proceedings of the VIIIth International Symposium on Problems of Landscape Ecological Research, October 3-7, 1988, Zemplinska Širava, Czechoslovakia; Theme 1: Spatial relations in Landscape Ecology, vol 1, pp 85-91.

Zee, D.van der 1988d Accessibility and the recreational use of waterfall sites. Poster presented at the VIIIth International Symposium on Problems of Landscape Ecological Research, October 3-7, 1988, Zemplinska Širava, Czechoslovakia.

Zee, D.van der 1988e Mae Sa's recreation boom remotely sensed. Analysing and evaluating Mae Sa valley's recreational resources with the aid of remote sensing. In: Proceedings of the ninth Asian Conference on Remote Sensing, November 23-29, 1988, Bangkok, Thailand; pp J-8-1/7.

Zee, D.van der 1989 The importance of the spatial aspect in the evaluation of recreational resources in the landscape. In: Ekológia (ČSSR), vol 8. no 2. pp 143-154.

Zee, D.van der 1990 The complex relationship between landscape and recreation. In: Landscape Ecology, vol 4, no 4, pp 225-236.

Zee, D.van der & J.A.Cox 1988 Monitoring in Moneragala district, Sri Lanka, with SPOT images. In: ITC-Journal, no 3, pp 260-271.

Zee, D.van der & Zwiep, K.van der 1977 Rekreatie en ruimtelijke ordening. In: Eilanden onder de voet. Werkgroep Rekreatie van de Landelijke Vereniging tot Behoud van de Waddenzee, Harlingen. pp 37-58.

Zonneveld, I.S. 1979 Landevaluation and land(scape)science. ITC textbook of photo-interpretation, vol VIII, Chapter VII. Second, amended and corrected edition. ITC, Enschede.

Zonneveld, I.S. 1984 Landschapsbeeld en landschapsecologie. In: Landschap. Tijdschrift voor landschapsecologie en milieukunde, vol 1, no 1, pp 5-9.

Zonneveld, I.S. 1987 Toepassingen van geavanceerde methodologieen voor ecologische inventarisaties. In: ITCetera, no 33, p 17-20 (reprinted from Vakblad voor Biologen, 1986).

Zonneveld, I.S. 1988a Observation means and platforms. In: Küchler, A.W. & Zonneveld, I.S. (eds), Vegetation mapping. Kluwer Academic Publishers, Dordrecht, the Netherlands. pp 233-248.

Zonneveld, I.S. 1988b Interpretation of remote sensing images. In: Küchler, A.W. & Zonneveld, I.S. (eds), Vegetation mapping. Kluwer Academic Publishers, Dordrecht, the Netherlands. pp 265-268.

Zonneveld, I.S. 1990 Scope and concepts of landscape ecology as an emerging science. In: Zonneveld, I.S. & Forman, R.T.T. (eds), Changing Landscapes: An Ecological Perspective. Springer-Verlag New York, Inc.

Zonneveld, J.I.S. 1960 The use of aerial photographs for geographical purposes. In: Geografisch Tijdschrift, pp 291-297.

Zonneveld, L.M.L. 1987 Betredingsonderzoek Schiermonnikoog. In opdracht van de Beheersadviescommissie van het Overlegorgaan Nationaal Park in oprichting Schiermonnikoog uitgevoerd door Langbroek, Bureau voor Landschaps-oecologisch Onderzoek, Leeuwarden.

Zube, E.H. 1987 Percieved land use patterns and landscape values. In: Landscape Ecology, vol 1, no 1, pp 37-45.

Zwaan, P., Lengkeek, J. & Voet, J.M.L.van der 1990 Gemeentelijk toeristisch beleid: een kwestie van kiezen! In: Recreatie & Toerisme, no 5, pp 127-132.

ANNEX

SPECIFICATIONS OF THE AIRPHOTOS AND CASE STUDIES REFERRED TO IN THE TEXT.

Of the different case studies referred to in this study, the type of material used -type, date(s) and scale(s) of airphotos, satellite images, maps- will be mentioned, as well as what has been the main topic for interpretation in that study. Also the location of the area will be indicated. When (sections of) photos have been used as illustration, also the source of the airphotos, if known, will be mentioned. The information will be presented for each case study separately and then be summarized in two tables, A.1 and A.2.

Weststellingwerf.
A special second home photo interpretation study was carried out in 1970 for an area in the municipality of Weststellingwerf in Friesland, the Netherlands (see figure A.1.). Airphotos of the whole area of 1962 in 1:25000 and airphotos of a part of the area of 1967 in 1: 8000 could be compared with a topographic map of 1:25000 on which the location of all second homes in the municipality in 1967 was indicated. The data for this map were collected by the municipality in order to be able to collect a special recreation tax. (Van der Zee, 1971).

Ameland, Loosdrecht, United Kingdom.
The *Sample Collection Geography* (Van der Zee, 1973) is a collection of stereo pairs, stereo triplets and small coverages of airphotos showing typical examples of various land uses and land cover types. It is available in several copies meant for self study purposes at the ITC in Enschede. Volume 12, *Various*, includes examples of recreational land use. Since 1973 no new examples have been added anymore. Of none of these airphotos the exact source is known. For none of the examples real field observations are available. The interpretations are based on specialist reference knowledge and in the case of number 12-7 also of local reference knowledge.
The numbers 12-5, 12-6, 12-12 and 12-13 are stereo pairs from the United Kingdom at scales of respectively 1:5000, 1:6000, 1:10560 and 1:3000. No exact locations are known.
Number 12-7 consists of four airphotos in a scale of approximately 1:18000, probably of June 1968, of the central part of the island of *Ameland*, one of the Dutch Wadden Sea islands (see figure A.1.).
The numbers 12-8, 12-9, 12-10 and 12-11 are taken from two airphoto coverages of the *Loosdrechtse Plassen* area, a lake district in Holland (see figure A.1.). One is at the scale of 1:17000, taken on 24-3-1968, the other of 1:8000, taken on 9-4-1968. Almost all information given by the 1:8000 can also be derived from the 1:17000. The larger scale is a big help however in speeding up recognition and it is also easier to mark the different categories, especially where they are complicated and mixed. The 1:17000 photos were taken on a Sunday or in an hour of peak traffic, because cars are more numerous than on the 1:8000 photos. But for both coverages applies that they are taken early in the watersport season because only very few boats are out sailing.

The Enschede area.
The Enschede case study was done especially to test the accuracy of interpretation of some recreational land uses. The area around Enschede (see figure A.1.) was chosen for two reasons. A coverage of recent airphotos, 28-7-1988, made by the ITC department of Aerial Photography at a scale of 1:7500 was available. The area being in the near vicinity of the ITC made a complete field check possible, without loosing too much time in travelling to and from the area. The interpretation was carried out in August/September 1989, the field observations were done October/December 1989. Not all parts of the municipality of Enschede were covered. The southern part was just missed in the photo flight, the northern part not included because of the airbase. Some sections are obscured by clouds. Of the available coverage the densely built-up urban areas were not incorporated in the interpretation.

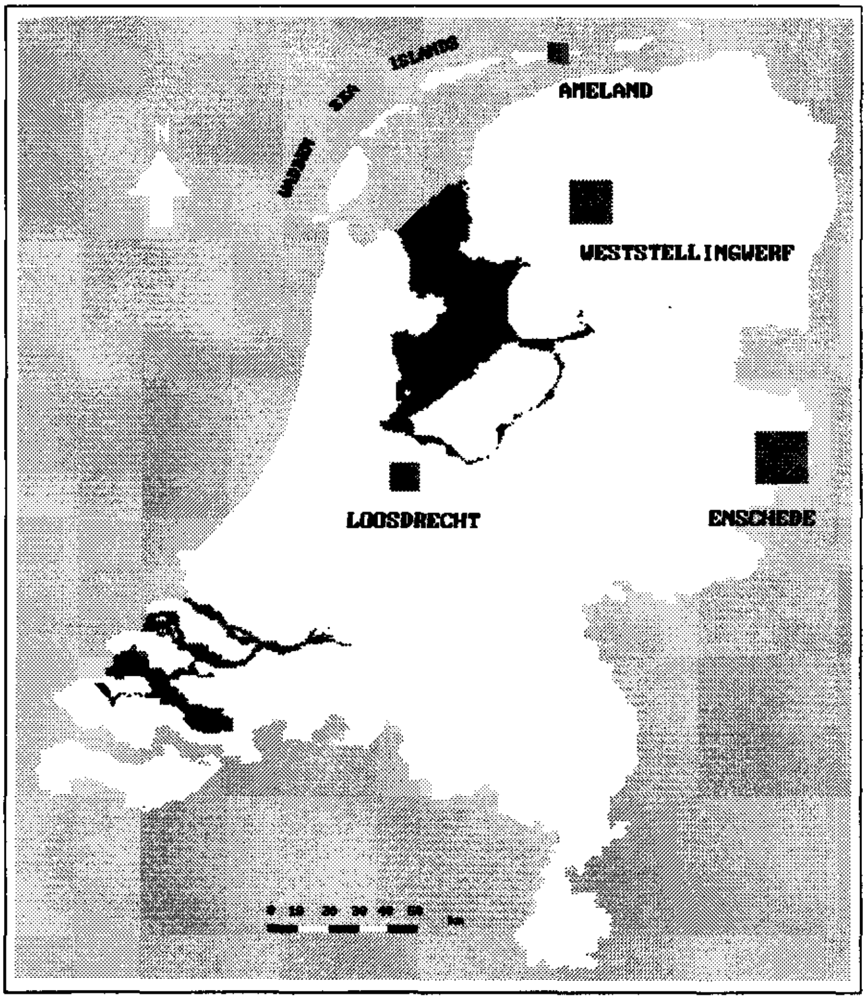

Figure A.1. *Location of the case study areas in the Netherlands.*

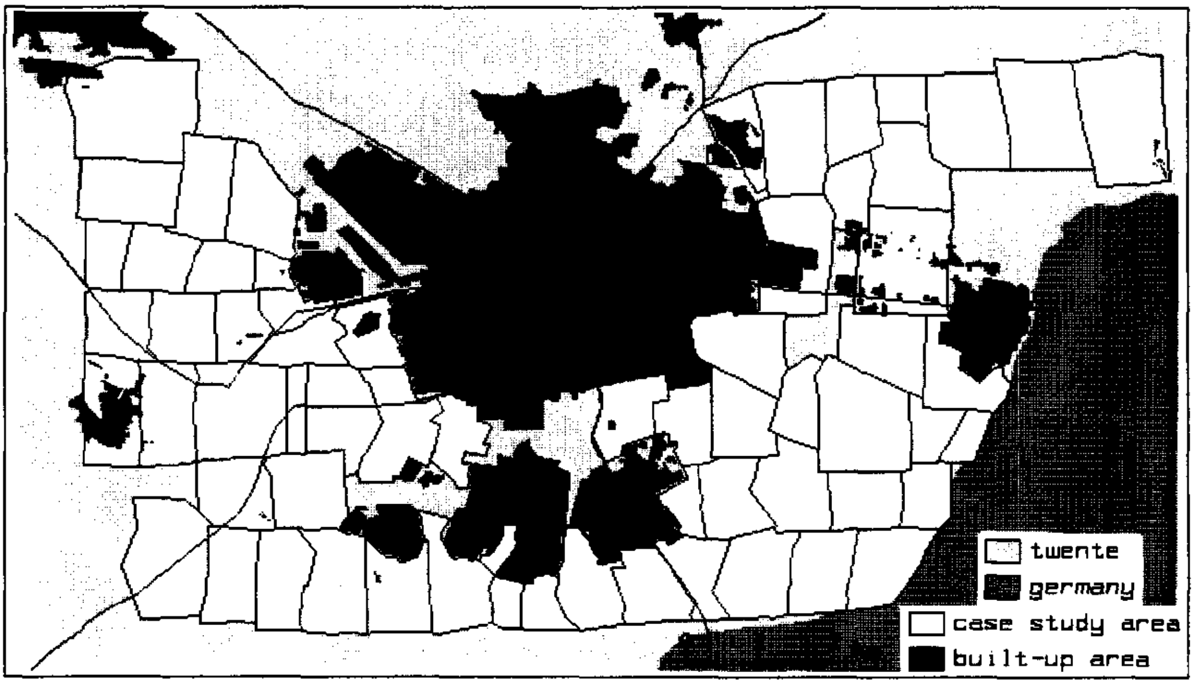

Figure A.2. *The airphoto coverage of the Enschede case study area.*

The coverage used is indicated in figure A.2. Of the rural area 130 airphotos in total were examined under the mirror stereoscope for anything related to recreation as well as for the roads and paths. All parts of the area have been visited in the field to check the correctness and completeness of the interpretation.

Lake Proserpina

The Proserpina case study was carried out in 1979 and 1980 in the context of the fieldwork programme of the Rural Survey course of the ITC in the region of Mérida in South Western Spain (see figure A.3). With respect to recreation the study concentrated on the area around Lake Proserpina, in origin a Roman reservoir, but also interpretations and field observations were made in a larger area around Merida. The airphotos used were from 1978 (1:20000), 1975 and 1974 (1:10000), 1969 (1:25000) and 1956 (1:32000). (Van der Zee, 1982). The 1978 airphotos were made by CEFTA for ITC, the other coverages were obtained from the Spanish topographical service.

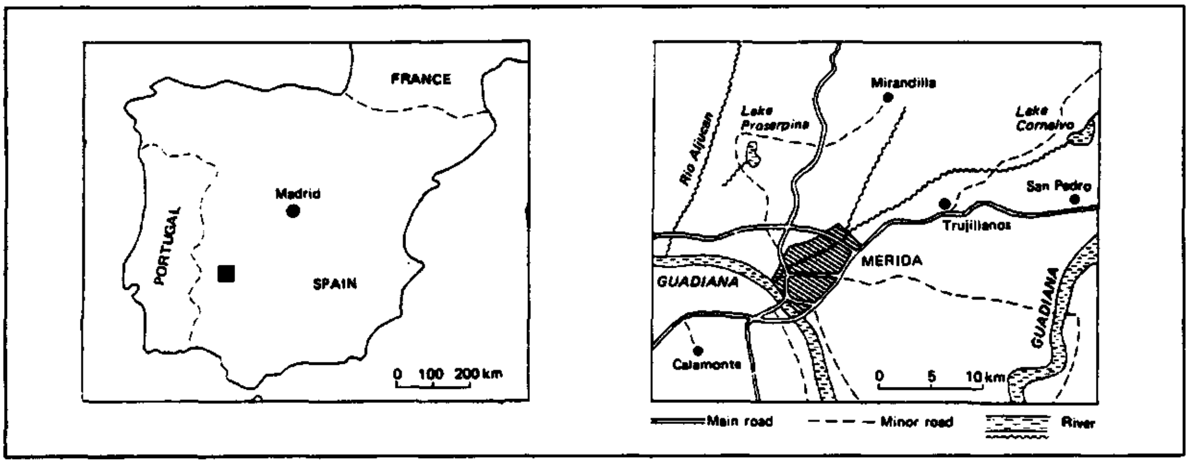

Figure A.3. *Location of the Proserpina study area.*

Mae Sa valley.

The Mae Sa case study was carried out in 1986 and 1987 in the Mae Sa valley area in Northern Thailand in the context of fieldwork of the Rural and Land Ecology Survey course. The airphotos used were from 1983/84 and 1976/77 (1:15000), 1969/70 (1:40000?) and 1954/55 (1:40000). The indication of two years means that some runs of the coverage are from December of one year, other runs from January of the following year. (Suwan and Nurbaya, 1986; Suwan, 1987; Van der Zee, 1987; 1988e). All photos were provided by the Thai Topographical Service.
In addition a panchromatic SPOT image of January 1987 was available, processed at ITC for interpretation on scale 1:50000 as well as 1:250000 and in normal, low values stretched, high values stretched and edge enhancement modes. (Van der Zee, 1988e).

The Puncak area.

The study of the Puncak area (see figure A.5) was carried out in the context of an MSc study in Rural and Land Ecology Survey at the ITC. Of the whole study area panchromatic airphotos of 1:50000 of 1982 were available. For the western part in addition black and white copies of originally colour infrared airphotos of 1982 at 1:10000 were available, and for the eastern part panchromatic airphotos of 1988 at scale 1:20000. Only for a narrow zone in which these two coverages overlapped sequential analysis could be carried out. Interpretation and fieldwork were done in 1990. None of these photos could be used for illustrations.

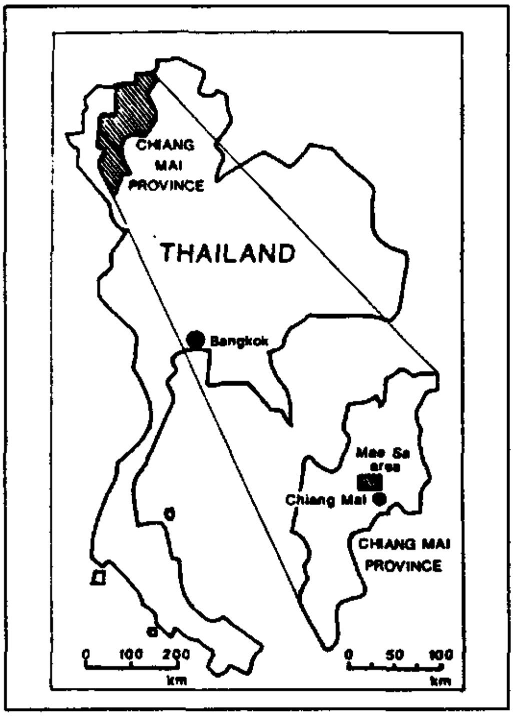

Figure A.4. *Location of the Mae Sa valley area.*

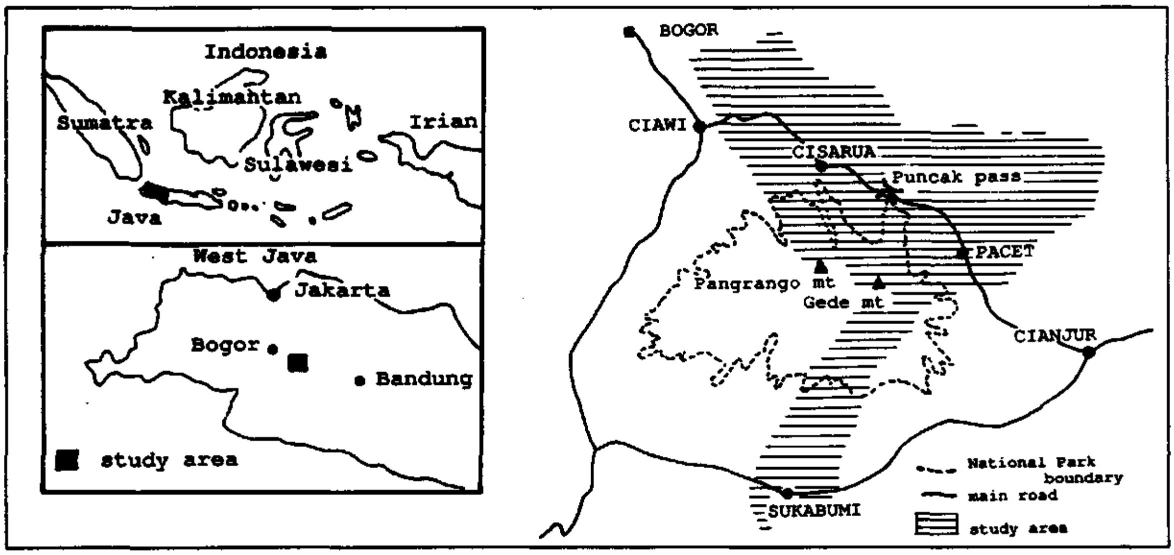

Figure A.5. *Location of the Puncak area.*

Dutch Wadden Sea Islands.

The survey of recreational erosion on the Dutch Wadden Sea islands (see figure A.1. for general location, and A.6. for the position of the individual islands) was carried out by Van Ittersum and Kwakernaak in an assignment of the *Werkgroep Recreatie* of the *Landelijke Vereniging tot Behoud van de Waddenzee* of which the author was a member. For the survey airphotos of 1969 were used with slightly different scales for the different (parts of) islands: Terschelling, 1:24000; Texel and Vlieland, 1:20000; Schiermonnikoog and the western part of Ameland, 1:22000; the eastern part of Ameland, 1:16000. Airphotos of 1975 were available for all islands except Texel in a scale of 1:20000. In addition for Schiermonnikoog airphotos of 1:6000 (1970) and 1:5000 (1976) were used.

The same coverages were also used by the author to analyse changes in the protected village areas of Schiermonnikoog, Vlieland, Ameland and Texel.

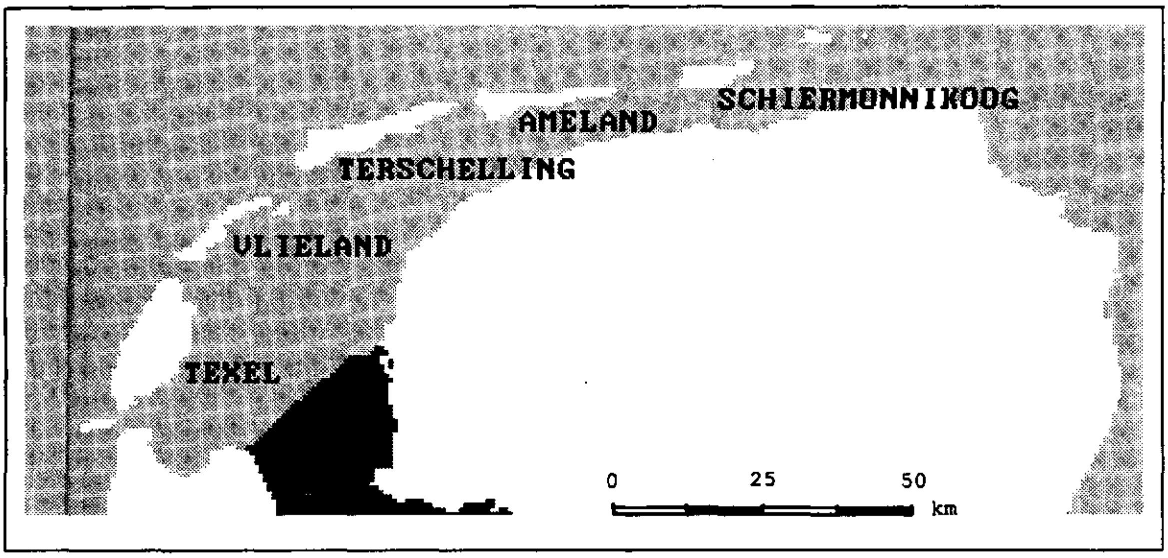

Figure A.6. *The Dutch Wadden Sea Islands.*

Schiermonnikoog.

For the island of Schiermonnikoog, for location see figure A.5, the study into recreational erosion has been repeated at least two times. The first time was in the context of a special study programme at the ITC, comparing the 1:5000 airphotos of 1976 with airphotos of 1979 of 1:10000 of which the sections needed for comparison have been enlarged to approximately 1:5000 too. Both series have been made by the ITC department of Aerial Photography. The study concentrated on the western part of the island. A simplified impression of the landscape of the island is given in figure A.7.

A re-interpretation of one sample was carried out on the 1976 airphotos in order to more closely analyse the degree of subjectiveness inherent to this type of interpretation. The location of this sample area is indicated in figure A.7.

A second comparison has been carried out in 1986 in the context of the studies preparing the National Park on Schiermonnikoog. The airphotos of 1976 now have been compared with airphotos of 1982. The fieldwork to check the interpretation could only be done in 1986 however.

The Dutch watersport case study areas.

The location of the watersport areas included in the case studies on watersport mentioned in chapter 4.3., pages 201 and 202, are presented in figure A.8. For details on the aerial photographs see table 4.3., 4.4. and 4.5.

The location of some of the case studies referred to in the last section of chapter 4.2. on impact on shoreline vegetation can also be found in this figure.

The vertical airphotos used as illustration all have been made by KLM Aerocarto for the different institutions carrying out the research. The oblique airphotos were made by Provinciale Waterstaat Friesland.

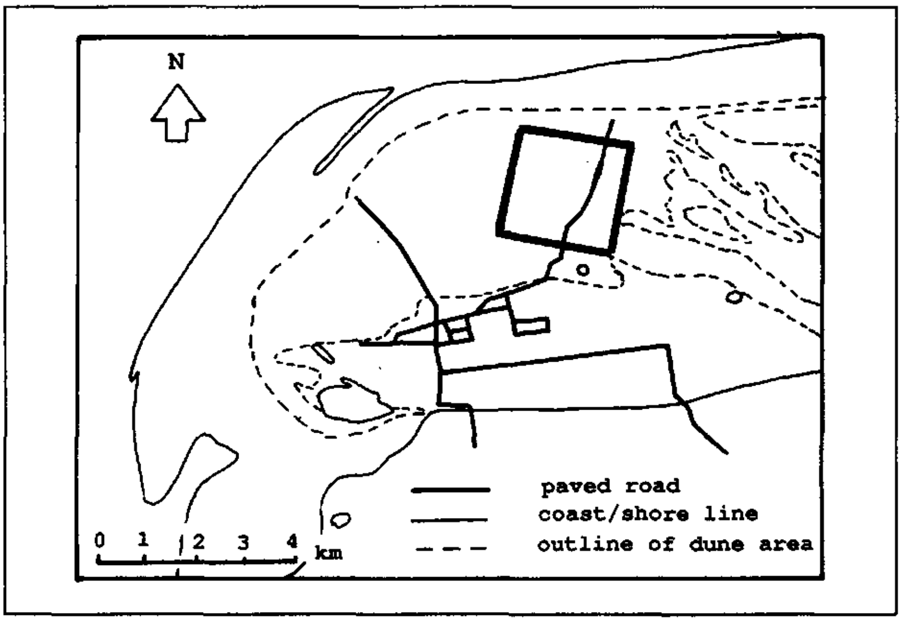

Figure A.7. *Schiermonnikoog with the location of the sample area.*

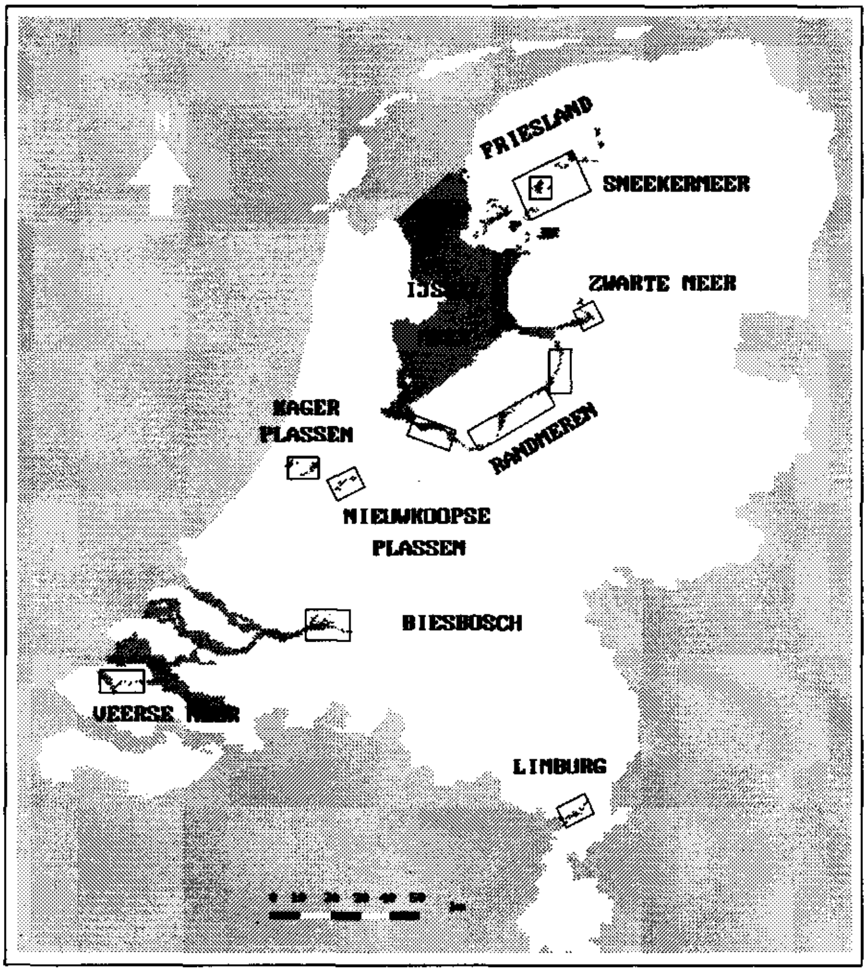

Figure A.8. *Location of the watersport case study areas in the Netherlands.*

Table A.1. *Type of remote sensing applied in the different case studies.*

Case study area	Type of material used			
	vertical airphotos		SPOT image	airphoto scale
	single coverage	sequences		
Weststellingwerf		+		1:25000; 1:8000
Dutch Wadden Sea islands		+		1:24000; 1:20000 1:22000; 1:16000
Ameland	+			1:18000
Schiermonnikoog	+	+		1:5000; 1:10000
Loosdrecht	+			1:17000; 1:8000
Enschede	+			1:7500
United Kingdom	+			1:5000; 1:6000 1:10560; 1:13000
Lake Proserpina (Spain)	+	+		1:20000; 1:10000 1:25000; 1:32000
Mae Sa Valley (Thailand)	+	+	+	1:15000; 1:40000
Puncak area (Indonesia)	+	(+)		1:50000; 1:10000 1:20000

For the various case studies on watersport surveys see table 4.3., page 208.

Table A.2. *Type of applications comprised in the different case studies.*

Case study area	Interpretation applied to:								
	1	2	3	4	5	6	7	8	9
Weststellingwerf			+						
Dutch Wadden Sea islands						+	+	±	+
Ameland	+	+	+	+	+	+			
Schiermonnikoog							+	+	
Loosdrecht	+	+	+	+					
Enschede	+	+	+	+	+				
United Kingdom				+					
Lake Proserpina (Spain)	+	+	+	+					+
Mae Sa Valley (Thailand)	+		+	±	+	+			+
Puncak area (Indonesia)	+		+	±	+				+
Dutch watersport case studies							+		

1 = Stay accommodation: hotels/restaurants;
2 = stay accommodation: camping grounds;
3 = stay accommodation: second homes;
4 = secondary facilities;
5 = transportation infrastructure;
6 = recreational resources;
7 = recreational impact;
8 = spatial behaviour of recreationists;
9 = development processes.

Curriculum Vitae.

The author was born in 1944 in Den Haag ('s Gravenhage), the Netherlands. After completing his secondary school in 1963, he started his study in human geography and planning at the State University of Groningen, with a specialisation in geography of recreation. After graduation in 1971, he had to fulfil his compulsory military service.

In 1972 he got a temporary assignment at the Geography Department of the International Institute for Aerospace Survey and Earth Sciences (ITC).

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