Planbureau-werk in uitvoering

Towards an indicator for recreational use of nature: modelling car-born visits to forests and nature areas (FORVISITS)

A. Jellema
S. de Vries

Werkdocument 2003/17

Alterra, Research Instituut voor de Groene Ruimte

Wageningen, 2003

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Inhoud

1 Introduction

1.1 Background

To assist policy makers in their decision making the Netherlands Environmental Assessment Agency (MNP) is developing a framework of indicators to assess the quality of nature and landscape. These indicators have to provide easy understandable and objective scientific information on the quality of our natural environment. Eleven of such indicators are under development, one of which is an indicator for recreation (Wiertz et al., in prep.). Indicators for recreation have been developed in two directions.

The first and main Recreation-indicator deals with recreation as a goal in itself: to provide the Dutch population with enough nearby opportunities for outdoor recreation in a natural environment. The development of this indicator will be reported elsewhere (De Vries et al., 2003). The second indicator, the topic of this report, deals more with the consequences of the recreational use of natural areas for the ecological functioning of the area. In this sense it is more a part of the indicator for Conditions for Biodiversity within the MNP-framework. The intention is that this sub-indicator can be used as input for the ecological models that are used for the Biodiversity-indicator. The link between this sub-indicator and the main Recreation-indicator is that, as much as possible, both will use the same data sets and basic assumptions as input. Beyond that, they develop in quite different directions. The main Recreation-indicator has a rather normative content and leads to judgements on the local supply situation of recreational opportunities for a given residential area. The present sub-indicator, on the other hand, tries to predict the actual usage of forests and nature areas as well as possible.

The sub-indicator for recreational use also has links with still other indicators within the MNP-framework. For example, the indicator on Landscape Appreciation is intended to be used as input for this sub-indicator, as an important part of assessing the recreational quality of destination areas. Furthermore, the intensity of recreational use indicates the social importance of the natural area. At a more abstract level, it may be partly by way of visits to natural areas that people (learn to) appreciate nature. Therefore the present sub-indicator may also be relevant for the indicator on Social Support for Nature and Landscape. However, this latter relationship has not yet crystallised within the MNP-framework.

1.2 Developing a (sub-) indicator for recreational usage

In this report a first attempt to develop a specific indicator for recreational usage is presented. In first instance the indicator is limited to visits made to a forest or nature area by car, with the intention to go and walk in the area. Furthermore, only visits originating from a local residential area are taken into account. The present indicator therefore only constitutes a first part of the overall indicator for recreation. Other parts will deal with visits originating from Dutch holiday resorts (campgrounds, bungalow parks), and visits to natural areas made by other means of transport (bicycling and walking). See also De Vries en Goossen (2001). With regard to the (recreational) purpose of the visits, the model focuses on walking and cycling.

For the development of the indicator ‘Car-Born Recreation’ a modelling approach has been chosen and the model used is a copy of a regional model used in a case to evaluate

recreational visits around the city of Breda (De Vries en Goossen, 2002). This model is automated and the study area has been extended to the whole of the Netherlands. The model has been named ***FORVISITS***. This report focuses especially on the problems of such a nation-wide application and how they have been tackled.

2 Model Description

The indicator Car-Born Recreation as described in this report is a distribution model based on a network analysis. As mentioned in the introduction, car-born recreational visits are visits to a forest or nature area for recreational purposes made by car originating from a local residential area. In the model visitors are distributed to forest and nature areas according to their attractiveness.

In short the *FORVISITS*-model functions as follows (see also figure 1):

1. For each residential area all access points to a recreational area within a certain distance (15 km) are selected. This selection defines the local choice set of access points.

2. For each access point within this choice set an attractiveness value is calculated, depending on size and quality of the destination area attached to this access point and the distance by road from the residential area to the access point according to:

   $$A_{ij} = (S_i * Q_i^2) / sqrt(D_{ij})$$ **Equation (1)**

   A_{ij} = Attraction value of destination with access point i for origin j
   S_i = Size of destination area attached to access point i
   Q_i = Quality score of destination area with access point i
   D_{ij} = Distance between access point i and origin j by road network

3. The ratio between the attraction value of an access point and the total attractiveness of all the local access points is used to distribute the yearly number of visits over the access points within the choice set, according to:

   $$V_{ij} = V_j * (A_{ij} / A_j)$$ **Equation (2)**

   V_{ij} = **Y**early number of visits to access point i by origin j
   V_j = Total number of visits per annum originating from origin j
   A_{ij} = Attraction value of destination with access point i for origin j
   A_j = Sum of all attraction values of all access points in the choice set for origin j

4. Because an access point can receive visits from several residential areas, all these visits are summed per access point in the last step of the model.

Several simplifying assumptions were made:

- All visits originate from (the midpoint of) a residential area
- A visitor does not travel beyond 15 km Euclidean distance from the place of residence to visit a natural area for recreational purposes.
- The yearly number of visits originating from a residential area only depends on size of the local population, and not on the composition of the population, nor is the number of visits

made from a certain residential area depending on the availability, accessibility or attractiveness of the recreational areas.
- The average number of car-born visits to natural area per person per year is 8 (after De Vries & Goossen, 2002).
- The likelihood of a natural area being visited depends only its attraction value, relative to the attraction values of the other local natural areas and not on other factors.
- Attractiveness is defined as a function of size, quality and accessibility of the recreational area. In this initial model distance by road is used as accessibility measure. The recreational quality is derived from another study (see the chapter about the data sets).

A more elaborate explanation of the different assumptions and how parameters are derived can be found in De Vries en Goossen (2002).

The model has been developed as an extension in Arcview and needs the Network Analyst extension. The input for the model is a network theme, an origin theme and a destination theme:

- The network theme is a line theme, containing the road network to calculate the travelling distances from the origins to the destinations. This road network can contain a cost-field according to the rules set by ESRI for the Network Analyst. If a cost-field is not available, distance will be used.
- The origin theme is a point theme containing all residential areas. This theme should contain an ID-field with a unique number for each area and a field containing the number of visits originating from this residential area.
- The destination theme is a point theme containing the access points to the recreational areas. This theme should contain a field with a unique ID for each access point, a field with the size of the area and a field with the quality of the area. NB: the (size of the) area should be uniquely assigned to the access point.

To optimise the working performance all points of both point themes should be situated on the network theme.

The model is built with input screens in such a way that some adjustments can be made easily:

- The radius to define local access points (choice set) can be changed
- The formula to calculate attractiveness can be adjusted
- Different cost-fields can be used as the accessibility measure

A listing of the model can be found in Appendix 1.

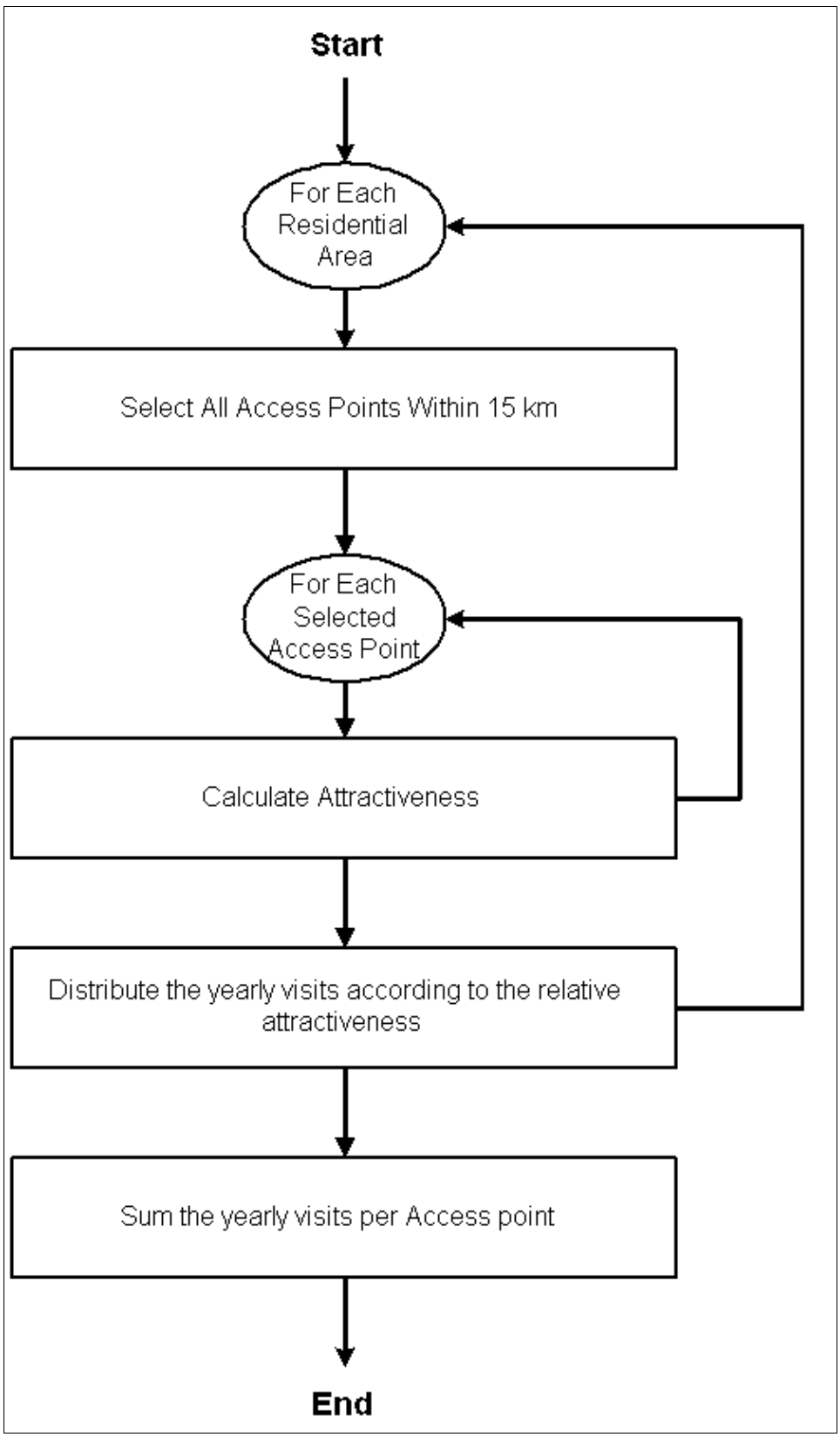


Figure 1: Recreation Indicator Car-Born Visits

3 Database-development

To make the model operational the three data sets had to be developed: a line theme containing the road network, a point theme with the residential areas and a point theme with the access points of the recreational areas.

3.1 Road network

To obtain a road network the National Road Database (NWB) has been used. This is a highly accurate line database (scale 1:10 000), that is updated several times a year by the ministry of Transport, Public Works and Water Management. Unfortunately this database contains different types of roads that are not suitable for cars, such as cycle paths and foot passages. These paths had to be removed from the database. However, the road type is not identified in the database. Therefore another database has been used to derive the required information. An overlay has been made with the Top10 Vector database. This database is a polygon database that is less up to date then National Road Database, but contains coding for different types of road.

Because of spatial inaccuracies the overlay was not 100% correct. The spatial inaccuracy was corrected by selecting per road section (as defined by the National Road Database) the Top10 code with the largest overlap (Figure 2).

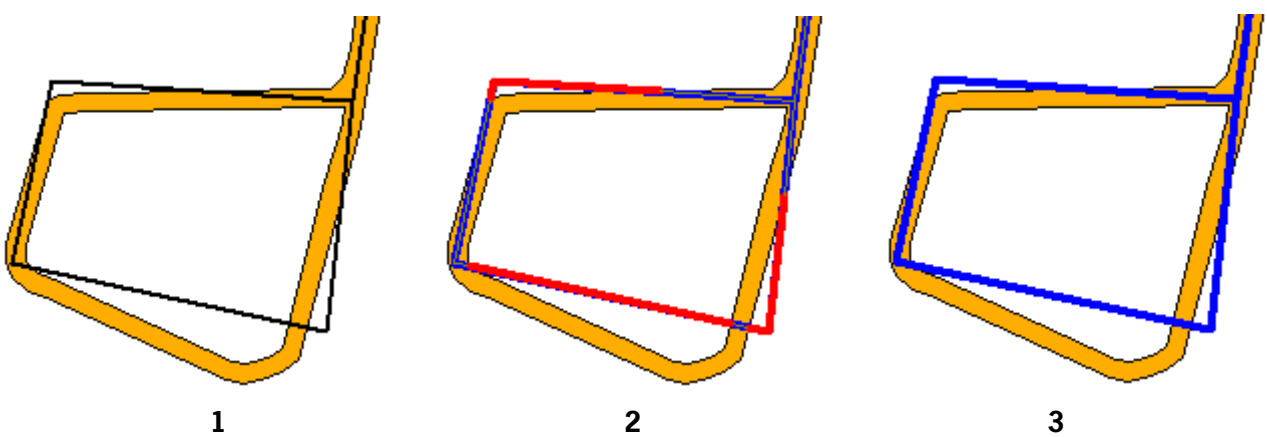


Figure 2: Thematic correction because of spatial inaccuracies

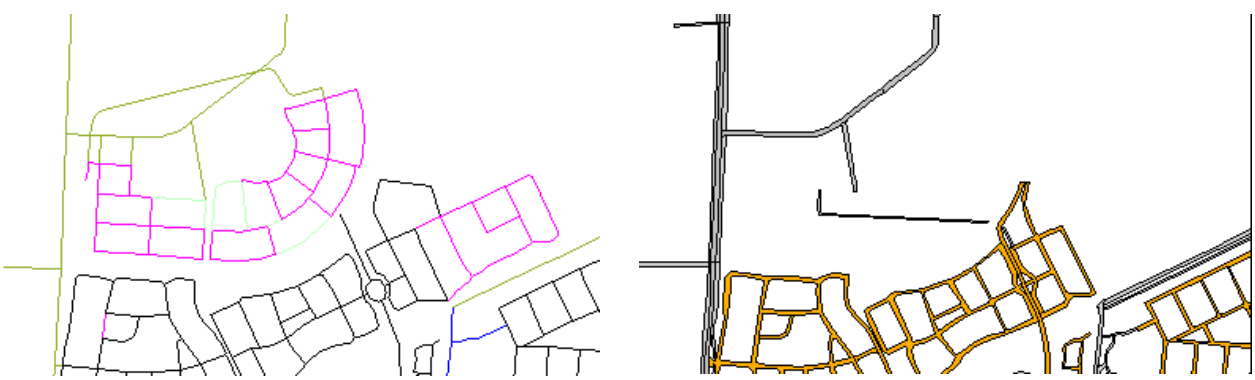
1. In step one the NWB arc is overlaid with the Top10 Vector Polygon.
2. The overlapping blue parts of the arc will get the Top10 vector code; the red part will receive no code.
3. By selecting per NWB road section the largest part of Top10 coded arc the whole road section can be recoded according to that code.

After the NWB road database has been coded according to the Top10 Vector database, the classification was been simplified, according to the table in Appendix 2. Seven road types were distinguished (Table 1).

Table 1: New codes used in the National Road Database (NWB)

Code	Description
1	Highway
2	Motorway
3	Connecting Road
4	Other Road
5	Street
6	Cycle Path
7	Foot Passage

Beside the spatial inaccuracy as mentioned above, there is also a temporal inaccuracy between the two databases. Because the Top10 Vector database is updated less frequent, some information is out of date. Because these inaccuracies are too complex, they have to be corrected by hand. This can be done by selecting the uncoded arcs and giving them the most likely code depending on their spatial configuration (Figure 3). Unfortunately, due to time constraints this operation has not been performed for the whole data set.



(1) NWB **(2) Top10 Vector**

Figure 3 : Temporal Inaccuracy

In the NWB database (**1**) it can be seen that a new quarter has been developed. This quarter is not present in the Top10 Vector database (**2**), only a connecting road is present, there for some of the streets of this quarter are coded by this road (the green roads). Others are not coded at all. To correct this by hand all of these roads should be selected and coded as street.

The resulting database has about 3% uncoded roads; most of these roads are streets in new residential areas. The algorithm used can be found in Appendix 1, listing 'Recode lines'.

3.2 Residential areas

The Residential Area data set has been created from the CBS neighbourhood database. The CBS neighbourhood is one of the smallest administrative units on which population information is nationally available. The Netherlands is divided in about 10,000 neighbourhoods with an average size of roughly 340 hectares. In order to calculate the yearly number of visits the population size of each neighbourhood is multiplied by the average number of visits made on a yearly basis by the Dutch. This value seems to be about 8 (De Vries en Goossen, 2002). Because the network analysis works with points rather than polygons, the centre point of a neighbourhood has been used as a starting point (Appendix 1, listing 'Centroids'). Each centre point has been snapped to the nearest road of the network to improve analysis performance. The algorithm used can be found in Appendix 1, listing 'Snap'.

3.3 Recreational areas

For recreational areas, it was thought desirable to use management units as the destination entities in the analysis. If there are data on the actual use of areas, these are likely to be available at this level. Also other managerial information with relevance to recreational use might be available at this level: access, recreational infrastructure and facilities etc. Some organisations, such as the National Forest Service (Staatsbosbeheer, SBB), have such a database for the areas they manage. However, there is no national database containing all management units that might be used as a recreational destination. Therefore another approach was chosen.

The recreational areas have been derived from the land use database as developed by Statistics Netherlands (CBS). This is a national database describing land use and land cover. From this database all forests and natural areas have been selected as recreational areas. The database also contains a class 'recreational areas'. This class itself has been neglected in our selection. This has been done, because this class consists largely of built-up areas, like parking places, or commercial facilities, like zoos and marinas. If such a recreation park contains a large piece of woodland, within the database it can usually be found in the forest or nature class, rather than in the recreational class.

Although some walking areas consist for a large part of grassland, like floodplains, this class has not been included into the recreational areas, because recreational grasslands can not be distinguished from non-recreational grasslands. Agricultural grasslands are considered unlikely to be chosen as a destination area, at least for car-born visits. Once people have got into their car, they are likely to visit destinations areas that are generally more preferred (see also Ploeger et al., 2000).

In addition to this selection three more rules haven been applied to create the recreational areas:

1. Only recreational areas larger than 5 hectares are used in the analysis.
2. Sometimes a recreational area consists of fragments of forest and nature, each of these parts being smaller than five hectares, but together covering more than five hectares. Therefore forest and nature areas being not further apart than 500 m are considered to be part of one recreational area.
3. Motorways and highways are considered not to be crossed by visitors. If a motorway or a highway crosses the recreational area this area will be split into two or more separate recreational areas using the road as a borderline.

This operation resulted in a data set with 8641 recreational areas of an average of 252 hectares.

The network analysis uses points rather then polygons as input. Therefore access points to the recreational areas had to be defined. The most logical way of defining access points for car-born recreation would be to use parking places. Unfortunately there is no database defining all parking places in the Netherlands, especially not those which are not paved. Therefore it has been decided to define the access points based on the roads entering the recreational area. To create the access points, the following rules have been used.

1. A recreational area can only be accessed from a local road, not from a highway or a motorway. The local road network has been used to make the overlay (Figure 4).

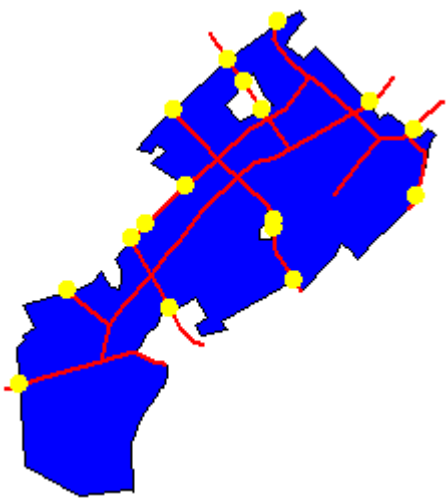


Figure 4: Recreational area overlaid with the local road network

2. A road has to penetrate the recreational area at least 10 m. Due to spatial inaccuracies, roads running parallel to the recreational area will cut the borderline several times. This rule has been developed in order to prevent this road from getting multiple access points (Figure 5).

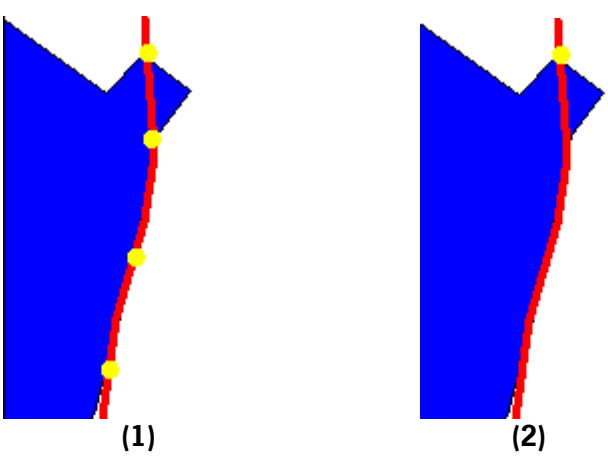


Figure 5: Access points due to spatial inaccuracies (1). Only where the road penetrates deeper then 10 m into the recreational area access points remain (2).

3. If a road arc cuts the recreational area multiple times, only the outer two access points remain. (Figure 6)

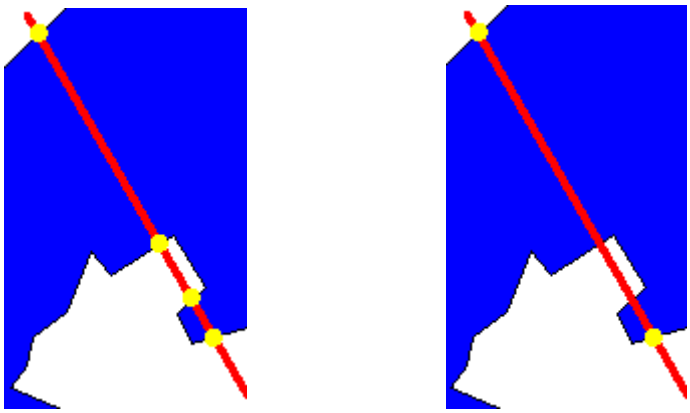


Figure 6: If a road arc cuts the recreational area multiple times (1) only the outer two access points remain (2).

4. Access points have to be situated at least 500 m Euclidean distance apart. If two access points are closer to each other then this 500 m, the access point closest to the centre of the recreational area will be removed. The relation with the centre point is used in an attempt to create the access points as much as possible at the outside of the shape (Figure 7)

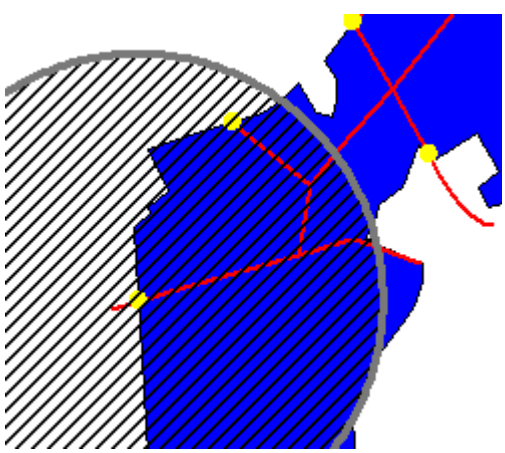
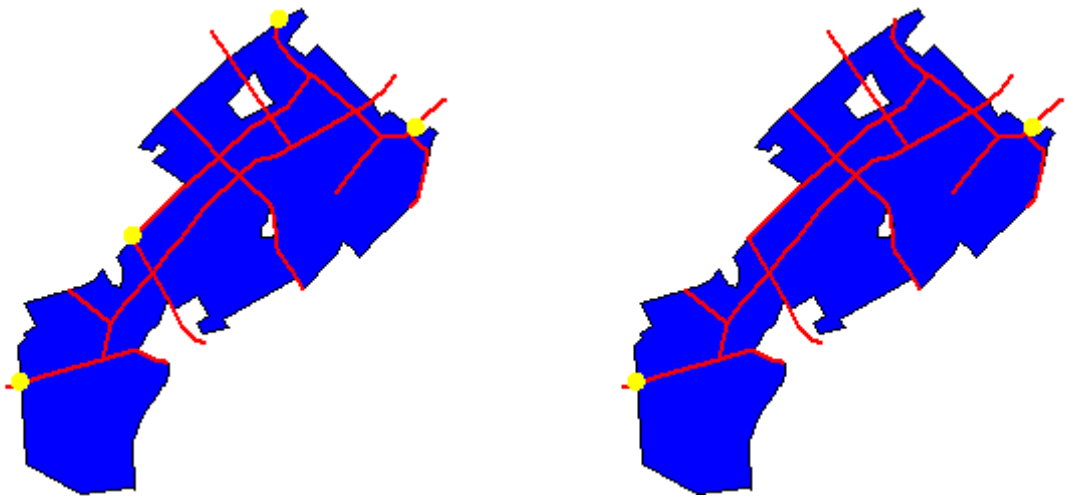


Figure 7: Access points have to be situated at least 500 m Euclidean distance apart. The grey circle represents this distance from one of the access points.

5. If many roads intersect the recreational area, a lot of access points will be created. Because in further analysis (see below) the access points are used to cut-up the recreational area into several sub-areas, it is important to have not too many access points. If a recreational area has too many access points the cutting can result in sub-areas smaller than 5 ha. Therefore the rule is adapted that the size of the recreational area divided by the number of access points should not be below 25 ha. 25 ha instead of

5 ha have been chosen, because if the recreational area has a very irregular shape it may be split up quite unevenly. In such cases the size of a defined sub-area might otherwise still fall under 5 ha. The necessary access points are removed one by one in such a way that for each reduction, the access point that is closest to all other access points is removed. This is done to keep the access points nicely distributed over the shape and to keep accessibility as large as possible from all directions (Figure 8).



(1) **(2)**

Figure 8 Reduction in the number of access points due to size constrains. Initially the ratio area/access points is 15.3 ha (1), after reduction 30.5 ha (2).

6. If no road is accessing the recreational area, the centroid of the polygon representing this area was snapped to the nearest road. This point represents a parking place from which the area can be accessed by foot (Figure 9). The algorithm used to calculate all these access points can be found in the Appendix 1, listing 'Access points'.

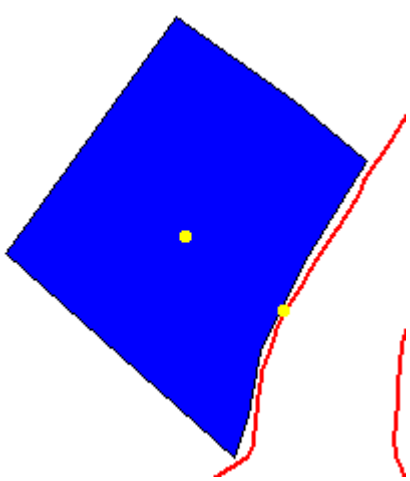


Figure 9 Snapped centroid to the nearest road.

To be able to calculate the attractiveness according to Equation (1), size and quality has to be addressed to each access point. Although the whole area of course can be accessed from each of the access points in the real world, in the analysis each access point is treated as a separate recreational area. The reason for this is the way the attraction value is calculated. The value of an area is linear to its surface area (Equation 1). This means if the other factors are considered constant (C) then:

Total Attraction value = Total Area * C

If the area has two access points and access point 1 provides access to Area 1 and access point 2 provides access to Area 2, then the sum of the attraction scores of the access points equals the total attraction value of the total recreational area.

Total Attraction value = Area_1 * C + Area_2 * C
= (Area_1 + Area_2) * C
= Total Area * C

If the total area would be addressed to each of the access points, the sum of the attraction values of the access points would be:

Total Attraction value = Total Area * C + Total Area * C = 2 * Total Area * C

Consequently in the last case the attractivity, and as a result the number of visits, would be directly related to the number of access points. Given the procedure that was used to derive the access points, this was considered an undesirable feature. Therefore it was decided to assign sub-areas to each access point and treat them as separate destinations. Of course, afterwards the visits to the different sub-areas may be summarised to arrive at the estimated total number of visits for the area as a whole.

The size of the sub-area is calculated as the total area of the recreational area divided by the number of access points.[1] Now the situation may occur that an area has less access points than desirable. Considering that the distance people will walk during one visit is limited, too large an area disclosed by only one access point will make the attraction value of this area unrealistically high. Therefore the maximum effective size was set at 500 ha per access point. If this value is exceeded, additional access points have been placed by hand. The algorithm used can be found in Appendix 1, listing Access points'. The quality of each sub-area is derived from the recreational quality grid developed by Goossen and Langers (1999a, 1999b). For each sub-area the average quality has been calculated.

During the GIS-analysis 10,000 Residential Areas were connected to about 8,000 Access Points with about 200,000 Arcs in order to distribute the Recreational Visits. The processing was not completely smooth due to some problems with the snap function of ArcView. Not all centre points of the residential areas were originally snapped to the nearest road. This

[1] An alternative procedure would have been to split up the area according to the nearest access point, creating Thiessen polygons.

problem became apparent during the analysis and resulted in several breaks in the procedure. The reason why points had not automatically snapped to the network remained unclear. The problem was solved by using another technique to project the centroids on the network. For about 60 points a small circle was drawn around the centroid that cuts the nearest network line in two points, using these two points, the new residential point was located in the middle and on the network line (Appendix 1, listing Circle'; Figure 10).

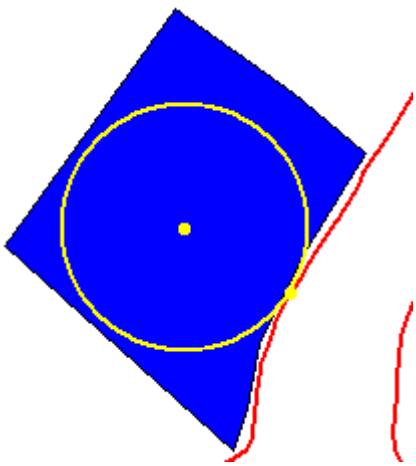


Figure 10 Locating a residential area by means of a circle

At the end of the analysis it became apparent that some of the centroids of the recreational areas also had failed to snap. This applies mainly to some of the small recreational areas, which have no intersections with the road network. It is assumed the fact that these destination areas subsequently remained without visits will not influence the bigger picture.

4 Results and Discussion

To get an overall impression, the number of visitors per access point is recalculated as the **number of visitors per ha per recreational area**. This visiting density is thought to be the most robust statistic for the comparison of model estimates with observed numbers of visits for specific destination areas. Due to the use of pseudo access points on areas defined by land use, the areas that are used within the model will not always coincide with actual destination areas (in terms of management units) and their (real) access points. The average visiting density for the pseudo access points within the real destination area, weighted by the size of the area attached to the pseudo access point, is expected to give the most robust model estimate. The visiting density numbers vary from 0 to 19,100 visits per ha on a yearly basis. These densities are not distributed evenly over the country (see Figure 11).

Clusters of high densities can be found in the recreational areas situated closely to or in between the very densely populated cities of the Randstad and in the southern region of the province Limburg (Figure 12).[2] By and large this is a logical outcome, because a major part of the Dutch population is situated here and there are not many natural areas to go to for a walk. Within the limits of the project, it is not possible to compare estimates for a large number of specific destination areas with their known numbers of visits, partly because such data are not widely available. Therefore a more global approach has been adopted. We first look at the areas with a high predicted visiting density.

4.1 High estimated densities

The National Forest Agency (Staatsbosbeheer, SBB) has assigned recreational targets to their areas. Visschedijk (1995) estimates that the type of area with the highest recreational target realises a visiting density of about 1300 visits per hectare per year on average. Over 1600 visits per hectare per year is used here as a threshold to select the areas with a high visiting density (see Figure 12). Areas with such a high visiting density should typically be well known for their recreational function, especially when considering that only car-born visits from residents with walking as the dominant activity are included in the estimate thus far. To get an idea of a reasonable upper limit, we will take a look at the actual density of visits in the forest & recreation area "Amsterdamse Bos", located directly south of the city of Amsterdam. This area of about 900 hectares includes recreational water surfaces and many recreational facilities. The "Amsterdamse Bos" is reported to draw a total number of 4.5 million visits.[3] This implies a density of 5000 visits per hectare per year. Given the location of this forest area and its special features, this is likely to be one of the highest densities in the whole of the Netherlands. So, higher densities are unlikely to occur in green areas outside the city limits. Actually, the model estimate for this area is about 3700 visits per hectare per year (for car-born visits by residents only). Since the additional features of this area are not completely accounted for in the model, this too low estimate does not seem unreasonable, also given the fact that other categories of visits (by bicycle, by foot) are not included in the estimate.

[2] Randstad: a conurbation in the west of the Netherlands.
[3] Website Amsterdamse Bos (2003): http://www.amsterdamsebos.nl/amsterdamsebos/abos/index.html

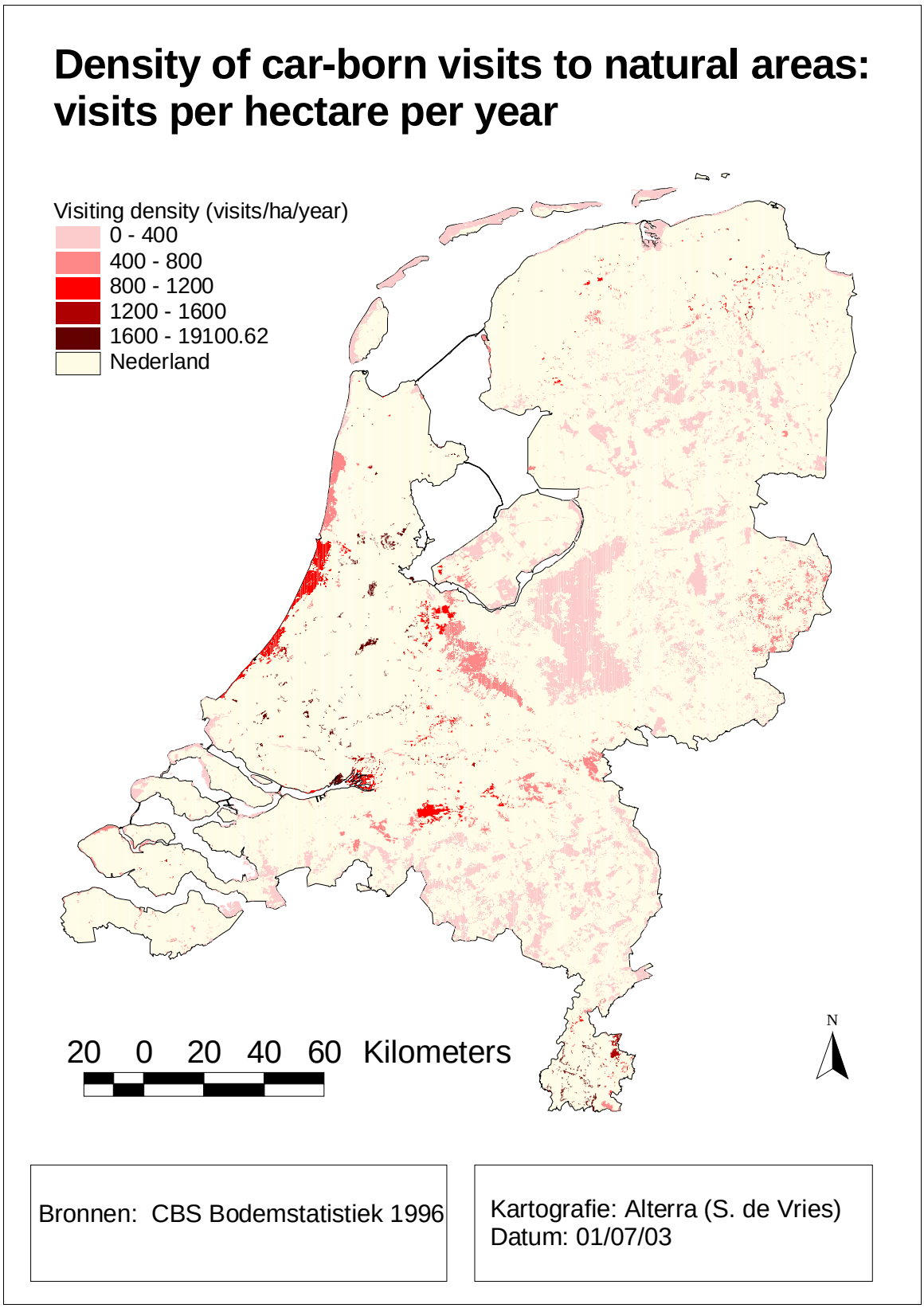


Figure 11 Density of visits to areas

About 210 of the 1800 natural areas (12%) have estimated densities above 1600 visits per hectare per year. Of these, about 50 areas, all located in the provinces South and North Holland, even have estimated densities above 5000 visits. And only in a few cases these areas are well known for their recreational function (such as the "Kralingse Bos" in Rotterdam with an estimated density of about 13.600 visits per hectare per year). So clearly the model in its present form overestimates the visiting density in a number of cases. When looking closer at the areas with high visitation densities, it appears that there are many small natural areas within the 15-km reach of several (large) cities that receive large numbers of visits. In fact, 62% of the 210 destination areas with visiting densities above 1600 per year are smaller than 15 ha. From the other 1590 destination areas with lower visiting densities, only 44% is smaller than 15 ha.

4.2 Low estimated densities

Also the destination areas with the lowest visiting densities (< 400) were examined in more detail. About 970 of the 1800 natural areas belong to this category (54%). By and large these areas are located in the east and the south of the Netherlands, especially on sandy soils (see Figure 13). Notable exceptions (with higher densities) are the southern part of the province Limburg in the south and the area around the cities of Enschede, Hengelo and Almelo in the east. This clearly has to do with the concentration of demand originating from these cities. Also remarkable is that the well-known national park "De Hoge Veluwe" falls within a low density sector. This may be due to the fact that visits originating from holiday resorts and campground have not yet been included in the model. The same is likely to be true for areas with low densities along the coast and on islands, especially when the natural area consist of dunes and beaches.

With regard to "De Hoge Veluwe" it is also likely that only some parts of this park experience a high density: other parts have little recreational infrastructure. Precisely because all visitors have to follow the (few) paths within the park, they are likely to experience the park as being quite heavily visited. On a per hectare basis, however, the density may not be that high after all. Actually, the estimated density is 136 visits per hectare per year. Given the size of the park, about 5000 hectares, the estimated number of visits by residents is 680,000. According to the official web-site of the park, the total yearly number of visits is 'only' about 600,000.[4] So, the present density is already on the high side![5]

[4] Website: http://www.hogeveluwe.nl/content/default.asp?action=subpage&subid=38&id=40

[5] It should be mentioned that entry to this national park is not free. This is something that our model only incorporates to some extent: it lowers the quality score of an area, but maybe not as much as it should. Because we did not use management units as destination area, but land use areas, the negative impact of the fact that one has to pay an entrance fee was averaged out over a much larger destination area than the park area. On the other hand, the park includes a famous museum and a popular visitor centre. This is also not taken into account in the model.

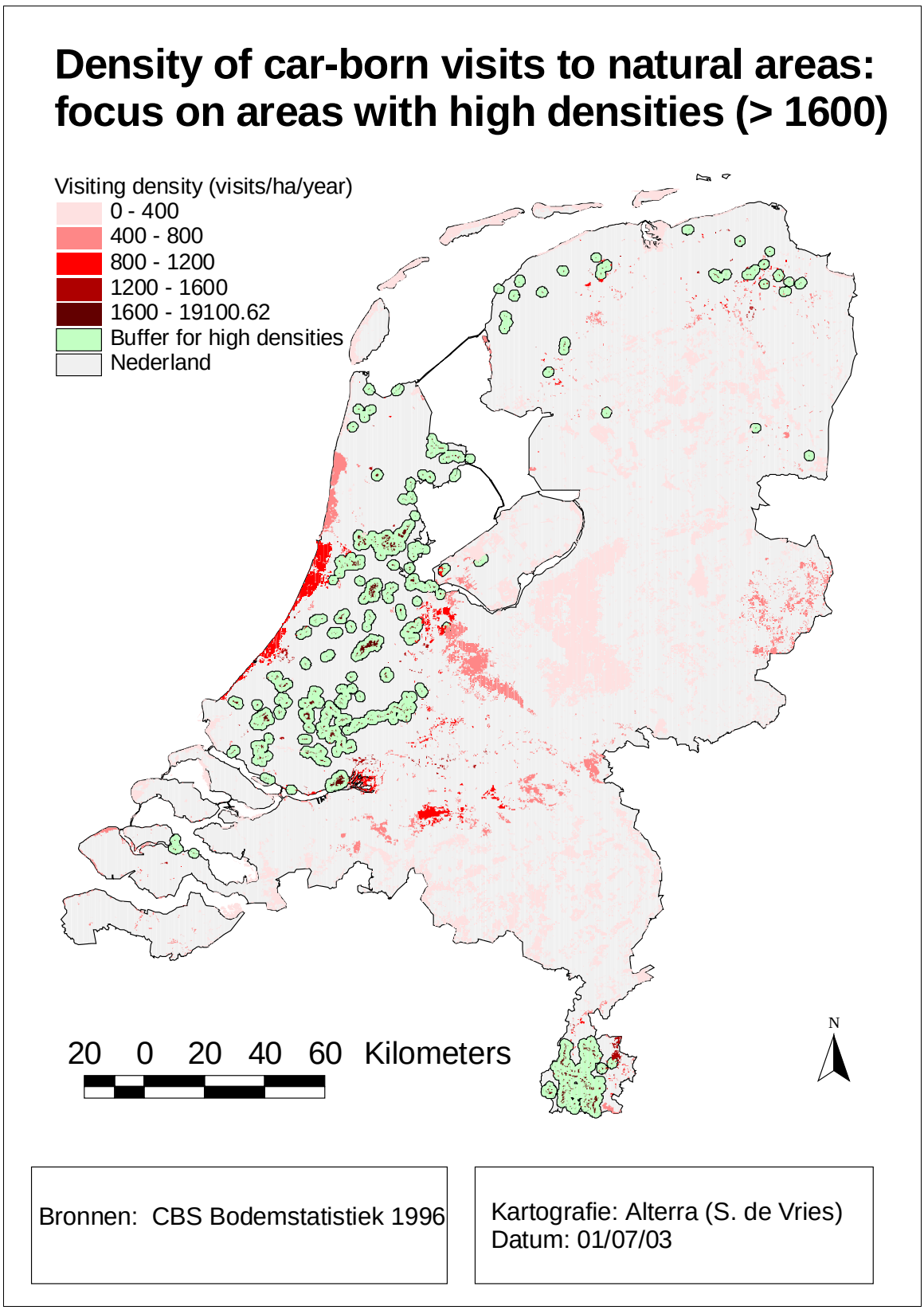


Figure 12 Areas being visited > 1600/ha

4.3 Possible reasons for too high estimates

To summarise, at this moment to largest errors in the model's predictions seem to occur in the case of often small areas within the 15-km radius of a large city, or of other densely populated residential areas, that have a relatively bad local supply situation. In those cases visiting densities are predicted to become unrealistically high. We will discuss some of the possible reasons for these large errors in more detail. To begin with, some of the model's assumptions may be wrong. For example, people living in the Randstad may be willing to travel beyond the 15 km used here as a limit to the choice set of local opportunities. Another possibility is that, because of a relatively bad local supply situation, they may visit natural areas for recreational purposes less frequently. Up till now the assumption has been that every Dutch citizen make the same number of nature trips by car. But supply could influence demand and the present distribution model may be too simplistic to reflect this. Moreover, also demand could influence demand. If an area is already heavily visited, the next potential visitor that comes along may decide to drive further, to another, more quiet area. Such 'interactions' between recreationists have not been included either, partly because it was expected that they would make the model considerably more complicated.

It may also be possible that some of the arguments introduced above interact with each other. If the choice set within 15 kilometres does not offer (enough) attractive and quiet destinations, then the choice set may be expanded. But at the same time the frequency of visits to forests and nature areas may be lowered. It may be noted that the impact of expanding the choice set will depend on the sensitivity of the attractiveness of a destination to the its distance from the origin. The higher this sensitivity, the lower the impact of expanding the choice set will be. The present impact of distance on the attractiveness may appear to be low (inversely related to the square root of the distance) when compared to model formulations suggested in other studies (see Sen & Smith, 1995, p. 93). However, in these other studies the model usually does not explicitly incorporate alternative destinations (see e.g. Brainard et al., 1999). If that is the case, the distance decay parameter also has to account for these competing destinations. This makes distance a much more important factor in those studies.

Finally, we want to go in a little bit more detail regarding the quality assigned to destinations. At present, the quality scores are based on a model that assigns scores to the whole of the Dutch countryside, so also to agricultural areas. This model may be too coarse with regard to differentiating between forests and natural areas. Such areas are now mainly found at the upper end of the quality scale. It would be preferable to have a quality indicator specifically geared to this more natural subset of outdoor recreation destinations. For example, taking into account that some small areas are now predicted to be (too) densely visited, it might be that small nature and forest areas should be depreciated compared to their present quality score. Preferably such adjustments to the model should be substantiated by empirical research.

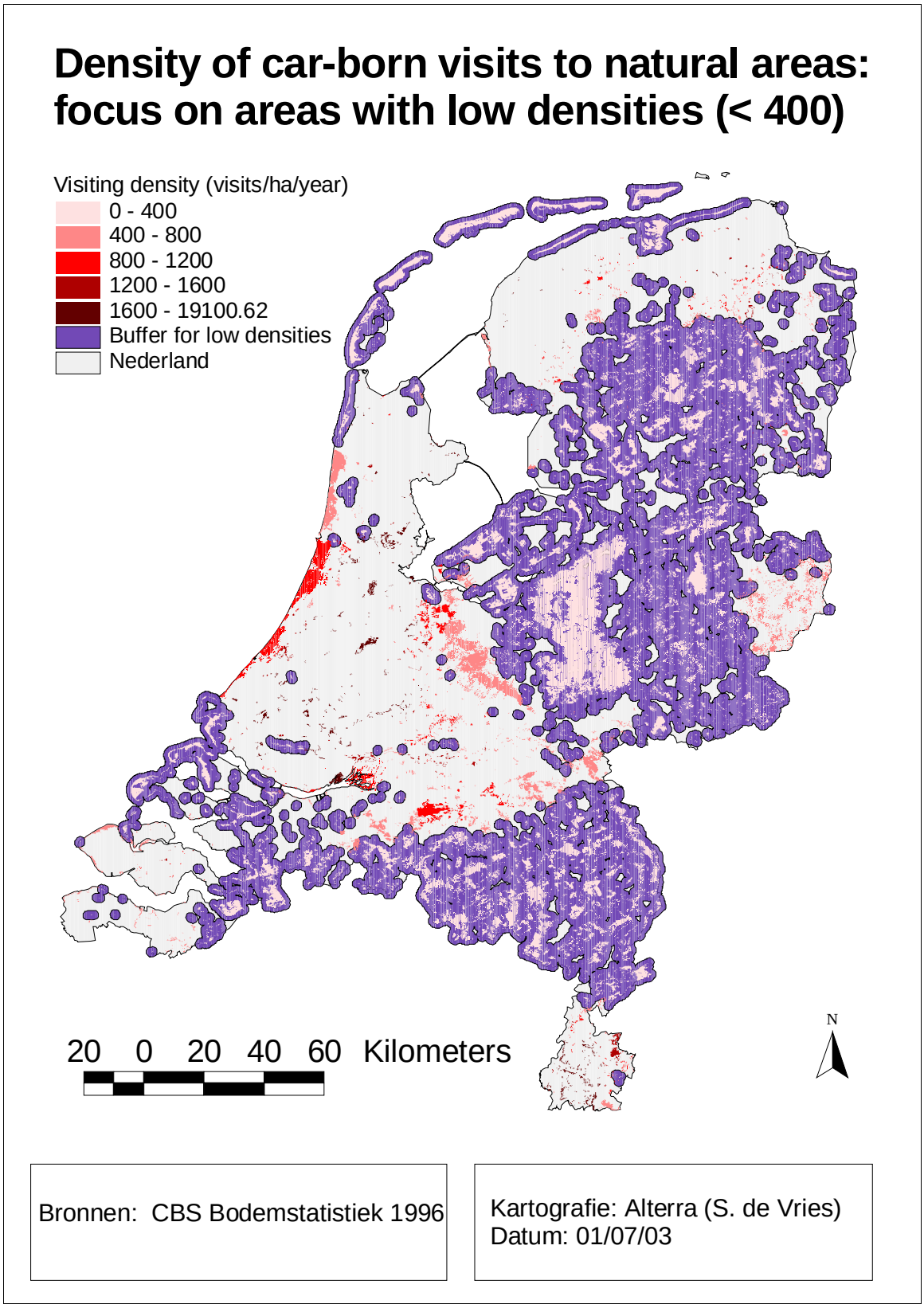


Figure 13 Areas being visited < 400/ha

4.4 Practical issues

Calculating the car-born visits in the way presented here proved to be a quite a laborious undertaking. It has taken two 2 gHz machines 3,5 days to calculate all the network paths necessary to distribute the visitors over the recreational areas. This is not the main problem, because it would be easy to leave a computer working overnight. Unfortunately the algorithm is very sensitive: centroids that are not located on the network arcs are likely to produce an error which means that the algorithm has to be restarted. This makes it very labour intensive. The reason why some points do not snap to the nearest network line is not looked into. To overcome this problem some (or all) the processing could be done in Arc/Info, assuming this program would tackle this software problems better, the snapping as well as the network analysis.

If the points are guaranteed to be positioned on the network lines, the algorithm works fine but remains very computing intensive. This is not a problem for smaller areas but calculating national data sets is very time consuming. This issue becomes even more problematic if the choice set is to be expanded from all access points within 15 km to e.g. 25 km. A simple way of making the whole exercise quicker is to use the Euclidean distance instead of the network distance. This would improve the processing speed a lot and makes experimenting with the algorithm more feasible. It would also make it easier to extend the algorithm in different ways, like redistributing visitors according to visiting density (to more quiet destination areas). But before the distance function can be simplified first the relative importance of the different parameters should be established, which brings us to the next section.

4.5 Further development

The *FORVISITS*-model as described in this working paper is still in its early stages. A considerable effort is required for this instrument to become a reliable tool. One of the first things that come to mind is a validation of the model's predictions. Or, perhaps better, a calibration of the model: adjusting parameters so as to make the predictions more in line with the actual visiting densities. However, this requires data on the actual yearly numbers of visits for a large number of destinations. It may be doubted whether such data are available in the Dutch situation. To collect such data especially for the purpose of calibration and validation will be an expensive undertaking. Another option is to perform sensitivity analyses. Especially with regard to distance it would help to know if predictions are much different when airline distances are used rather than distances by road. If not, the use of airline distances would make it much easier to, for example, extend the distance used to define the local choice set of destinations.

Apart from improving the model as such, also the input for the model may be improved. Especially the quality indicator could probably be refined, depending on the nationally available data on forests and nature areas with relevance for their recreational qualities (scenic beauty, suitability for the activity etc.). But also on the demand side some improvements might be made. For example, it might help to differentiate between population segments with different recreational demands and behaviour. In another study it has been shown that differentiating between people from ethnic minorities and autochthonous people has a considerable impact on the demand originating from a residential area (De Vries et al., 2003). The reason for this is that a. the demands of these two groups differ considerably and b. the two groups are not evenly distributed over residential areas. People from ethnic minorities seem to be focused more on urban green (city parks) and may visit natural areas outside cities much less often

than autochthonous people do. It would even be possible to have different sets of quality scores for these two population segments.

Finally, the model also needs to be expanded. Besides car-born visits, residents may also visit forests and nature areas using other modes of transport, especially by bicycle and by foot (when living very near the destination area). Furthermore, besides residents also tourists may visit these areas during overnight stays. In some destination areas this latter group may contribute even more to the total number of visits than the local people. Another issue, relevant with regard to the use of the model output as input for disturbance models, is the distribution of the yearly number of visits over seasons. For example, most types of birds are especially sensitive to disturbance in the breeding season. So, not only who recreates where is important, but also when. Given the desired improvements and expansions, the difficulty will be to find the appropriate balance between the level of detail and accuracy of the results and the ease with which the model may be applied at a national level, time-, effort- and cost-wise.

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Appendix 1 - Extension “Indicator Car-Born Visits”

Listing “Indicator Car-Born Recreation”

```
'This is the script for the Indicator Car-Born Recreation. The indicator is 'based on a network
analysis and distributes the number of visits in an 'residential area over the access points of a
neighbouring recreational areas 'according to their attraction value. Attraction is depending on
size, quality 'of the recreational area and distance by road to get there



  'Selecteer de actieve View
  aView = AV.GetActiveDoc
  If (Not (aView.Is(View))) Then
    MsgBox.Error("Active document is not a view.","Interact")
    Exit
  End


'SELECT THE NETWORKTHEME

 ' make a list of Line themes For the user to choose from
  aNetFTab = nil
  aLineThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Arc") Then
       ft = t.GetFTab
       If (NetDef.CanMakeFromFTab(ft)) Then
          aLineThemeList.Add(t)
       End
    End
  End


  ' did we find any Line themes?
  If (aLineThemeList.Count = 0) Then
    MsgBox.Error("No Network themes found.","Interact")
    Exit
  End

  ' prompt For the origin theme
  NetworkTheme = MsgBox.List(aLineThemeList,
                             "Select the Network theme:",
                             "Interact")

  If (NetworkTheme = NIL) Then
    MsgBox.Error("No Network Theme Selected.","Interact")
    Exit
  End


' DEFINE THE NETWORK

  aNetFtab = NetworkTheme.GetFTab

  ' did we find a networkable FTab?

  If (aNetFTab = nil) Then
    MsgBox.Error("Network table not found.","Interact")
    Exit
  End
```

```
  ' make the NetDef and check it for error
  aNetDef = NetDef.Make(aNetFTab)
  If (aNetDef.HasError) Then
    MsgBox.Error("NetDef has error.","Interact")
    Exit
  End

  ' make the Network object
  aNetwork = Network.Make(aNetDef)

  ' Select Cost Field
  klaNetCostFieldList = aNetDef.GetCostFields
  If (klaNetCostFieldList.Count > 1) Then
    klaNetCostField = MsgBox.Choice(klaNetCostFieldList, "Select a cost-item:", "Interact")
  Else
    klaNetCostField = klaNetCostFieldList.Get(0)
    MsgBox.Info("There is no allowed cost-item in the attribute table (see ''Setting up cost
fields in a line theme'' "+
                "in the ArcView online-help). Therefore the length of the lines will be used as
cost.",
                "Interact")
  End

  aNetwork.SetCostField(klaNetCostField)


'SELECT ORIGINE THEMES

  ' make a list of point themes For the user to choose from
  aPointThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Point") Then
      aPointThemeList.Add(t)
    End
  End

  ' did we find any point themes?
  If (aPointThemeList.Count = 0) Then
    MsgBox.Error("No point themes found.","Interact")
    Exit
  End

  ' prompt For the origin theme
  origTheme = MsgBox.List(aPointThemeList,
                          "Select the origin point theme:",
                          "Interact")
  If (origTheme = NIL) Then
    MsgBox.Error("No Origine Themes Selected.","Interact")
    Exit
  End

  origFTab = origTheme.GetFTab


'INITIALISE ID AND WALKINGDAYS FROM THEME

  ' make a list of fields
  fl = {}
  for each f in origFTab.GetFields
    if (f.IsVisible and (f.IsTypeNumber )) then
            fl.Add(f)
    end
  end

  ' check if valid conversion field exists
  if (fl.Count = 0) then
    MsgBox.Error("No Valid Walking Days Fields in Origine Theme","Interact")
    Exit
  end
```

```
  aField = MsgBox.List(fl,"Pick the field Containing the Origin ID","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Field Selected.","Interact")
     Exit
  end

  IDorigFieldname = aField.GetAlias



  ' check if valid conversion field exists
  if (fl.Count = 0) then
    MsgBox.Error("No Valid Walking Days Fields in Origine Theme","Interact")
    Exit
  end

  aField = MsgBox.List(fl,"Pick the field Containing the Number of Walking Days","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Field Selected.","Interact")
     Exit
  end

  WdaysFieldname = aField.GetAlias

  notlist = { "ID" , "IDorig" , "IDdest" , "Cost" , "Attr" , "Visits", "sum_visits" , "Sum_attr" }

  for each str in notlist
    if (WdaysFieldname = str) then
      MsgBox.Error("Field name can not be " + str + ". Change Fieldname in Table","Interact")
      Exit
    end
  end


  origShapeField = origFTab.FindField("Shape")
  origIDField = origFTab.FindField(IDorigFieldname)

  msgbox.info (IDorigFieldname.asstring, WdaysFieldname.asstring)


'INITIALISE MAXIMUM DISTANCE

  MaxDistString = MsgBox.Input( "Maximum Travelling Distance", "Interact", "15000" )

  If ( MaxDistString = NIL) Then
    MsgBox.Error("No Maximum Travelling Distance Selected.","Interact")
    Exit
  End


  MaxDist = MaxDistString.AsNumber


'SELECT DESTINATION THEMES

  ' prompt For the destination theme
  destTheme = MsgBox.List(aPointThemeList,
                          "Select the destination (facility) point theme:",
                          "Interact")

  If (destTheme = NIL) Then
    MsgBox.Error("No Destination Theme Selected.","Interact")
    Exit
  End

  destFTab = destTheme.GetFTab
```

```
'INITIALISE ID
  ' make a list of fields
  fl = {}
  for each f in DestFTab.GetFields

    if (f.IsVisible and (f.IsTypeNumber )) then
           fl.Add(f)
    end
  end

  ' check if valid conversion field exists
  if (fl.Count = 0) then
    MsgBox.Error("No Valid Walking Days Fields in Origine Theme","Interact")
    Exit
  end


  aField = MsgBox.List(fl,"Pick the field Containing the Destination ID","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Field Selected.","Interact")
     Exit
  end

  IDDestFieldname = aField.GetAlias




  destShapeField = destFTab.FindField("Shape")
  destIDField = destFTab.FindField(IDDestFieldname)


'INITIALISE QUALITY AND AREA FROM THEME

  ' simplify selection after multiple runs
  destFTab.UnjoinAll


  ' make a list of fields
  fl = {}
  for each f in destFTab.GetFields
    if (f.IsVisible and (f.IsTypeNumber )) then
      if (f.GetAlias <> "ID") then
        fl.Add(f)
      end
    end
  end

  ' check if valid conversion field exists
  if (fl.Count = 0) then
    MsgBox.Error("No Valid Quality or Area Fields in Destination Theme","Interact")
    Exit
  end

  aField = MsgBox.List(fl,"Pick the field Containing the Area","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Area Field Selected.","Interact")
     Exit
  end

  AreaFieldname = aField.GetAlias

  for each str in notlist
    if (AreaFieldname = str) then
      MsgBox.Error("Field name can not be " + str + ". Change Fieldname in Table","Interact")
      Exit
```

```
    end
  end

  aField = MsgBox.List(fl,"Pick the field Containing the Quality","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Quality Field Selected.","Interact")
     Exit
  end

  QualFieldname = aField.GetAlias

  for each str in notlist
    if (QualFieldname = str) then


      MsgBox.Error("Field name can not be " + str + ". Change Fieldname in Table","Interact")
      Exit
    end
  end


'INITIALISE ATTRACTIVENESS CALCULATION

  myAnswer = MsgBox.YesNo( "The Standard Calculation for Attractiveness is:   " + "[" +
AreaFieldname + "] * ( [" + QualFieldname + "] ^ 2 ) / ( [Cost] ^ 0.5 ) " + " Do you want to use
this Formula ?", "Interact", TRUE )
  if (myAnswer) then
    AttrCalculationString = "[" + AreaFieldname + "] * ( [" + QualFieldname + "] ^ 2 ) / ( [Cost]
^ 0.5 ) "
  else
    AttrCalculationString =  MsgBox.Input( "Adapt the Formula for Attractiveness", "Interact","["
+ AreaFieldname + "] * ( [" + QualFieldname + "] ^ 2 ) / ( [Cost] ^ 0.5 ) " )
  end

  if (AttrCalculationString = NIL) then
     MsgBox.Error("No Formula for Attractiveness.","Interact")
     Exit
  end


'CREATE THEME CONTAINING ALL THE PATHS

  pathFN = av.GetProject.GetWorkDir.MakeTmp("path","shp")

  pathtbl = FTab.MakeNew(pathFN, polyline)
  if (pathtbl.HasError) then
     if (pathtbl.HasLockError) then
        MsgBox.Error("Unable to acquire Write Lock for file " + pathFN.GetBaseName, "")
     else
        MsgBox.Error("Unable to create " + pathFN.GetBaseName, "")
     end
     return nil
  end

  pathSHAPEFld = pathtbl.FindField("Shape")

  pathIDfld = Field.Make("ID", #FIELD_DECIMAL, 8, 0)
  pathIDORIGfld = Field.Make("IDorig", #FIELD_DECIMAL, 12, 0)
  pathIDDESTfld = Field.Make("IDdest", #FIELD_DECIMAL, 12, 0)
  pathCostfld = Field.Make("Cost", #FIELD_DECIMAL, 12, 2)
  pathAttrfld = Field.Make("Attr", #FIELD_DECIMAL, 12, 2)
  pathVisitsfld = Field.Make("Visits", #FIELD_DECIMAL, 8, 2)

  pathIDfld.SetVisible( TRUE )
  pathIDORIGfld.SetVisible( TRUE )
  pathIDDESTfld.SetVisible( TRUE )
  pathCostfld.SetVisible( TRUE )
  pathAttrfld.SetVisible( TRUE )
  pathVisitsfld.SetVisible( TRUE )
```

```
  pathtbl.AddFields({pathIDfld, pathIDORIGfld, pathIDDESTfld, pathCOSTfld, pathAttrfld,
pathVisitsfld })

  pathtbl.SetEditable(False)
  pathID = 0

  pathTheme = FTheme.Make(pathtbl)




'START NETWORK ANALYSIS


'PER ORIGINE
  count = 0
  For Each rec In origFTab
    origPointList = {}
    count = count + 1
    p = origFTab.ReturnValue(origShapeField, rec)

    If (aNetwork.IsPointOnNetwork(p)) Then
      p.SetName(OrigFTab.ReturnValue (OrigIDField, rec).AsString)
      origPointList.Add(p)
    end



'SELECT DESTINATIONS WITHIN SEARCH DISTANCE

    destPointList = {}

    aCircle = Circle.Make( P.ReturnCenter , MaxDist)
    ShapeList = {}
    ShapeList.Add (aCircle)
    DestFTab.SelectByShapes (ShapeList, #VTAB_SELTYPE_NEW)

    i= 0
    For Each rec In destFTab.GetSelection
        i = i + 1
       p = destFTab.ReturnValue(destShapeField, rec)
       If (aNetwork.IsPointOnNetwork(p)) Then
          IDORIGValue = destFTab.ReturnVAlue (DestIDField, rec)
          p.SetName(IDORIGValue.AsString)
          destPointList.Add(p)

       End
     End



'LOCAL ANALYSIS

     ' set the  parameters For FindClosestFac
     numToFind = destPointList.Count        ' find all destinations
     cuttOff   = 0                          ' cut off distance
     toFrom    = TRUE                       ' travel to destination

     ' solve the problem
     numFoundList = aNetwork.FindClosestFac(origPointList, destPointList, numToFind, cuttOff,
toFrom)


     ' Make sure FindClosestFac succeeded
     If (not (aNetwork.HasClosestFacResult)) Then
         MsgBox.Error("Solution not found.","Interact")
         Exit
     End
```

```
'STORING RESULTS

     'If a theme in the view is being edited, Stop Editing it before creating new theme
      theView = AV.GetActiveDoc
      editThm = theView.GetEditableTheme
      if (editThm <> nil) then
        doSave = MsgBox.YesNoCancel("Save edits to "+editThm.GetName+"?","Stop Editing",true)
        if (doSave = nil) then
           MsgBox.Error("Save Cancelled.","Interact")
           Exit
        end

        if (editThm.StopEditing(doSave).Not) then
          MsgBox.Info("Unable to Save Edits to "
                 + editThm.GetName +
                ", please use the Save Edits As option", "")
          return nil
        else
          theView.SetEditableTheme(NIL)
        end
      end

      ' Storing all Path polygons in PathTheme
      if (pathtbl.StartEditingWithRecovery) then

       for each j in 1..numFoundList.get(0)

          aPathShape = aNetwork.ReturnClosestFacShape(0,j)
          listIDdest = aNetwork.GetClosestFacIndex(0,j)
          if (listIDdest >= 0) then
            IDdestValue = destPointList.Get(listIDdest).GetName.AsNumber
          else
            IDdestValue = -1
          end

          PATHcost= aNetwork.GetClosestFacPathCost(0,j)


          pathtbl.BeginTransaction
          rec = pathtbl.AddRecord
          pathtbl.SetValue(pathIDFld,Rec,pathID)
          pathtbl.SetValue(pathIDORIGfld,Rec,origPointList.Get(0).GetName)
          pathtbl.SetValue(pathIDDESTFld,Rec,IDdestValue)
          pathtbl.SetValue(pathCOSTFld,Rec,PATHcost)
          pathtbl.SetValue(pathSHAPEFld,Rec,aPathShape.AsPolyLine)
          pathtbl.EndTransaction

          pathID = pathID + 1


        end
      end


      pathtbl.StopEditingWithRecovery(TRUE)


    End


    pathtbl.DeActivate

'DISTRIBUTION OF VISITs OVER THE DIFFERENT RECREATIONAL AREA'S

  pathtbl.SetEditable(True)


  pathtbl.Join (pathIDDESTfld, destFTab, destIDField)


  ' Calculation attractiveness
```

```
  pathtbl.calculate (AttrCalculationString,pathAttrfld)

  ' Sum of all the possibilities within the seacrh area of each origin
  sumFN = av.GetProject.GetWorkDir.MakeTmp("temp","dbf")
  newVTab = pathtbl.Summarize( sumFN, dBASE, pathIDORIGfld,{pathATTRfld},{#VTAB_SUMMARY_SUM })
  newIDORIGField = newVTab.FindField("Idorig")



  'Distribution of the visits according to attractiveness of the local areas

  pathtbl.Join (pathIDORIGfld, OrigFTab, origIDField)


  pathtbl.Join (pathIDORIGfld, NewVTab, newIDORIGField)

  pathtbl.Calculate (" [" + WdaysFieldname + "] *  [attr] / [sum_attr]" , pathvisitsfld)

  ' Sum of all the visits in each Destination Area
  visitsFN = av.GetProject.GetWorkDir.MakeTmp("Visits","dbf")
  VisitsTbl = pathtbl.Summarize( visitsFN, dBASE, pathIDDESTfld,{pathvisitsfld},{#VTAB_SUMMARY_SUM
})
  VisitsIDORIGField = VisitsTbl.FindField("Iddest")
  DestFtab.Join (DestIDField, VisitsTbl, VisitsIDORIGField)
  pathtbl.UnjoinAll

  pathtbl.SetEditable(False)

'SHOWING RESULTS IN ARCVIEW

  ' Make the theme visible and add it to a view
  theView.AddTheme(pathTheme )
  pathTheme.SetName ("The many Routes to Destiny")

  'Make Visit Distribution Table visible
  VisitsTable = Table.Make (VisitsTbl)
  VisitsTable.SetName(VisitsTbl.GetName)
  VisitsTable.GetWin.Open

  'Make Destination Table visible
  DestTable = Table.Make (destFTab)
  DestTable.SetName(destFTab.GetName)
  DestTable.GetWin.Open
```

Listing "Access Points"

```
' This script creates the initial access for the Indicator Car-Born Recreation.
' First all intersect-points between the network theme and the recreational area themes are
defined.
' Secondly only access points on roads that penetrates a recreational area more the X meters are
preserved.
' This to take spatial inaccuracies into account.
' In the third step to make sure that all access points are at least Y meters apart.
' It two or more access points are to close one of the accespoints will be removed.

' The fourth step asures that there will be not more then Z parkings per Area
' The last step will create an access point for all areas which are not intersected by a road by
snapping to the nearest road


'Selecteer de actieve View
  aView = AV.GetActiveDoc
  If (Not (aView.Is(View))) Then
    MsgBox.Error("Active document is not a view.","Interact")
    Exit
  End


'SELECT THE NETWORKTHEME

 ' make a list of Line themes For the user to choose from
  aNetFTab = nil
  aLineThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Arc") Then
       ft = t.GetFTab
       aLineThemeList.Add(t)
    End
  End


  ' did we find any Line themes?
  If (aLineThemeList.Count = 0) Then
    MsgBox.Error("No Network themes found.","Interact")
    Exit
  End


  ' prompt For the Network theme
  NetworkTheme = MsgBox.List(aLineThemeList,
                             "Select the Network theme:",
                             "Interact")

  If (NetworkTheme = NIL) Then
    MsgBox.Error("No Network Theme Selected.","Interact")
    Exit
  End

  NetworkFtab = NetworkTheme.GetFtab

  aPolygonThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Polygon") Then
       ft = t.GetFTab
          aPolygonThemeList.Add(t)
    End
  End

' prompt For the origin theme
  AreaTheme = MsgBox.List(aPolygonThemeList,
                             "Select the Network theme:",
                             "Interact")
```

```
If (NetworkTheme = NIL) Then
  MsgBox.Error("No Network Theme Selected.","Interact")
  Exit
End

AreaFtab = AreaTheme.GetFtab

' make a list of fields
fl = {}
for each f in AreaFTab.GetFields
if (f.IsVisible ) then
   if (f.GetAlias <> "Shape") then
       fl.Add(f)
    end

  end
end


fieldlist = MsgBox.MultiListAsString(fl,"Pick the fields to Copy the result Theme","Interact")

addfieldlist = {}


if (fieldlist.Count = 0) then
   MsgBox.INFO("No Fields Selected.","Interact")
end


afield = field.make ("AccesID" , #FIELD_FLOAT  , 12 , 0 )

IDFieldIndex = fieldlist.find(afield)
if (IDFieldIndex = -1) then

    addfieldlist.add(afield)
end






for each f in fieldlist
  aFieldname = f.GetAlias
  if (afieldname <> "shape") then
    aPrecision = f.GetPrecision
    aType = f.GetType
    aWidth = f.GetWidth
    afield = field.make (aFieldname , aType , aWidth , aPrecision )
    addfieldlist.add(afield)
  end
  NoFields = False
end


outFName = av.GetProject.GetWorkDir.MakeTmp("point","shp")
pointFtab = FTab.MakeNew( outFName, Point )
PointShapeField = pointFtab.FindField( "Shape" )

pointFtab.AddFields ( addfieldlist )

myText = MsgBox.Input( "Select Minimum Penetration Depth", "Interact", "10" )

if (MyText = NIL) then
  msgbox.INFO("No Input, Value is 10", "Interact")
  MyText = "10"
end

X = MyText.AsNumber
```

```
    myText = MsgBox.Input( "Select Minimum Distance Between Acces Points", "Interact", "500" )

  if (MyText = NIL) then
    msgbox.INFO("No Input, Value is 500", "Interact")
    MyText = "500"
  end

  Y = MyText.AsNumber

  myText = MsgBox.Input( "Select Minimum Area per Acces Point in Square Meter", "Interact",
"50000" )

  if (MyText = NIL) then
    msgbox.INFO("No Input, Value is 50000", "Interact")
    MyText = "50000"
  end

  Z = MyText.AsNumber

  AreaShapeField = AreaFTab.FindField( "Shape" )
  NetworkShapeField = NetworkFTab.FindField( "Shape" )


  for each rec in AreaFtab

     ashape = AreaFtab.ReturnValue( AreaShapeField, rec )
     CenterP = ashape.ReturnCenter
     buffshape = aShape.ReturnBuffered (-1 * X)
     theGraphicShape = GraphicShape.Make(buffshape)


     theGraphicShape = GraphicShape.Make(buffShape)
     shapes = { buffshape }
     networkFTab.SelectByShapes (Shapes, #VTAB_SELTYPE_NEW)
     TotalAccessPointList = {}


     for each selrec in networkftab.getselection

        roadshape = networkFtab.ReturnValue( NetworkShapeField, selrec )
        amultipoint = roadshape.PointIntersection (aShape)
        buffmultipoint = roadshape.PointIntersection (buffShape)
        pbuff = buffmultipoint.returnbuffered (X * 4)


        apointlist = amultipoint.aslist

        AccessPointlist = { }

        for each p in apointlist

           if (pbuff.Contains (p)) then
               AccessPointlist.Add(p)
           end

        end



        numpoints = AccessPointlist.count



        if (numpoints > 2) then


          multilist = roadshape.Split (amultipoint)


          apointlist = {}
```

```
    for each ml in multilist

      buffml = ml.returnbuffered (1)

      multimulti = aMultiPoint.PointIntersection (buffml )
      multimultilist = multimulti.aslist


      if (multimultilist.count = 1) then
         apointlist.add( multimultilist.get(0) )
      end

    end

    Accesspointlist = apointlist

  else

       if (numpoints = 0) then


      end

  end


  for each p in AccessPointList

     TotalAccessPointList.add (P)

  end


end


numpoints = TotalAccessPointlist.count


if (numpoints > 1) then

  j = 0


      for each i in 0..(numpoints - 1)

          p1 = TotalAccessPointlist.get(j)

          remove = false


          for each p2 in TotalAccessPointList


               Dist = p1.distance (p2)


               if (Dist < Y) then


                  dist1 = CenterP.distance (p1)
                  dist2 = CenterP.distance (p2)

                  if (dist1 < dist2) then

                           remove = true

                  end
```

```
               end

            end

            if (remove = true) then

               TotalAccessPointList.remove(j)

            else

              j= j + 1


            end

         end




end

 numpoints = TotalAccessPointlist.count

if (numpoints > 1) then

 renum = numpoints - 2

 for each i in 1 .. renum
    area = ashape.returnarea
    parkdense = area / numpoints
    if (parkdense < Z) then

       ddlist = {}

       for each p in TotalAccessPointlist
           d = 0
           for each anotherp in TotalAccessPointlist
               d = d + p.Distance (anotherp)
           end

           ddlist.add(d)
       end

       dmin = ddlist.get(0)

       for each d in ddlist
           if (d < dmin) then
              dmin = d
           end

       end

       dref = ddlist.FindByValue(dmin)
       TotalAccessPointlist.remove(dref)
       numpoints =  TotalAccessPointlist.count

    end
 end
end

numpoints = TotalAccessPointlist.count

if (numpoints = 0) then

   p = ashape.ReturnCenter
   pbuff = p.returnbuffered(2000)
   buffshapes = {pbuff}
```

```
        NetworkFTab.SelectByShapes (buffshapes, #VTAB_SELTYPE_NEW)
        ddlist = {}
        shapelist = {}

        for each selrec in networkftab.getselection

            RoadShape = Networkftab.ReturnValue( NetworkShapeField, selrec )
            d = p.distance(RoadShape)
            ddlist.add(d)
            Shapelist.add(RoadShape)

        end


        if (ddlist.count > 0)  then

          dmin = ddlist.get(0)

          for each d in ddlist

             if (d < dmin) then
               dmin = d
               listnum = ddlist.findbyvalue (d)
             end

          end

          roadshape = shapelist.get(listnum)

          snapped = p.Snap (roadShape, 50000)


          if (snapped = true) then
              TotalAccessPointlist.add(p)
          end
        end
      end



      for each p in TotalAccessPointList

          newRec   = pointFTab.AddRecord
          pointFTab.SetValue( pointShapeField, newrec, p )


          for each f in addfieldlist
            aname = f.getalias

            if (aname = "AccesID") then

              InField = PointFtab.FindField( aname )
              pointFTab.SetValue( InField, newrec, newrec)

            else

              OutField = AreaFtab.FindField( aname )
              InField = PointFtab.FindField( aname )
              pointFTab.SetValue( InField, newrec, (AreaFtab.ReturnValue( OutField, rec)))


            end
          end

        end
    end

mergeTheme = FTheme.Make( pointFtab )

aView.AddTheme( mergeTheme )
```

Listing "Centroids"

```
'This Script converts a polygon theme in a centroid point theme.

'Selecteer de actieve View
  aView = AV.GetActiveDoc
  If (Not (aView.Is(View))) Then
    MsgBox.Error("Active document is not a view.","Interact")
    Exit
  End


'SELECT THE POLYGONTHEME


  ' make a list of point themes For the user to choose from
  aPolygonThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Polygon") Then
      aPolygonThemeList.Add(t)
    End
  End

  ' did we find any point themes?
  If (aPolygonThemeList.Count = 0) Then
    MsgBox.Error("No Polygon Themes found.","Interact")
    Exit
  End

  ' prompt For the origin theme
  PolyTheme = MsgBox.List(aPolygonThemeList,
                          "Select the overlay Polygon theme:",
                          "Interact")
  If (PolyTheme = NIL) Then
    MsgBox.Error("No Polygon Themes Selected.","Interact")
    Exit
  End

  polyFTab = PolyTheme.GetFTab

  ' make a list of fields
  fl = {}
  for each f in polyFTab.GetFields
    if (f.IsVisible ) then
      if (f.GetAlias <> "Shape") then
         fl.Add(f)
      end
    end
  end

  ' check if valid conversion field exists
  if (fl.Count = 0) then
  end

  aFieldlist = MsgBox.MultiListAsString(fl,"Pick the fields to copy into result
Theme","Interact")


  if (aFieldlist.count = 0) then
     MsgBox.Info("No Fields Selected.","Interact")
  end


  addfieldlist = {}
  namelist = {}

  for each f in aFieldlist

    aName = f.GetAlias
```

```
    namelist.add( aName )

    aType = f.GetType
    aWidth = f.GetPixelWidth
    aPrecision = f.GetPrecision

    aField = Field.Make (aName, aType , aWidth , aPrecision )
    addfieldlist.add( aField )

  end


  outFName = av.GetProject.GetWorkDir.MakeTmp("center","shp")
  intFtab = FTab.MakeNew( outFName, Point )
  intFtab.AddFields ( addfieldlist )

    PolyShapeField = polyFTab.FindField( "Shape" )
    intShapeField = intFtab.FindField( "Shape" )

    for each rec in PolyFtab


    aShape  = PolyFtab.ReturnValue( PolyShapeField, rec )

    newShape = aShape.ReturnCenter
    newRec = intFtab.AddRecord

    intFtab.SetValue( intShapeField, newRec, newShape)

    for each n in namelist


        intFtab.SetValue(intFTab.FindField(n),newrec,PolyFTab.ReturnValue(PolyFTab.FindField(n),
rec))


     end

   end


  intTheme = FTheme.Make( intFtab )
  aView.AddTheme( intTheme )
```

Listing "Circle"

```
'this script moves a point of a point theme to the nearest line of a line theme, based on a
circle
‘overlay


 Number.SetDefFormat( "ddddddddddd" )

  'Selecteer de actieve View
  aView = AV.GetActiveDoc
  If (Not (aView.Is(View))) Then
    MsgBox.Error("Active document is not a view.","Interact")
    Exit
  End


'SELECT THE NETWORKTHEME

 ' make a list of Line themes For the user to choose from
  aNetFTab = nil
  aLineThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Arc") Then
       ft = t.GetFTab
          aLineThemeList.Add(t)
    End
  End


  ' did we find any Line themes?
  If (aLineThemeList.Count = 0) Then
    MsgBox.Error("No Network themes found.","Interact")
    Exit
  End


  ' prompt For the origin theme
  NetworkTheme = MsgBox.List(aLineThemeList,
                             "Select the Network theme:",
                             "Interact")

  If (NetworkTheme = NIL) Then
    MsgBox.Error("No Network Theme Selected.","Interact")
    Exit
  End


  NetworkFtab = NetworkTheme.GetFtab

  outFName = av.GetProject.GetWorkDir.MakeTmp("trap","shp")
  mergeFTab = FTab.MakeNew( outFName, point )
  outField = mergeFTab.FindField( "Shape" )

  ' make a list of fields
  fl = {}
  for each f in networkFTab.GetFields
    if (f.IsVisible and (f.IsTypeNumber )) then
              fl.Add(f)
     end
  end
  aField = MsgBox.List(fl,"Pick the field Containing the ID","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Field Selected.","Interact")
     Exit
  end
  IDFieldname = aField.GetAlias
```

```
  apointThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Point") Then
       ft = t.GetFTab
          apointThemeList.Add(t)
    End
  End

' prompt For the origin theme
  ReserveTheme = MsgBox.List(apointThemeList,
                             "Select the Network theme:",
                             "Interact")

  If (NetworkTheme = NIL) Then
    MsgBox.Error("No Network Theme Selected.","Interact")
    Exit
  End

  ReserveFtab = ReserveTheme.GetFtab

  fieldlist = { }
  for each f in reserveFTab.GetFields
    aFieldname = f.GetAlias
    if (afieldname <> "shape") then
      aPrecision = f.GetPrecision
      aType = f.GetType
      aWidth = f.GetWidth

      afield = field.make (aFieldname , aType , aWidth , aPrecision )

      fieldlist.add(afield)
    end

  end
  mergeFtab.AddFields ( fieldlist )


  inField  = NetworkFtab.FindField( "Shape" )
  cutfield = reserveFtab.FindField( "Shape" )
  reserveFtab.Join (cutfield, networkFTab, inField)
  DistanceField = reserveFTab.FindField( "Distance" )
  IDField  = reserveFtab.FindField( IDFieldname )



   theBitmap = networkFTab.GetSelection

     for each rec in reserveftab

     P = reserveFtab.ReturnValue( cutField, rec )
     ID = reserveFtab.ReturnValue( IDField, rec )
     Dist = reserveFtab.ReturnValue( DistanceField, rec )
     Dist = 1.0001 * dist

      aCircle = Circle.Make( P.ReturnCenter , Dist)
      ShapeList = {}
      ShapeList.Add (aCircle)


   networkFTab.SelectByShapes (ShapeList, #VTAB_SELTYPE_NEW)


   newRec   = mergeFTab.AddRecord
   for each f in mergeFTab.GetFields

     aFieldname = f.GetAlias

     if (afieldname <> "shape") then
      afield = reserveFtab.FindField( aFieldname )
      avalue = reserveFtab.ReturnValue( afield, rec )
       mergeFTab.SetValue( f, newrec, avalue)
```

```
   end
  end


  for each selrec in networkftab.getselection

    snapshape = networkftab.returnvalue( infield, selrec)
    amultipoint =  acircle.PointIntersection (snapShape)
    apointlist = amultipoint.aslist



    numberofpoints = apointlist.count


  if (numberofpoints = 1) then

    apoint = apointlist.get(0)

  else

     if (numberofpoints = 2) then

       point1 = apointlist.get(0)
       point2 = apointlist.get(1)
       pointx = ( point1.getx + point2.getx ) / 2
       pointy = ( point1.gety + point2.gety ) / 2
       apoint = point.make( pointx , pointy)


     else

     if (numberofpoints = 0) then

        apoint = p


     else

         apoint = apointlist.get(0)

     end

     end


   end



   mergeFTab.SetValue( outField, newrec, apoint)


  end



 end

ReserveFTab.UnjoinAll

mergeTheme = FTheme.Make( mergeFTab )

aView.AddTheme( mergeTheme )
```

Listing "Snap"

```
'This script snappes a point to a line

  aView = AV.GetActiveDoc
  If (Not (aView.Is(View))) Then
    MsgBox.Error("Active document is not a view.","Interact")
    Exit
  End



 ' make a list of Line themes For the user to choose from
  aNetFTab = nil
  aLineThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Arc") Then
       ft = t.GetFTab
          aLineThemeList.Add(t)
    End
  End


  ' did we find any Line themes?
  If (aLineThemeList.Count = 0) Then
    MsgBox.Error("No Line themes found.","Interact")
    Exit
  End


  ' prompt For the origin theme
  NetworkTheme = MsgBox.List(aLineThemeList,
                             "Select the Network theme:",
                             "Interact")

  If (NetworkTheme = NIL) Then
    MsgBox.Error("No Network Theme Selected.","Interact")
    Exit
  End



  NetworkFtab = NetworkTheme.GetFtab

  outFName = av.GetProject.GetWorkDir.MakeTmp("Snapped","shp")
  mergeFTab = FTab.MakeNew( outFName, point )
  outField = mergeFTab.FindField( "Shape" )

  ' make a list of fields
  fl = {}
  for each f in networkFTab.GetFields
    if (f.IsVisible and (f.IsTypeNumber )) then
              fl.Add(f)
      end
  end
  aField = MsgBox.List(fl,"Pick the field Containing the ID","Interact")

  if (aField = NIL) then
     MsgBox.Error("No Field Selected.","Interact")
     Exit
  end
  IDFieldname = aField.GetAlias



  apointThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Point") Then
       ft = t.GetFTab
```

```
          apointThemeList.Add(t)
    End
  End

' prompt For the origin theme
  apointheme = MsgBox.List(apointThemeList,
                           "Select the Point theme:",
                           "Interact")

  If (NetworkTheme = NIL) Then
    MsgBox.Error("No Point Theme Selected.","Interact")
    Exit
  End

  pointFtab = apointheme.GetFtab

   fieldlist = { }
  for each f in pointFtab.GetFields
    aFieldname = f.GetAlias
    if (afieldname <> "shape") then
      aPrecision = f.GetPrecision
      aType = f.GetType
      aWidth = f.GetWidth

      afield = field.make (aFieldname , aType , aWidth , aPrecision )

      fieldlist.add(afield)
    end

  end
  mergeFtab.AddFields ( fieldlist )


  inField  = NetworkFtab.FindField( "Shape" )
  pointfield = pointFtab.FindField( "Shape" )
  pointFtab.Join (pointfield, networkFTab, inField)
  DistanceField = pointFtab.FindField( "Distance" )
  IDField  = pointFtab.FindField( IDFieldname )



 theBitmap = networkFTab.GetSelection

  for each rec in pointFtab

     P = pointFtab.ReturnValue( pointField, rec )
     ID = pointFtab.ReturnValue( IDField, rec )
     Dist = pointFtab.ReturnValue( DistanceField, rec )
     Distcircle = 1.0001 * dist
     Distsnap =  2 * dist

    aCircle = Circle.Make( P.ReturnCenter , Distcircle)



    shapelist = { acircle }

  networkFTab.SelectByShapes (Shapelist, #VTAB_SELTYPE_NEW)
   newRec   = mergeFTab.AddRecord
   for each f in mergeFTab.GetFields



    aFieldname = f.GetAlias

    if (afieldname <> "shape") then
      afield = pointFtab.FindField( aFieldname )
      avalue = pointFtab.ReturnValue( afield, rec )
      mergeFTab.SetValue( f, newrec, avalue)
```

```
  end
end


  for each selrec in networkftab.getselection
snapshape = networkftab.returnvalue( infield, selrec)

snapped = p.Snap (snapShape, DistSnap)

end




    mergeFTab.SetValue( outField, newrec, p)


  end



pointFtab.UnjoinAll
mergeTheme = FTheme.Make( mergeFTab )
aView.AddTheme( mergeTheme )
```

Listing "Recode lines"

```
'This Scripts recodes a linetheme on the basis of the largest overlapping lenght of another line
theme

'Selecteer de actieve View
  aView = AV.GetActiveDoc
  If (Not (aView.Is(View))) Then
    MsgBox.Error("Active document is not a view.","Interact")
    Exit
  End


 'SELECT THE LINETHEME

 ' make a list of Line themes For the user to choose from

  aLineThemeList = {}
  For Each t in aView.GetThemes
    If (t.GetFTab.GetSrcName.GetSubName = "Arc") Then
       ft = t.GetFTab
       aLineThemeList.Add(t)
    End
  End


  ' did we find any Line themes?
  If (aLineThemeList.Count = 0) Then
    MsgBox.Error("No Network themes found.","Interact")
    Exit
  end

  CodeTheme = MsgBox.ChoiceAsString(alinethemelist, "Select Line Theme with the Codes", "SELECT"
)

  CodeFTab = CodeTheme.getFTab

  for each f in CodeFTab.GetFields
      aName = "length"
      if (f.getalias = aName) then
        myAnswer = MsgBox.YesNo( "a Field called 'Length' already in to be Code Theme. Do you
want to recalculate Arc Lengths ?", "Interact", TRUE )
        if (myAnswer = True) then

           CodeFtab.SetEditable(True)
           CodeFTab.RemoveFields ({f})
           CodeFtab.SetEditable(False)

        else

          exit

        end
      end

  end

           aType = #FIELD_FLOAT
           aWidth = 12
           aPrecision = 2
           alengthField = Field.Make (aName, aType , aWidth , aPrecision )
           CodeFtab.SetEditable(True)

           CodeFtab.AddFields ( {alengthfield} )
           Calculation = CodeFTab.Calculate ("[shape].returnlength", alengthField)
           CodeFtab.SetEditable(False)


  tobeCodedTheme = MsgBox.ChoiceAsString(alinethemelist, "Select Line Theme to be Coded",
"SELECT" )
```

```
tobeCodedFTab = tobeCodedTheme.getFTab

if (CodeTheme = tobeCodedTheme) then

  Msgbox.Error ( "Selected the same Theme twice", "Interact")
  exit

end

addfieldlist = {}


  ' make a list of fields
fl = {}
for each f in CodeFTab.GetFields
if (f.IsVisible ) then
   if (f.GetAlias <> "Shape") then
       fl.Add(f)
    end

  end
end



tobecodedFtab.SetEditable(True)



f = MsgBox.ChoiceAsString(fl, "Select Coding Field", "SELECT" )

if (f = NIL) then
   MsgBox.Error("No Coding Field Selected.","Interact")
   Exit
end

  aName = f.getalias
  aType = f.GetType
  aWidth = f.GetPixelWidth
  aPrecision = f.GetPrecision
  aField = Field.Make (aName, aType , aWidth , aPrecision )
  addfieldlist.add( aField )


CodingField = CodeFtab.FindField( aname)

tobecodedFtab.AddFields ( addfieldlist )


tobeCodedShapeField = tobeCodedFtab.FindField( "Shape" )


for each rec in tobeCodedFtab

  theShape = tobeCodedFtab.returnvalue(tobeCodedShapeField , rec)
  theShapes = {theShape}
  CodeFtab.SelectByShapes (theShapes, #VTAB_SELTYPE_NEW)

  Codelist = {}
  Lengthlist = {}

  for each selrec in CodeFtab.GetSelection
    aLength = CodeFtab.returnvalue(alengthField , selrec)
    acode = CodeFtab.returnvalue(CodingField , selrec)

    if (codeList.FindByValue (acode) = -1) then
      codelist.add(acode)
      Lengthlist.add(aLength)
    else
      oldlength = 0
```

```
        checknum =  codeList.FindByValue(acode)
        oldlength =  lengthList.Get (checknum)
        newlength = alength + oldlength
        LengthList.Set (checknum, newlength)
      end
    end



    alength = 0000000

    for each l in lengthlist

    if (l >  alength) then

         alength = l

    end

    end

    if (alength > 0) then
      checknum =  LengthList.FindByValue (alength)
      thecode =  codeList.Get (checknum)

      tobeCodedFtab.SetValue( aField, rec, thecode)

    else

      tobeCodedFtab.SetValue( aField, rec, 1)

    end

end

      tobecodedFtab.SetEditable(False)
```

Appendix 2 - Recoding Table “Top10 Vector Codes”

TDN_CODE	TDN Description	Recode	Description
2002	Autoweg ongelijkvlrs 2 rijb.	1	snelweg
2003	Autoweg ongelijkvlrs 2 rijb.	1	snelweg
2102	AW-rood	2	autoweg
2103	AW-rood	2	autoweg
2342	Autoweg 2 rijb.	2	autoweg
2343	Autoweg 2 rijb.	2	autoweg
2802	Verb. weg/auto-weg 2 rijb.	2	autoweg
2803	Verb. weg/auto-weg 2 rijb.	2	autoweg
2872	Verh. weg lok. belang 2 rijb	2	autoweg
2873	Verh. weg lok. belang 2 rijb	2	autoweg
2902	Verb. weg/auto-weg > 7	2	autoweg
2903	Verb. weg/auto-weg > 7	2	autoweg
2083	Autoweg lok. belang > 7	2	autoweg
2442	Autoweg lok. belang 2 rijb.	2	autoweg
2443	Autoweg lok. belang 2 rijb.	2	autoweg
2202	Hoofdverb. weg 2 rijb.	3	verbindingsweg
2203	H8	3	verbindingsweg
2302	Hoofdverb. weg > 7	3	verbindingsweg
2303	H > 7	3	verbindingsweg
2402	H > 4	3	verbindingsweg
2403	H > 4	3	verbindingsweg
2503	Hoofdverb. weg 2-4	3	verbindingsweg
3002	Verh. weg 2 rijb.	3	verbindingsweg
3003	Verh. weg 2 rijb.	3	verbindingsweg
3102	Verh. weg > 7	3	verbindingsweg
3103	V > 7	3	verbindingsweg
3202	V > 4	3	verbindingsweg
3203	V > 4	3	verbindingsweg
3302	Verh. weg 2-4	3	verbindingsweg
3303	V > 2	3	verbindingsweg
3342	L > 2	3	verbindingsweg
3343	L > 2	3	verbindingsweg
3142	L > 7	3	verbindingsweg
3143	L > 7	3	verbindingsweg
3242	L > 4	3	verbindingsweg
3243	L > 4	3	verbindingsweg
3402	Overige Weg > 2m	4	overigeweg
3403	Overige Weg > 2m	4	overigeweg
3412	Ged. verh. weg > 2	4	overigeweg
3413	GV3	4	overigeweg
3432	Onverh. weg > 2	4	overigeweg
3433	OW3	4	overigeweg
3533	Straat	5	straat
3532	Straat	5	straat
3902	Parkeerterrein	5	straat
3903	Parkeerterrein	5	Straat
3602	Fietspad > 2m	6	Fietspad
3603	Fietspad > 2m	6	fietspad
3633	Aanliggend fietspad	6	fietspad
3462	Passage	7	voetgangers
3463	Passage	7	voetgangers
3472	Voetgangersgebied	7	voetgangers
3473	Voetgangersgebied	7	voetgangers

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