

CREATE ECO-FRIENDLY AND ATTRACTIVE RURAL LANDSCAPE

THE CASE OF BINNENVELD, NETHERLANDS



Han Shuangyu

**Master Thesis Landscape Architecture
Wageningen University
The Netherlands
January 2012**

@Wageningen University, 2012
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Preface

This report is the result of research and design by one Chinese landscape architecture student. In this period, I focus on the subject of "sustainable rural development in the Netherlands", and try to explore a landscape approach on water purification, urbanism, biodiversity and local identity. I did intensively research and analysis of the Binnenveld in the Netherlands, its historical development, today's landscape, its major problems and possible opportunities. In these months, I overcame many obstacles, and got a lot of help as well. It is an unforgettable experience for me to study and grow. All the results will be presented in the report.

During this process, I was guided and inspired by my supervisor Ingrid Duchhart (Wageningen University). She inspired me on my starting point, helped me to form a more logical and structural work, taught me the essence of the Wageningen approach on research and design. In addition, her critical views on the research and design encouraged me to reach a higher level. I was deeply moved by her passion on landscape architecture and teaching.

Then, I would like to thank people who help me to get useful materials. As a non-native designer, it is not easy to learn the sites and find materials about them, especially for the historical ones. Fortunately, I met some quite nice people who are kind to tell me and give some materials. Some of them are staffs in the Wageningen university. There are also some farmers living in the Binnenveld. We discussed about their opinions of the Binnenveld and they are kindly to provide me some materials about site histories. Here, I would not list all of their names, but thanks for their kindly help.

Last but not least, I want to thank my family and friends. They gave me the largest encouragement not only on my thesis but also on my life of studying. My parents always encourage me to pursue my dreams. Without their encouragement, I wouldn't come to study in the Wageningen university. I am also grateful to my dear friends Jie Cong, Hao Liu, Yi Zhou, Huina Wang, Hao Hu and Zilong Yin who encouraged me and offered critical ideas in the process.

Summary

Rural areas in the Netherlands have a strong position. They occupy approximately 56% of the total areas in the Netherlands and take roughly two-thirds of the total land surface area. They have rich flora, fauna resources and highly ecological values. However, there are largely pressures on them as well. In the Netherlands, rural areas have intensively population. Land in these areas are used in high density and major devoted to agriculture. Nowadays, with the fast changing in the landscape, there are increasing number of uniformity in the Dutch rural landscape. Relationships between urban and rural areas, agricultural production and natural conservation become severe. There are a good deal of government documents and literatures proposing "suitable development" for the rural areas. In the EU framework, The Dutch framework: Agenda for a living countryside, Priorities in the second Rural Development Plan, they aim to develop rural areas into good living conditions, and a lively social structure with a strong sense of identity, a properly functioning ecosystem and an attractive landscape. Solutions in these documents are mainly built on the policy-making and planning approaches. In addition, there are some nature and biodiversity projects are going recently, i.e. Natura 2000. Take Natura 2000 for example, it is a network of nature conservation in European. It aims to "conserve valuable and threatened species and habitats". These solutions are useful and direct the right perspectives for us. However, they are lacking of concrete methods and approaches to work in the landscape. In addition, most of them focus on one direction of development: i.e. natural conservation or economical increasing. The integration of different landscape functions is lacking. Landscape architecture, "as an interdisciplinary, integrative and critical life science by design", can make up this shortage (<http://www.lar.wur.nl/UK/>). To conclude, there is a gap here as: the lack of landscape applications. Hence, research objective of this thesis is identified as: learn and develop design strategies, principles and methods for rural areas to relieve them from the negative impacts of urbanization and intensive agriculture; create sustainable landscape. Landscape strategies and principles will be developed to fill the gap. To achieve it, Binnenveld, a major agricultural areas in the Netherlands, is selected as a showcase to verify aforementioned principles and methods.

Binnenveld is a prominent agriculture region within the densely populated in Netherlands. Conflicts between the development of urban areas and rural areas, nature and production are drastic. As the oldest agricultural lands in the Netherlands, Binnenveld shows diverse and beautiful cultural appearances of landscape. To learn the landscape in the Binnenveld, I start from the formation of geological underground in the Pleistocene period. With the stabilization of geological and natural conditions, people occurred in the higher parts of the region and tried to accommodate the environments. Villages and arable lands were developed in the higher sandy parts. Then, with the fast development of technology and increasing requirements of human on the lands in terms of food, water and so on, people began to change the landscape. The lower parts were used for peat mining and pastures. The traditional landscape patterns were

created and left marks on the landscape. As a non-native designer it helps me understand physical geography of the studying area better. To know the landscape of Binnenveld nowadays, layer approach is used to analyze the abiotic, biotic and anthropogenic landscape. Diverse cultural landscape appearances are identified. There are a lot of problems existing in the Binnenveld. But the major problems are defined as increasing human activities, include the urbanisation and mono and intensive agricultural land use. The causes and results of them are analyzed. Major results of them are:

Urbanisation:

- (1) Landscape fragmentation
- (2) Lose of identity and landscape qualities
- (3) Change the ways of life in rural areas

Mono and intensive agricultural land use:

- (1) Water eutrophication
- (2) Loss of habitat and decline in biodiversity
- (3) Odour emission
- (4) Negative impacts on the landscape quality

To classify, these results are grouped into problems in water, green and human system. By literature research, possible design strategies and principles are proposed. On the basis of the former research and analysis, major functions of landscape in the region are described as production, ecology and living. Production is the major landscape function nowadays. Impacts of ecological and living plan on it should be minimized to increase peasants' acceptance on the plan. To improve ecological function, water and green system will be improved. Wetlands will be constructed to purify wastewater from arable lands and livestock. To improve landscape connectivity and conserve valuable habitats, green network is designed. An attractive and livable landscape will be created with the local identity, aesthetic qualities, communication and microclimate into considerations.

The process of design can be divided into three steps: ecological plan, detailed design and landscape plan. The first phase of design presented the ecological plan for water purification system and green network. Analysis on the suitable locations of these systems is based on the former theoretical research. On the basis of suitability analysis for constructed wetlands and buffer zones, water purification system will be consisted by: constructed wetlands closing to pollution sources, grassed waterways along main ditches and waterways, and riparian buffer zones along the stream. Green network includes conserved habitats for meadow birds in the wet meadows, buffers between urban and rural areas and green corridors to connect the landscape in the region and to exterior green structure.

In the second phase of design, ecological plan will be applied and tested in the concrete design and embedded into the local context. Design for living function will be opened up here. Because main purposes of detailed design is

the application of ecological plan and development of landscape plan, criteria of sites selection are different natural conditions for ecological plan and various cultural appearances for landscape plan. De Kaart and De Meent & De Kampen are selected as showcases. Based on the concrete analysis on sites, designs will not only improve ecological benefits but also create attractive and livable rural landscape. As a result, various design strategies and principles from ecological plan and detailed designs will be synthesized and produce landscape plan for the Binnenveld. In the landscape plan, landscape functions of production, ecology and living will be integrated. Possible landscape development in the further will be expected. The transformation between different scales help me to test and develop design strategies and principles in a more logical and precise way.

These design strategies and principles help me to achieve my research objective and provide practical design solutions for the Binnenveld. What's more, they will contribute to the landscape application in the rural sustainable development. They helps to fulfill the theoretical gap. The whole research procedure and methodology can present how to apply landscape approaches into the sustainable rural development. This thesis presents the role landscape architecture play in the rural development, to design for human and integrate various perspectives into a comprehensive plan.

Guide to the Reader

In this thesis, I did research on the Binnenveld of the Netherlands, and in specific, to develop the possibility for a eco-friendly, attractive and livable rural landscape in the Binnenveld where is suffering from urbanisation and intensive agriculture. To research on this topic, I did basic research at first. In the first chapter, my starting point: challenges in rural areas in Netherlands are introduced. In chapter two, theoretical research are opened up. Chapter three describes the studying area in general and definite two major problems. Chapter four poses my research objectives and questions based on the conclusions of the introduction. Then, start from chapter five, I begin to introduce my inventory and landscape analysis on the region, where historical development as well as today's landscape are included. Chapter six is about the specific analysis of problems. Then, by literature study, several theories, design strategies, principles are identified and research in the chapter seven. I present my strategies development and ecological plan in the regional scale in chapter eight. Chapter nine introduces the design taking the landscape qualities into account in local scale and final landscape plan in the regional scale. The last chapter is conclusion and discussion.

Chapter 1 describes current situation of rural development in the Netherlands. They own valuable natural sources but suffer from intensification of agriculture and increasing population. There are an increasing number of attention are paid on their development in the global. How to balance these opportunities and threats, develop rural areas in the sustainable way is the starting point of my research.

Chapter 1

Chapter 2 introduces my theoretical basis of research, which give me the right perspectives of studying and form a foundation for further research. In this chapter, theories about sustainable development, ecosystem services, multifunctional landscape, landscape ecology are explained in detail. My visions on them are described as possible application of them on my research. At the same time, chapter 2 explains what is the role of landscape architecture in a project. As a landscape architecture, we should not only focus on the problems solving, but also on the cultural landscape, landscape quality and aesthetics.

Chapter 2

In chapter 3, I zoom in from rural areas in the Netherlands to my studying area-De Binnenveld. The basic research on the social, economy, culture and nature is opened up. Urbanization and intensive agriculture are identified as threats in the sustainable development of region.

Chapter 3

On the basis of theoretical research and site inventory, I develop my research framework in chapter 4. The research question is: *How can my studying area be developed into a sustainable and attractive region, where negative impacts from urbanization and intensive agriculture are decreased, and various landscape functions be developed and integrated in a sustainable way?*

Chapter 4

- Chapter 5** Chapter 5 tells the stories of historical development and today's landscape in the Binnenveld. To understand the landscape and plan for it, it is important to learn how it is formed. It traces back to the Pleistocene period. Formations of underground, water system, villages and agricultural activities are studied. Today's landscape is split up in its social and economy, abiotic landscape (topography, surface water, groundwater and soil structure), biotic landscape (biotopes pattern, biodiversity in flora and fauna), and anthropogenic landscape (infrastructure, human occupation and fieldwork on the different appearance of landscape).
- Chapter 6** Chapter 6 is about the specific analysis of problems in the region. I did analysis on the driving forces, process and pattern of urbanization in the region. To be results, it causes landscape fragmentation, lose of identity and landscape qualities, and changing in the way of life in rural areas. For mono and intensive agriculture, it causes water eutrophication in the terms of nitrogen and phosphorus pollution, loss of habitat and decline in biodiversity, odour emission and negative impacts on the landscape quality. The distribution and specific influences of these results are analysed.
- Chapter 7** Chapter 7: Possible design theories, strategies, and principles are selected and research by literature study. It is consist of three aspects: water purification system, protection in biodiversity and a meaningful landscape. Water purification system describes mechanisms of purification, design guidelines, and relative factors. The second part introduces the significant of biodiveristy conservation, concepts and greenways approach. In the final part, a meaningful landscape is defined as concerve in the cultural context and perceive the sensory qualities. In additional, how to create a better living environment in the terms of communication and microclimate is considered.
- Chapter 8** On the basis of a great deal of research and analysis, I sum up the problems and their results. To classify, they will form three groups: problems in water system, green system and human system. And combine with major land use in the region, landscape functions for production, ecology and living are required. Then, based on my literature study, I chose suitable design strategy and apply them into the region.
- Chapter 9** Chapter 9 experiences the tranformation in the scale. From regional scale to local scale, landscape is designed for *De Kraats* and *De Meent* and *De Kampen*. They shows how the ecological plan in the former chapter can be applied in the local scale and how to embed ecological plan into the local context. Hence, landscape qualities and cultural landscape are took into account. Then, go back to regional scale, landscape plan for the region is made according to the design strategies and principles drew from the ecological plan and detailed design. The possible development of landscape in the timeline is presented.
- Chapter 10** Chapter 10 is the conclusion, discussion and recommendations for further research.

Personal background and learning goals

For me, my background studying in China, more focus on aesthetic and spatial design issues. It makes me always put humans' needs as priority in the process of design. Then study experiences in Wageningen University made me are aware about landscape architecture as an interdisciplinary, integrative and critical life science by design, should mediate between worlds of knowledge in the natural and social sciences, the arts and the humanities (<http://www.lar.wur.nl/UK/>). At the same time, I have been well-educated the significant of ecological planning and design. Our design should not dissociate from the organization of the natural system, away from the spatial logic of sites. What's more, in Wageningen University, I also learned the ideas that design as an important contribution to analysing and solving pressing global landscape problems, such as climate adaptation and mitigation. Hence, for the thesis, I want to learn more about sustainable and ecological planning, not only on the concepts and theories but also about how to transform them into practices.

Then, after half and one year studying experience in Wageningen University, I have more realization about the significant of research. In my bachelor studying, our projects are more emphasize on design forms without a schematic research. Nowadays, I have got more ideas of what is the role of research and how to integrate research and design. During the process of thesis, I hope I can learn more about this approach and how to apply it when I am backing home.

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Chapter 1

Introduction to challenges to rural areas in the Netherlands

Challenges to rural areas in the Netherlands

Rural areas in the Netherlands have a strong position. They occupy approximately 56% of the total areas in the Netherlands and take roughly two-thirds of the total land surface area (Rural development strategy, 2006). There are 38% of the country's population living in the rural areas (CBS). However, they are suffering from largely pressures as well. The economical and social dynamics in the urban development and relationships between urban and rural areas exert pressures on the rural parts. Rural areas in the Netherlands are densely populated over European standards. Most of them are suffering from urbanization. Rural areas are used very intensively in the Netherlands and relatively large areas are devoted to agriculture (Rural development strategy, 2006). They are major occupied by grasslands and arable farming.

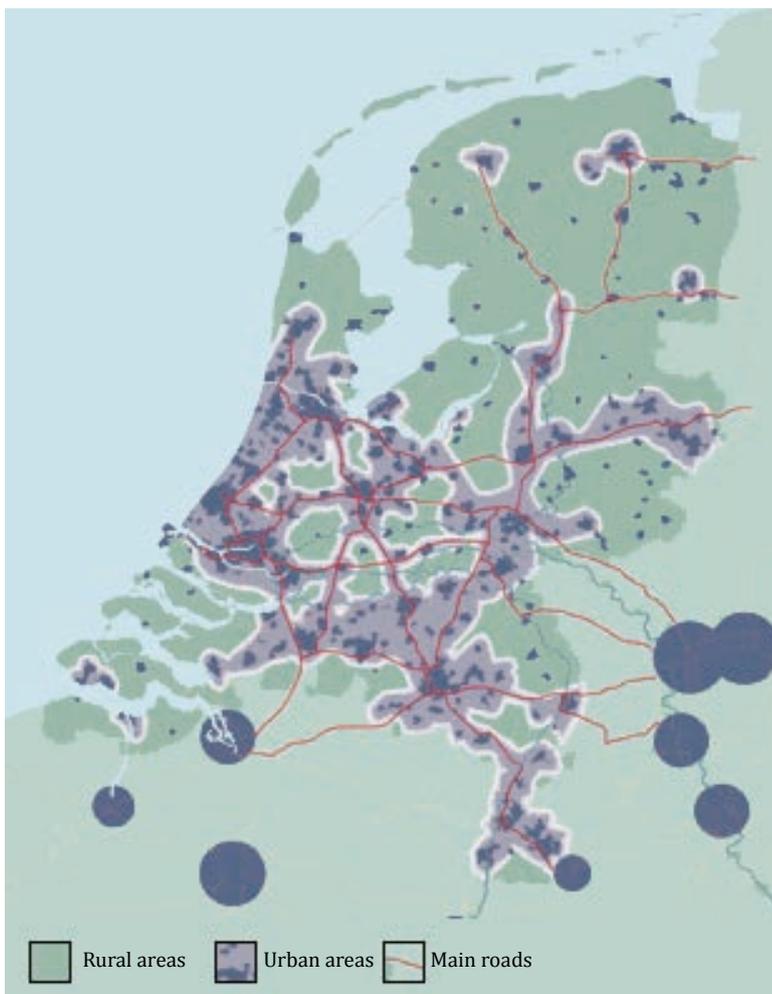
In the Netherlands, tourism in rural areas is developing quickly due to the attractive characteristics of the countryside, such as peace, nature and quiet. They can meet people's needs on relaxation, exercise and scenery. Roughly a fifth of the day trips made in the Netherlands are to the countryside and these visits generate one-tenth of the total spending on days out (1.2 billion euro in 2002) (Rural development strategy 2006). Although rural areas in the Netherlands display a strong advantage, there are problems in some aspects,

most of them related to the ecosystems and the quality of life.

The identity of rural areas in the Netherlands is formed by the great diversity of nature and landscapes, from dunes to mud-flats, from open pasturelands in the polders and the north of the country to small-scale enclosed landscapes, from the area around the large rivers to the marshy pasturelands (Rural development strategy, 2006). However, they are diminishing. In a quarter of the Netherlands urbanisation is having a negative impact on the appearance of the landscape (Rural development strategy, 2006). In addition, many key qualities and marks of landscape are suffering from increasing scale and intensification of agriculture.

The pressures on nature are also increasing. Decline in the biodiversity is major caused changing in land use. It causes lossing of habitat and landscape fragmentation. The pressures are greater in the Netherlands than on average

Figure 1.1 Urban-rual structure of the Netherlands
 Source: *Ruimte voor economische dynamiek, 1997* in National Council for agricultural Research 1998



in the EU. According to data from the European Environmental Agency, only 2% of the total area of agriculture land in the Netherlands has a high nature value compared with the estimated average of 15 to 25% in the EU-15.

Although it is gradually declining, the environmental impact of the agricultural sector is still greater than in most other countries due to its relatively large scale of horticulture and intensive livestock farming. For example, the use of chemical crop protection agents is roughly 2.5 times greater than the average in the EU-15 and discharges of nitrogen are approximately four times higher (Netherlands Environmental Assessment Agency 2005).

The urban pressure on rural areas is increasing due to the increasing demands for housing, infrastructure, and resources. And the same time, people living in the urban area are seeking for peace, quiet places for recreational activities. These developments will create more economic opportunities for rural areas. Besides, they will make problems because it is difficult to mix all of these functions in a place. Hence, the challenge is how to based on the existing sight and develop new understanding to find better ways of combining the different functions (Rural development strategy 2006).

To conclude, the agricultural lands in the rural areas of Netherlands will be gradually diminishing in order to create space for networks of protection areas, recreation and urban purposes (National Council for Agricultural Research 1998). In future, agricultural sector will not be major economic sources in rural areas any more. Instead of it, "new carriers for regional economy (National Council for Agricultural Research 1998)", which is benefit for ecology and landscape quality will be proposed.

Relevant rural development policy

1) The EU framework

Council regulation (EC) 1698/2005, Article 4

The guidelines principle for the European rural development is: Strong economic performance must go hand in hand with the sustainable use of natural resources. The European rural development policy will in future focus mainly on the agrifood sector, the environment and the border rural economy and population. The development strategies and programmes is therefore constructed around three key areas:

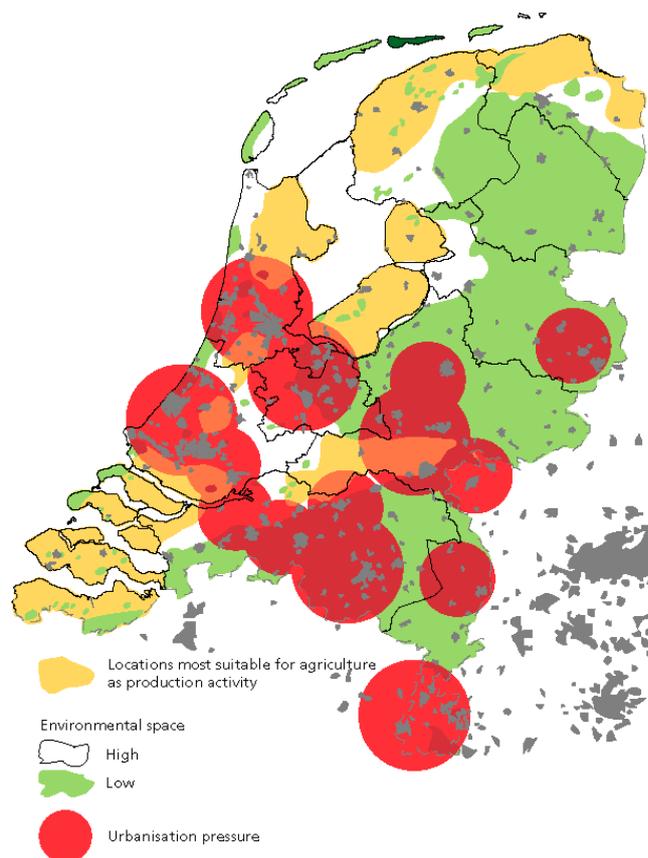


Figure 1.2 Production space for agriculture
Source: *Landbouw op de kaart, 1997* in in
National Council for agricultural Research
1998

- improving the competitiveness of agriculture and forestry by supporting restructuring, development and innovation;
- improving the environment and the countryside by supporting land management;
- improving the quality of life in rural areas and encouraging diversification of economic activity.

It expresses the ambition that in future, the rural development will emphasize on developing a strong and dynamic food production, conservation of the biodiversity and of agriculture and forestry systems with a high nature value, diversification in rural economics and making rural areas an attractive place to live and work.

2) *The Dutch framework*

Agenda for a living countryside

The general outline of the Netherlands' rural development policy was set out in the Agenda for a living countryside.

The life of an area depends on a flourishing economy, good living conditions, and a lively social structure with a strong sense of identity, a properly functioning ecosystem and an attractive landscape.

It addresses the diversity functions of rural areas - a place to live, to work and to relax and as a storage area of natural resources.

3) *Priorities in the second Rural Development Plan*

Rural Development Programme 2007-2013

The central challenge addressed in the RDP is the need for an integrated approach to the transformation of the agricultural sector. Where possible, measures designed to foster innovation and improve the structure of rural areas will be combined with measures to address the equally important challenges of further reducing the environmental impact of the agricultural sector and meeting the obligations arising from the Water Framework Directive.

It is used by the government to steer the developments in rural areas. On the one hand, it focuses on the natural and landscape management. On the other, it emphasizes on how to develop diverse regional economies and increase competitiveness. Environmental issues are mentioned in the RDP2 as the biodiversity, sustainable water management and climate policy. Various measures are provided with these issues.

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Chapter 2

Theoretical framework

2.1 Sustainability and sustainable development

2.2 Ecology and landscape ecology

2.3 Landscape planning and design

2.1 Sustainability and sustainable development

Concept

At the start of the twenty-first century, the problem of global sustainability became popular all around the world and recognised by leaders, scientists and citizens. The Brundtland Report defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (B Brundtland 1987). The concept of sustainability mainly includes three dimensions: environmental,



Figure 2.1 The interlocking circle
Source: <http://www.iucn.org/programme/>

social and economic sustainability. There are various explanations about their relationship, such as "pillars", "concentric circles" or "interlocking circles". The explanation of "interlocking circles", means a better integration of economic, social and environmental objectives and actions to build balance between them (The World Conservation Union 2006). This explanation of sustainability is accepted by an increasing number of people in recent years. The scales of sustainability are very complicated, which not only relate to the local ones, but also applied to the global balance of production and consumption. In addition, it can refer to a future intention: "sustainable agriculture" is not necessarily a current situation but a goal for the future, a prediction (Costanza, R. & Patten, B.C 1995).

Sustainability imperatives

As main aspects of sustainability, economic, social and environmental dimensions will be explained as following:

Wuppertal Institute, 1999

The environmental imperative describes the need to reduce the pressure on the physical environment to within ecological system limits. The environmental dimension of sustainability aims at keeping intact, indefinitely, the stability of the processes of the ecosphere, as a dynamic and self-organised structure. An economic system is environmentally sustainable only as long as the amount of resources utilised to generate welfare is permanently restricted to a size and quality that does not overexploit the sources or overburden the sinks provided by the ecosphere. This imperative is defined from an anthropocentric point of view.

The social imperative demands that all individuals have access to the resources and facilities they need to live a healthy and dignified life. This implies a non-discriminatory social fabric, supported by measures to reduce social exclusion and guarantee social minimum standards and human rights.

The economic imperative is to satisfy human needs for material welfare. This implies an economy which supports employment and livelihoods, in a framework which is competitive and stable at the macro-economic scale.

My vision on sustainability and sustainable development

However, with the development of natural and social sciences, human understanding of the ecosystems services will change and definition on the sustainability will be altered. Considering the definition of sustainable development, we can find that it is a vague concept. It contains two main concepts: needs and limitations. "Needs" means the essential needs of the present and next generation. "Limitations" focuses on the environment's ability to meet present and future needs. However, what are our needs? Whose needs need to be taken into account? And also next generation can't present their needs at this moment. Sustainability seems really good for everyone in some way; which can be seen for strength (Giddings B, Hopwood B, O'Brien G 2002). In other words, it also means that it can mean anything for anyone in any scale. Others argue (Workshop on Urban Sustainability 2000) that the blandness of meaning makes the concept almost meaningless. Hence, sustainable development is a comprehensive approach, but it is not clear about how to develop realisable concepts of sustainability and to achieve its implementations (Hubert Wiggering 2003). This concept can be used as my theoretical basis and design objective, but it should be researched deeply and combined with site conditions to transform into design.

2.2 Ecology and landscape ecology

Sustainable development, as a political and economic purpose in Our Common Future, declares "a need to define development in terms other than the conventional ones (Pearce et al 1991)". Orr (1992) describes that sustainable development includes technological sustainability and ecological sustainability as major parts. Here, ecological sustainability emphasizes on the important to think globally but act locally. The bottom-up approach is proposed. It maintains development should be driven from past practices, the local traditions of culture and places.

Landscape refers to ecological sustainability, is considered as "a highly promising scale for sustainable development in view of its relatively distinct boundaries and the commonality of ecological process over its area (Forman 1990 P273; Jala Makhzoumi et al 1999 P172)". It can relate to human and society. It can also emphasize on the roles of designer, user and society. Landscape ecology, for a holistic and dynamic understanding of landscape, will integrate natural and cultural landscape and help designers to form "an integrative and dynamic design methodology (Jala Makhzoumi et al 1999 P179)".

2.2.1 Ecosystem Services

In the last 50 years, humankind has modified the ecosystems heavily. These activities increase the economic values ecosystems provided, such as in the form of food production. However, they reduce their capacity to provide a broad range of services. According to statistics of the Millennium Ecosystem Assessment, approximately 60% of the ecosystem services evaluated in the global degraded or used unsustainably. The balance between development and ecosystem services has been broken. We are consuming and damaging resources for the next generation.

In order to protect the ecosystems and decrease the negative impacts of human activities on ecosystem systems, an integrated ecosystem services approach is required. Before it, we need to have a better understanding of the “ecology of ecosystem services”, which includes:

- *Linking specific ecosystem services to specific ecological processes*
 - *The time and geographic scales over which relevant ecological processes occur*
 - *The environmental factors that influence ecological processes*
 - *The species of other ecological assets that underpin ecological processes*
- (Millennium Ecosystem Assessment Synthesis Report 2005)

Key terms

An ecosystem is a collection of plants, animals, and micro-organisms interacting with each other and with their non-living environment (CBD 1993). Examples include a rainforest, desert, coral reef, or a cultivated system.

Ecosystem services are the benefits that people get from nature. Examples include fresh water, timber, climate regulation, recreation, and aesthetic values (World Resources Institute 2008). The Millennium Ecosystem Assessment grouped

Figure 2.2 Relation between ecosystem services and development
Source: Millennium Ecosystem Assessment Synthesis Report 2005



ecosystem services into four categories: Supporting services; provisioning services; Regulating services and Cultural services (Millennium Ecosystem Assessment Synthesis Report 2005).

An Ecosystem Services Approach being developed by Defra draws on the Convention of Biological Diversity definition- a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. However, it would seek to broaden the application away from the biodiversity perspective, putting an emphasis on

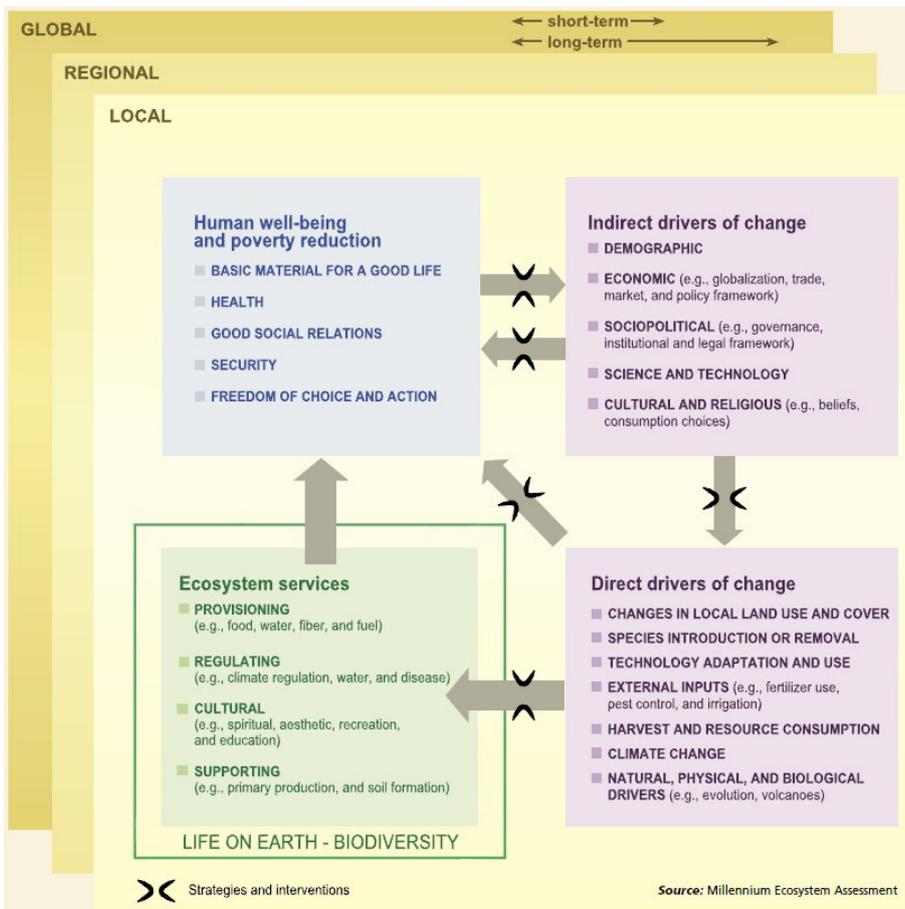


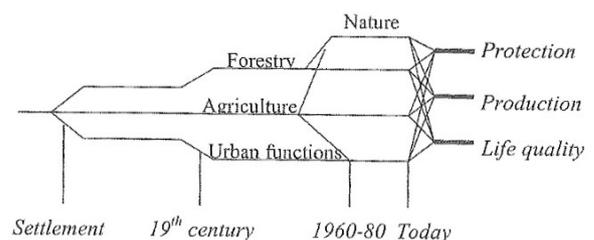
Figure 2.3 Conceptual framework
Source: World resources institute, 2008

maintaining the health of ecosystem as well as the sustainable human use of the environment, for present and future generations (Millennium Ecosystem Assessment Synthesis Report 2005).

Conceptual framework

The Millennium Ecosystem Assessment created a conceptual framework which is useful in implementing an ecosystem services approach. It focuses on the interactions within and between ecosystems from local to global scales. It does research on the relationship between ecosystems and development, and aim to get a better understanding of "how development goals both affect and depend on ecosystem services" (Millennium Ecosystem Assessment Synthesis Report 2005). Those working can start an analysis with elements of human well-being such as health or food and make the connections to ecosystem services. The environmental conservation community, on the other hand, can start with the ecosystem services and use the framework to assess the implications of conservation on development and human well-being. "Important relationships between human well-being and ecosystem services—often not initially apparent—are likely to emerge from applying the framework" (World resources institute 2008).

Figure 2.4 Railway metaphor of the landscape functions
Source: H. Gulinck



2.2.2 Multifunctional landscape

The concept of multifunctionality received an increasing number of attentions in landscape sciences. It seems to be an explanation of parts in the sustainable development, and easier to be applied in land use strategy (Gulinck 2003). This new strategy is especially applied in large areas. These areas are suffering from growing and pressure. Especially for areas dominated by monofunctional land use gradually due to industrialisation and increasing productive requirements. This process mainly took place during the 19th century. Nowadays, nature, as the youngest sector, is going to find its territory in parts reverted from all the other functions or sections. Based on so diverse functions, how to integrate them need to be consider. Multifunctional landscapes, as a tool, can be used to solve the segregation of functions and set conditions for sustainable development (Jesper Brandt, Henrik Vejre 2003).

Functionality

Research on multifunctional landscape should start with understanding on the core term of functionality. The concept of functionality originates from ecology. Forman and Godron defined function as “the interactions among the spatial elements, that is, the flows of energy, materials, and species among the components of ecosystems (Forman, R.T.T. & Godron, M 1986)”. It focuses on the interaction and processes. Applied to landscapes, function can further be defined as the capacity to master the landscape or change the landscape (Jesper Brandt, Henrik Vejre). In detail, functions can be drivers to change the landscape in a more or less given direction. Or it can be used to control landscape in a given state. Drived from it, linkage between landscape structure and landscape function is vital.

Based on this definition, there are three concepts of functionality are suggested according to the different divers of functions and capacities to maintain and master the landscape structure. They are ecosystem functionality, land use related functionality, and a reflexive and future oriented transcending functionality.

i. The functionality of landscape ecosystems reflecting the realised capacities in nature to maintain or change the environment

ii. Functionality pertaining to land use (usage) reflecting the realised capacities in society for changing the environment

iii. Transcending functionality, reflecting the intentional capacities in society for maintaining or changing the environment (landscape planning and means of management), including reflections on the capacity of the environment to provide immaterial services in order to change or maintain (aspects of) the noosphere.

(Jesper Brandt and Henrik Vejre)

	Existing material functions and their spatial intensity		Existing non-material functions as well as future material functions
	Ecosystem function	Land use function and intensity (usage)	Transcending functions
Production functions	<ul style="list-style-type: none"> Gaming (hunting) Fish (angling) Gathering of natural products (food, genetic and medicinal resources, household fabrics) Consumption of ground and surface water Collection of renewable energy 	<ul style="list-style-type: none"> perennial food and fodder crops perennial industrial crops permanent crops wood production pisciculture Extraction of non-renewable mineral raw materials and building materials 	<p><u>Future production oriented (e.g. neo-rural) ecosystem and land use functions and their spatial intensity</u></p>
Ecological regulation functions	<ul style="list-style-type: none"> Formation of topsoil and maintenance of soil-fertility Regulation of erosion and sedimentation Regulation of soil wetness and drying up Resistance against compaction Decomposition of harmful matters Groundwater recharge Water storage/run-off balance regulation Natural surface water purification Regulation of the energy balance Regulation of the climate at different landscape and trophic levels Self-renewal of biotic communities Self-renewal, maintenance and regulation of populations and metapopulations within landscapes (at different levels) of sources, sinks, buffers/corridors and habitats Conservation of gene banks Maintenance of biological (and genetic) diversity at different landscape levels 	<ul style="list-style-type: none"> Storage and recycling of human waste Regulation and maintenance of nature protection areas 	<p><u>Ecological regulation functions related to future (e.g. neo-rural) production oriented ecosystem and land use functions</u></p>
Information functions			<p><u>Perceived functions:</u></p> <ul style="list-style-type: none"> Aesthetic functions (scenery) Local and regional identity Spiritual and religious functions Expression of social power Ethical functions (gene funds, cultural heritage) Cultural and artistic inspiration Functions for science and education Recreative and tourist functions (social and psychological part) Indications of environmental situation <p><u>Designations:</u></p> <ul style="list-style-type: none"> Land registration Land use zoning Protected areas
Mechanical and spatial support	<ul style="list-style-type: none"> Filtering and buffering functions (soil/water/air/noise) 	<ul style="list-style-type: none"> Human habitation and settlements Industrial land Infrastructures Military grounds Recreation and tourist functions (human-ecological part) 	<p><u>Future (e.g. neo-rural) human-ecological support functions and their spatial intensity</u></p>

Figure 2.5 Interactions of landscape functions
 Source: Jesper Brandt and Henrik Vejre

Interactions of landscape functions

Multifunctionality is influenced by interactions between landscape functions (Sattler C., Schuler J., Zander P. 2006). In the PhD thesis of Louise Willemen, author describes the landscape function interaction as effect of one landscape function on another landscape function (Willemen 2010). And he classes landscape interactions into three classes:

- *Conflicts, the combination of landscape functions reduces a landscape function in its provision of services to society*
- *Synergies, the combination of landscape functions enhances a landscape function*
- *Compatibility, landscape functions co-exist without reducing or enhancing one other.*

Multifunctional landscape in rural areas

Most of rural areas are occupied by agricultural land use. Especially in the pre-industrial and industrial periods, development of technology led to an intensive and industrial agricultural land use in rural areas. The economic values are increasing based on the materials productive functions of landscape. However, an increasing number of diseconomies in the form of environment problems has appeared (Jesper Brandt and HenrikVejre 2003). Since the monofunctional use of landscapes trends to operate within steadily increasing land unit zones sizes and scales, the possibility for positive synergies between different functions has correspondingly decreased, and a growing discrepancy with the natural sizes, scales and mosaics of landscapes has developed (Gulinck 2003). Besides, there are diverse human requirements on the environment and they can not be reflect and meet in this monofunctional land use (Agger 1995).

During the past 30 years, people to began to recognise the significant of non-productional systems in the planning of rural areas gradually. There is increasing number of interest groups call for an integrated conceptual framework. Urbanisation and urban sprawl lead to increasing requirements of non-productive activities. Problems of the ecological functioning caused by the functions segregation want to be solved. These trends ask for a new landscape which is able to integrate the multiple land uses in the region.

The development of multifunctional landscape requires:

- *To adapt different land use functions to the ecological conditions of the local landscape instead of adapting the landscape conditions to specific types of land use technologies, and*
- *To tailor different functions to fit each other instead of separating them.*

(Jesper Brandt and HenrikVejre 2003)

The meanings of multifunctional landscape is call people's attention on the limitation of monofunctional landscape and arouse a suitment of land used in the landscape resources. However, multifunctional landscape can't be applied on all landscape patterns. Multifunctionality is primarily an alternative strategy to land use segregation in intensively used landscapes, which for the vast majority of the population is the everyday landscape.

Multifunctionality in landscapes

From a spatial point of view, there are at least three general types of multifunctionality which can be applied in different scales:

- *Multifunctionality as a spatial combination of separate land units with different functions (spatial segregation).*
- *Multifunctionality as different functions devoted to the same land unit, but separated in time, often in certain cycles (time segregation).*
- *Multifunctionality as the integration of different functions in the same unit of land (or overlapping units of land), at the same time (spatial integration or "real multifunctionality").*

My visions on multifunctional landscape

Landscapes can provide several services at the same time, such as the food production, sites for recreational activities and habitats for wildlife at the same time. The landscape which can meet diverse functional requirements is called multifunctional landscapes. For landscape architecture, concept of multifunctional landscape is more concrete than the concept of sustainable development and ecology. It can be used as the starting point of research and plan and can be carried out in the specific landscape development.

2.2.3 Ecological understanding of landscape

Many ecological concept can help us to get a intrinsic understanding of the landscape.

a. Landscape complexity

Ecology tell us that landscape is complexity. Different elements, processes and patterns affect each others and connect together. Abiotic, biotic and cultural components, as major parts of ecosystem, has a interrelationship and function as a whole. As forman states, considering landscape "as mosaic of local ecosystems", we should not only pay attention on the landscape elements but also the relationship of them (Forman 1990).

b. Living systems of landscape

According to self-organisation in ecosystems, landscape can be formed as living system, in which components and process affect each other. Living systems means balance can be kept through interior interactions and normal stressess from exterior can be coped with. For landscapes, external stresses refer to natural and human- interference. To maintain a dynamic balance between natural and semi-natural landscapes will form a self-organising system.

c. Biodiversity conservation

To develop ecosystems into resilience and dynamic balance, biodiversity should be conserved. Under the influences of nature and human, landscape nowadays is fragmented gradually and stressed on biodiversity. Therefore, to conserve biodiversity, we should solve landscape fragmentation and build linkages in the forms of natural corridors, greenways.

d. Diversity and heterogeneity of landscape

There are two important concepts of ecology relates to landscape: diversity and heterogeneity. Heterogeneity, as the substrate of landscape, is "an inherent character of the land mosaic " and support for improvement in biodiversity (Farina 1998). Naveh proposed to conserve ecodiversity, which refers to the "preservation and restoration of the total biological, ecological and cultural landscape diversity. (Naveh 1995, P14)" This conservation includes not only ecological stability but also cultural identity and scenic beauty.

e. Different scales of landscape

Different scales in landscape can be presentated in the hierarchy theory in ecology. There are two ecological principles in this theory. One is that differents scales are integrated and no clear boundaries between them. The other is that the hierarchy explains the relationship between them. The larger scale will lead the direction of smaller scales and depends on the smaller scales. Based on it, people proposed that landscape plan and design should be made in various scales. Besides, how to tranform between different scales is important.

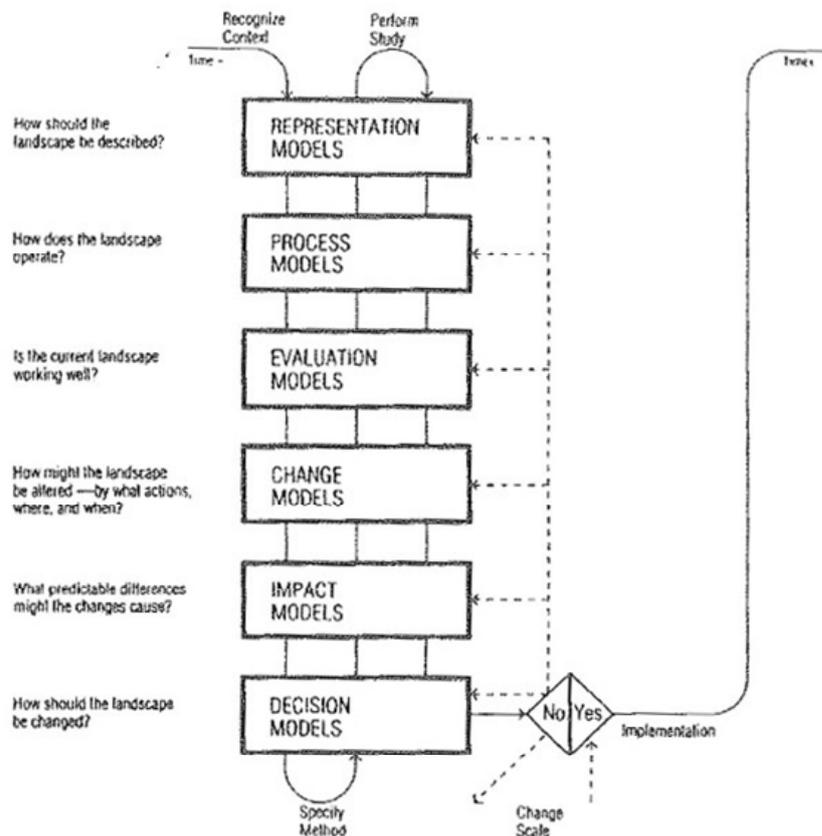
2.3 Landscape planning and design

There are various ways to definite Landscape architecture. They include: landscape architecture is a design discipline within the scope of ordering of space (Meeus 1984); landscape architects is one of the activities dealing with the mutual adjustment of human activities and the space available(Vroom 1986; Vroom and Steiner 1991); a conceptual approach with a strong emphasis on ecological processes and landscape form are the ingredients of landscape planning (Vroom 1990). In these definitions, design for space plays an important role, and spatial form and ecological processes are two major ingredients in the design (Ingrid Duchhart 2007). As Laurie Olin mentioned, "Landscape architecture as a subfield of art, processed by using a known body of forms, a vocabulary of shapes, and by applying ideas concerning their use and manipulation." However, where do these forms come from? It will relate to the concept of place and memory. The only thing that we can ever know for certain about the world is that which exists now or has existed in the past. So that to make something new we must start with what is or has been and change it in some way to make it fresh (Olin 2002).

Research framework

The primary means of design, the materiality and the organization of experience, are the appropriate roles of ecology and perception (Steinitz 1995). Thus, regardless of whether design is directed toward intentional change or intentional conservation, it has the primary social objective of changing people's lives by changing their environment and its processes, including its ecological processes (Steinitz 1995). Steinitz proposed a framework to organize the landscape project which consists of six different questions. The framework is "passed through" at least three times in any project: first, downward in defining the context and scope of a project-defining the questions; second, upward in specifying the project's methods-how to answer the questions, and third, downward in carrying the project forward to its conclusion-getting the answers(Steinitz 1995). The framework is presented as following model.

Figure 2.6 A framework for design
Source: Steinitz 1995



Landscape approach

Triplex model

In the 1980's Prof. Kerkstra and Ir. Vrijlandt of Wageningen University developed the triplex model. They define the landscape as “the visible result on the surface of the earth of the interactions between man and nature” (Kerkstra and Vrijlandt 1988) and use the triplex model to explain the interactions between human and nature. To reduce the complexities of landscape, they separate the landscape into layers: abiotic layer; biotic layer and anthropogenic layer. These layers are relying on each other but there is no absolute hierarchy. The abiotic layer consists of bedrock, soils, rivers and streams, climate and can be presented in the forms of geology, soil and hydrology maps and so on. The biotic means the patterns of fauna and flora. And the anthropogenic layer focuses on human occupation on natural environment in the patterns of dwelling, agriculture, roads, villages and cities. In a further elaboration of their definition, they stated that a landscape perceived at a certain moment is, in fact, a snapshot of a continuous and unavoidable process of change (Ingrid Duchhart 2007). They make clear that in their view the only constant factor in the landscape is change (Kerkstra and Vrijlandt 1988).

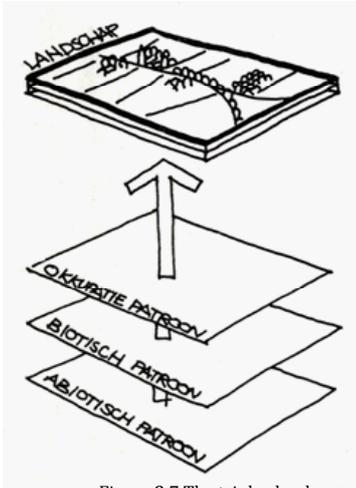
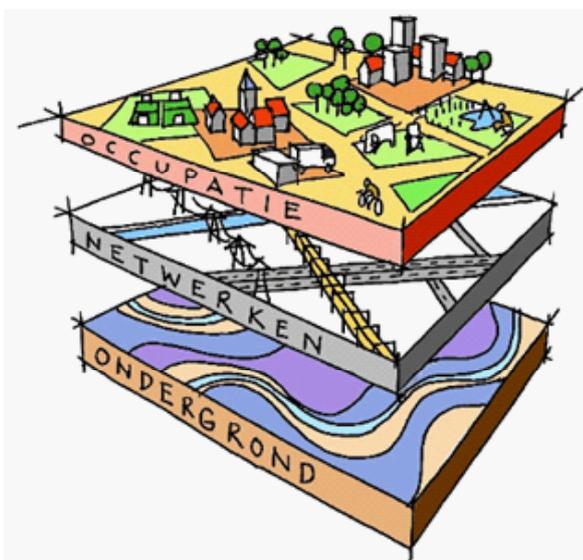


Figure 2.7 The triplex landscape
Source: Kerkstra and Vrijlandt

Layer approach

At the beginning of 2001 the Netherlands cabinet published the Fifth Memorandum on spatial planning. In this memorandum, the so-called layers approach was set out (Priemus 2004). It is used as a tool to understand modern landscape which has a loss of soil-dependency, with modernization, development of artificial fertilizer, changes in the watersystem and the change from rural to industrial. In the new layer approach, the underlying assumption is that spatial reality can be unpacked into three imaginary layers: Substratum, networks and occupation pattern (Priemus 2004). Each of these layers is liable to change, but the rate at which this is completed differs per layer (Priemus 2004). This layer model explains many aspects of modern landscapes which cannot be explained by the classical model.

Figure 2.8 Layer approach
Source: Priemus, Hugo, 2004



Substratum layer: it is the most stable layer which is formed by the soil system, the water system, and the biotic system.

Network layer: refers to infrastructure, but also to air routes and digital connections. The rate of change is substantially faster than in the substratum.

Occupation pattern layer: comprises human activities such as housing, work and recreation, and the spatial pattern that is derived from them.

Framework about land use dynamics

Later, Prof. Kerkstra and Ir. Vrijlandt put more focus on land-use dynamics. They said developments in agriculture affect the landscape in the Netherlands in a radical way (K.Kerkstra, P. Vrijlandt 1990). Industrial agriculture has damaged historical landscape, threatened to the diversity of plants and animal life, and caused pollution on the water and soils. In this framework, they consider agriculture as the high-dynamic land use. Natural conservation, forestry, recreation and water management as the low-dynamic land use types. To reduce the negative effects, they proposed this framework which will create long-term opportunities for low-dynamic land uses (Ingrid Duchhart 2007). Kerkstra and Vrijlandt evolved a philosophical approach that was based on a division into high-dynamic land uses and low-dynamic land use types (Ingrid Duchhart 2007). This involves the planning of a durable and stable framework, an interconnected pattern of zones in which nature management, forestry, outdoor recreation and water control is concentrated. The framework aims to conserve and improve the landscape amenity and ecological quality on the basis of improvement for agricultural production. They hope within the zones and corridors of the framework multiple land use will help in achieving visual and functional differentiation and also in meeting demands in society.

Sociophysical-organisation model

Kleefmann's sociophysical-organisation model is based on the reciprocal relationships between man and nature and should be seen as an abstract notion of the functioning and co-ordinating of human activities required for living a meaningful life (Ingrid Duchhart 2007). The model is made up by two components: natural environment and society environment. As we can see from the figure 2.9, nature environment is consisting of abiotic subsystem and biotic system. These two subsystems are closely interrelated through "ecological structures and laws of nature" (Ingrid Duchhart 2007). The natural organisation is independency and self-regulating. Two subsystems within the natural environment:

- Abiotic subsystems: non-living nature, including water, soil and air.
- Biotic subsystems: the living natural surroundings, include all living organisms

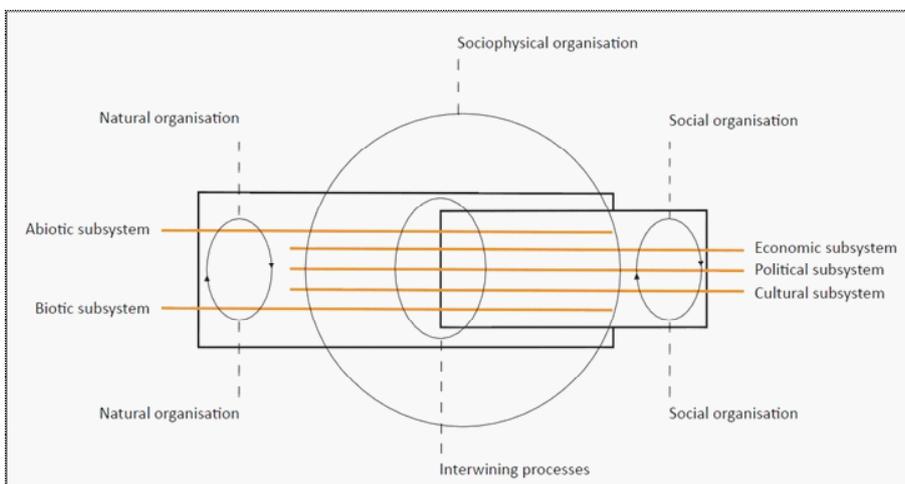


Figure 2.9 Sociophysical-organisation model
Source: Kleefmann, 1992

The social environment includes three subsystems: economic subsystem, political subsystem and cultural subsystem. These three subsystems are linked by the social organisation. This social organisation is various in different locations due to the various histories of society development process. Three subsystems within society:

- Economic subsystems: production and labour
- Cultural subsystems: shared patterns of norms and values
- Political subsystems: in-between of economic subsystems and cultural subsystems

This model emphasize on the sociophysical organisation, which means the relationship between natural environment and society. Whether they work in the same or opposite direction, decides it is a well-functioning system or not. This system is very complexity and it is hard to receive the desired relation between two sides. Because all subsystems are in pressure and they will affect each other always.

The value of Kleefmann's model can be located on its linkage between the physical aspects of landscape including soil and vegetation and social aspects such as culture and history (Ingrid Duchhart 2007). As a landscape architecture, from this model it is not difficult to realize that landscape is affected by the laws of nature and also the social and human activities. This model implies a clear vision for landscape analysis, which should not only focus on the natural surroundings but also the social aspects.

2.4. Conclusion

After my research on these concepts and theories, I have clear ideas about how to guide my studying with them. First, for the sustainability and sustainable development, it emphasizes that we should develop environmental, economic and economic dimensions at the same time and the significance for better integration of them. It is my guiding ideology to develop this region. However, the concept of sustainability and sustainable development is too wide and difficult to transform into practices. Secondly, ecosystem services and multifunctional landscape, as stages in the sustainable development are more concrete. According to general problems in the rural areas in the Netherlands-mono agricultural land use, multifunctional landscape can be used as a strategy to solve problems. In the multifunctional landscape, three concepts are very important: landscape functions, interactions between landscape functions, and multifunctionality. They can guide me to analysis what are mainly landscape functions in my area and how will they be integrated. After these analysis, I can find main problems in my studying area. At the same time, the patterns of multifunctionality will be used as core design ideas.

Finally, research on the landscape planning and design is very significant. Landscape design consist of design forming and ecological process. A nice

design on the appearances of landscape will increase the acceptances of ecological design by local people. Hence, in my research and design, I would not only focus on the ecological functions of landscape, but also the spatial quality.

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Chapter 3

Site introduction and problem definition

3.1 Site introduction

3.2 Problem definition

3.1 Site introduction

My studying area is part of Gelderland Valley region in the central of Netherlands. It lies roughly between Utrecht Ridge in the west, low Rhine in the south, the highway N244 in the north and the Veluwe in the east. This region crosses the boundary of province Utrecht and Gelderland and closed by Veenendaal, Ede, Bennekom, Wageningen and Rhenen. It is a prominent agriculture region within the densely populated in the netherlands. About 60% of total size of the studying area is currently under agriculture use, 26% of the land is covered by urban areas and the remainder of the area is composed of nature areas, infrastructure and water.

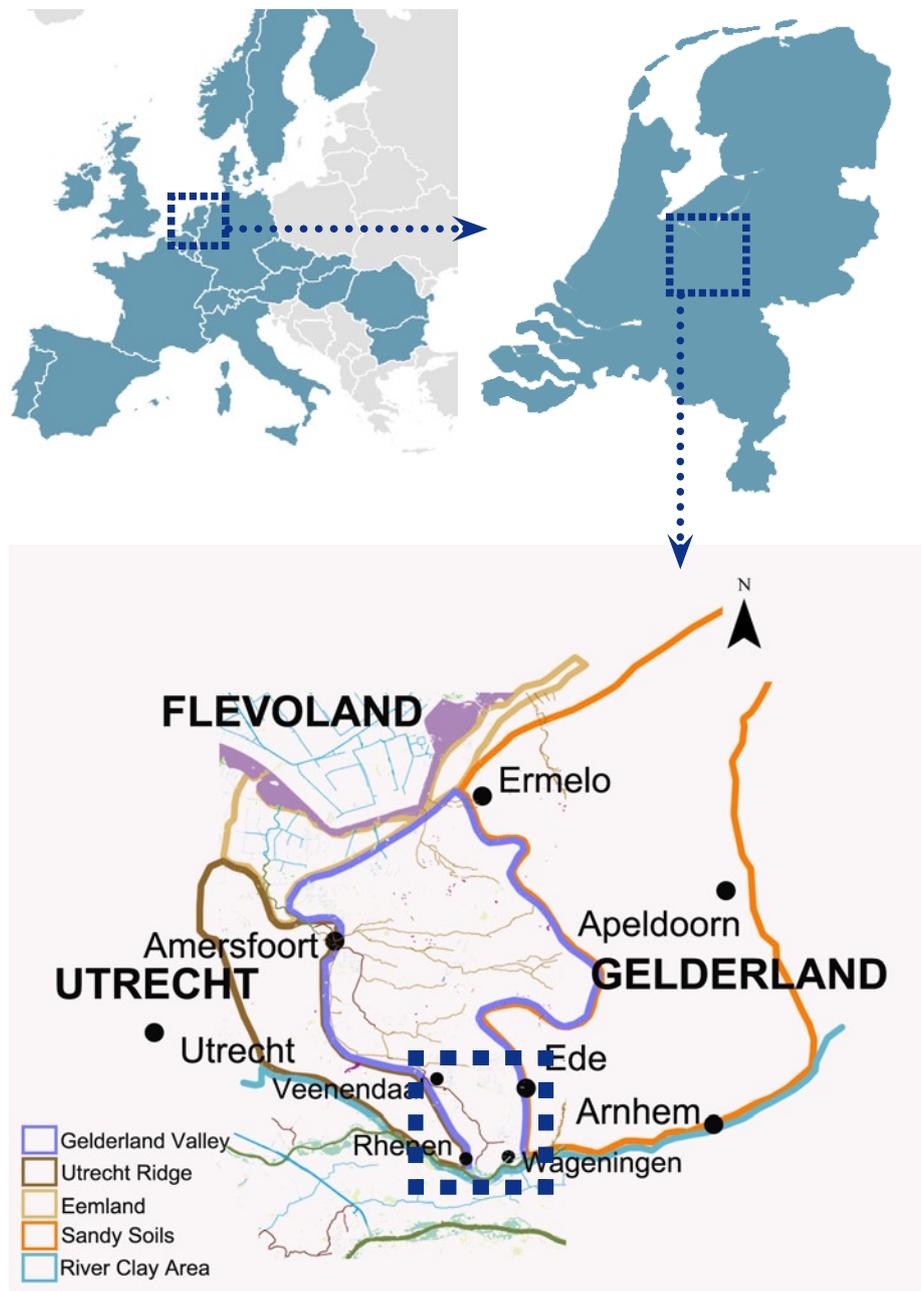


Figure 3.1 Map of European, Netherlands and Gelderse Vallei
Source: by author

The region is a shallow valley. It is formed in the Pleistocene period by a glacier that covered a part of the Netherlands. In the pleni-glacial, the ice-sheet advanced as a series of lobes which both gouged out deep basins and pushed up high ridges on their flanks (Audrey 1985). The push moraines now formed the border of the region. Due to differences in elevation in the studying area, a gradient in many biophysical conditions occurred.

It is the oldest agricultural areas in the Netherlands. There are diverse and beautiful cultural landscape which can reflect on the past of region development. At the same time, Binnenveld is important because its valuable natural habitats. All these cultural and natural landscapes can be found on a relatively small area: a few dozen square kilometers!

Figure 3.2 Scope of Binnenveld
Source: Beeldkwaliteitsplan Binnenveld

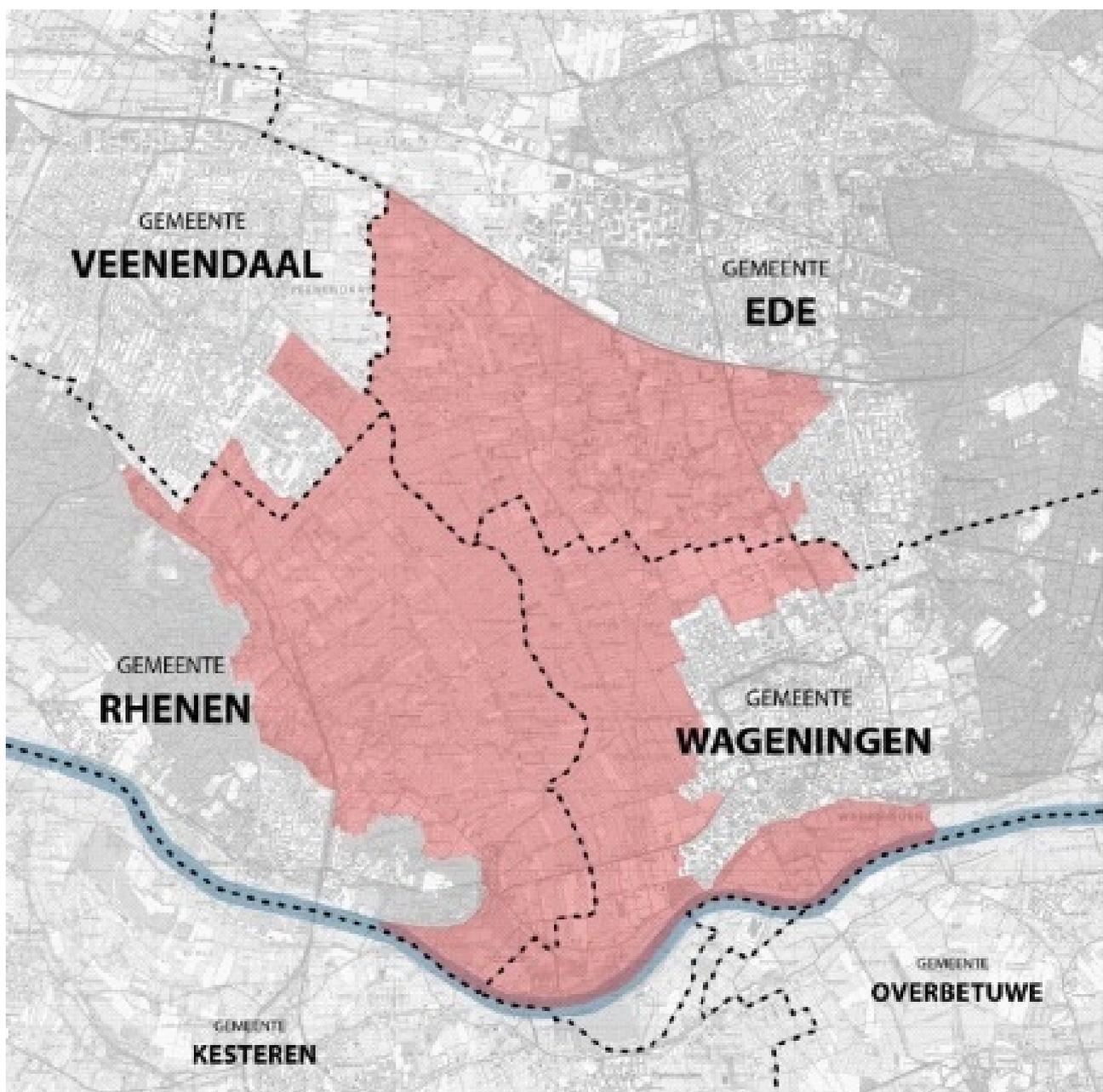




Figure 3.3 Photos of Binnenveld
Source: by author

3.2 Problem definition

The small size is a problem and that problem is getting bigger by the encroaching buildings for housing and businesses, and the intensification of agriculture. They threaten nature and landscape values and especially for nature it is disastrous.

In hundreds of years, landscape and nature in the Binnenveld was influenced by human activity. Nowadays, the worrying is the speed with which landscapes are changing, the increasing in uniformity of the Dutch landscape and especially the isolation of natural areas. Binnenveld, used to be planned as courtyard of the WERV municipalities, which maybe enjoyable but unfortunately isolated from surrounding natural environment. The experiences surprised you will come from nature instead of garden, The new perspectives of development should focus on preserving the natural and landscape benefits.

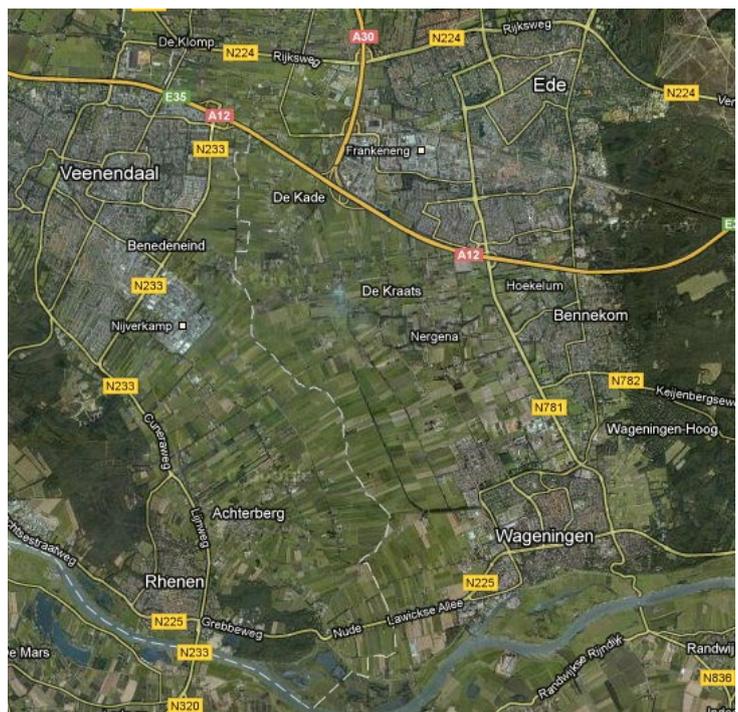
Therefore, problems in the region are defined as increasing human activities. in the terms of the urbanisation and mono and intensive agricultural land use. Due to the urbanisation and increasing of urban population, size of rural areas is shrinking and pressures on them are increasing quickly not only on the needs of food production but also on the recreation and ecological functions. However, mono and intensive agricultural land use in the region ignored the ecological and societal functions of landscape. It will result in conflicts with the ecological dynamics of the landscape and decline in the diversity of cultural landscape. These two core problems led to the region are developing in the unsustainable way.

Urbanisation

The satellite image (Google Earth, 2012) shows that the Binnenveld almost entirely enclosed by urban areas. Urban areas in the Ede, Bennekom and Wageningen has almost grown together. Veenendaal with the extensions to the south-east, has closing to Ede gradually. A large piece Binnenveld near Helen and Benne Think Doom converted into industrial estates.

The urban expansion has lasting for a long time. During the past 60 years, the urbanisation and urban sprawl are very remarkable in this production driven developed rural areas and led to stronger interest in using landscapes resources from non-farming residents of the countryside. Go back to look historical map, it is clear that the surrounding urban areas are sprawling fast in the region and there are increasing numbers of urban settlements in the

Figure 3.4 Satellite image of Binnenveld
Source: google earth 2012



Current situation

rural areas. The urban areas have now reached the size of landscape in the rural. Parts of them even cause the losses of cultural-historical landscapes. Besides the abovementioned expansion in terms of land cover (horizontal expansion), there are also an increase in intensity (vertical expansion) (Schanze 2002). In addition to the production of food stuffs and renewable raw materials, agriculture land needs to take on additional ecological and societal functions, especially for the urban areas (Werner et al. 1995). There includes the increased needs of groundwater, efflux of cold and fresh air, conservation of cultural landscapes, recreation, tourism, etc. As a result, a growing pressure on non-production considerations in the planning of my studying area is taking place.

The plans for further expansion of Ede and Veenendaal are not presented on the map. But along the A12, they plan to develop business and recreation area, and Veenendaal will continue to develop residential areas in the eastern side. The consequences of these plans will be that the ecological connections of the Binnenveld to the northern part of the Gelder Valley almost nothing remains. The plans are almost certainly affect the level of the water table and it will be difficult for the extremely rare habitats in the wet seepage areas of Hellen, the Benne Kommer Think on the southern side of the A12, and Alleman camp on the northern side of the A12, to maintain.

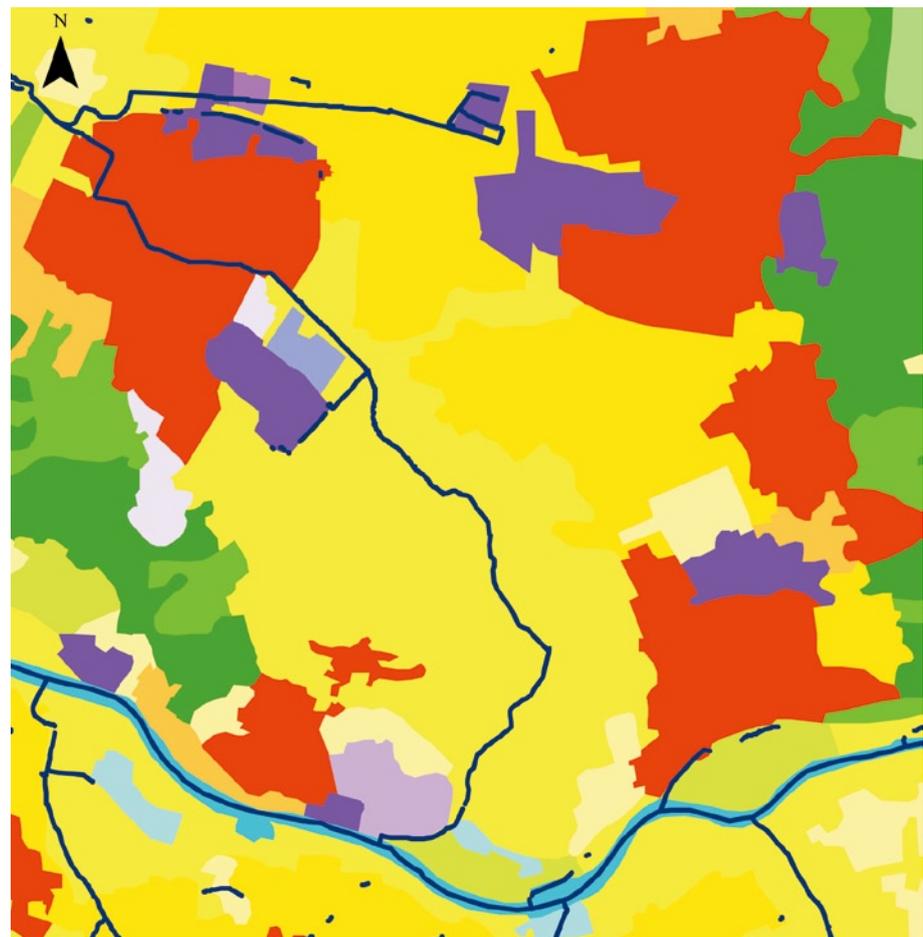
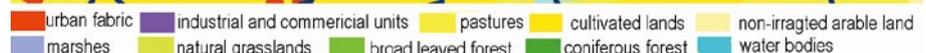


Figure 3.5 Land use map
Source: illustrated by suthor according to GIS database



Mono and intensive agricultural land use

This region is dominated by agriculture land use, includes the industrial agriculture and intensive livestock production. Mono-functional land use has been supported by constant technological improvements depending on the construction of spatially standardised local conditions, and resulting in a structural homogenisation of the cultural landscapes, which is often conflict with the ecological dynamics of the landscape (Werner et al. 1995). Through the mono-functional food production is economically efficient; it will cause increasing diseconomies in the environment aspect. The mono-functional development of this region has apparently suffered from problems for the ecological functioning. Firstly, the original interconnected vegetation patterns are damaged and fragmented. It decreases the opportunities for survival of plants and animal (McArthur, 1967). Remaining copses, hedgerows and other minor natural elements in the landscape are too weak to resist destructive outside forces (Kerkstra, K. en, P. Vrijlandt. 1990). Secondly, the intensive agricultural land use causes pollution and eutrophication of the natural environment. The abundant use of fertilizer and manure increases the amount of phosphate and nitrogen in the sub-soil and makes the quality of both surface water and deeper aquifers are at risk. Thirdly, large scales of agriculture brought about the landscape pattern became more uniform. The identity of this region is formed by historical landscape patterns which are formed by the land reclamation and division. However, nowadays the landscape units of rough, wild land have fallen apart, and contrast between the open areas and the enclosed farm land has almost disappeared. The cultural landscapes were structural homogenisation and human's experiences in the region are boring. The aesthetic quality is declined and increased needs of non-farming residents on the recreation and tourism can't be met.

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Chapter 4

Research structure

4.1 Significant

4.2 Research objective

4.3 Research questions

4.4 Research methodology

4.1 Significant

The importance of this study is presented on the research about possible theories, strategies and design principles to solve problems, suitable plan and design for the Binnenveld. Driven from it, it aims to develop general principles, which will be tested in this region, on how to design for different landscape functions, how to mix them together and led to sustainable region development. Due to the characters of landscape architecture as interdisciplinary one, the integrated research on natural, environmental, social and planning sciences will arouse effective approaches which are away from traditional ways to solve problems.

Conflicts between food production and human's needs on recreation and ecological functions in the rural areas are not only relevant in the Dutch context, but also very much on the agenda in other countries at the moment, especially in the developing countries with current debates on the population increasing, urbanization and even economic globalization. Thus I believe that my work can be a basis for the discussion on a valid issue, and of importance for our future development of rural regions in the Netherlands, and even other countries, such as China. The site I chose is actual typical case, where are the food valley in Netherlands and with high population density. Design guidelines and principles applied and tested here can be spread out to other similar areas. Thus the significance of the study is also reflected on its practical ability to apply.

4.2 Research objectives

My research objective is to learn and develop design strategies, principles and methods for rural areas to relieve them from the negative impacts of urbanization and intensive agriculture; create sustainable landscape.

This goal can be achieved in different scales. On the regional scale, research will open up on the possible strategies and plan will present that where these design strategies will be applied to solve existing problems. In the design for parts of the region, research and analysis will be developed in local scale. In this scale, design will be more concrete about how to transform these design principles and methods into sites design. Then, back to regional scale, I will focus on how to integrate various design strategies and principles for different landscape functions together. Therefore, to achieve my research objective, the whole process of research and design will be cyclic and experiences the transformation between different scales.

4.3 Research questions

The research will be conducted with several research questions. My main research question is:

How can my studying area be developed into a sustainable and attractive region, where negative impacts from urbanization and intensive agriculture will be decreased, and various landscape functions be developed and integrated in a sustainable way?

Then, several sub-research questions are defined:

- a. How was landscape in the studying area developed in the timeline?
- b. How does landscape in the studying area work nowadays?
- c. What are major problems in my studying area and what are the results of them?
- d. What sustainable and innovative design principles and methods can be applied to solve problems and develop landscape functions?
- f. How to plan and design for the studying area as a showcase to verify aforementioned principles and methods?

4.4 Research methodology

4.4.1 Research flow

In order to answer above research questions, a systematically research flow is required. Instead of linear relationship, the research procedure will be in a cycle. It can be divided into four parts: 1) prepare for proposal; 2) work in the regional scale 3) concrete design in the local scale; 4) discussion and conclusion.

The first part starts with the selection of subject. Then, I will work on two lines. One is research on my studying area, which consists by the inventory and problems statement. The other is to build my theoretical basis. It includes theories of sustainable development, landscape ecology, and landscape planning and design. Based on them, I formed my research objectives, research questions and research methodology. Following the proposal, research will be opened up on two aspects: literature review and site inventory & analysis. Literature review is the backbone of research and it will provide design principles and methods to guide research and design. Inventory and site analysis can help me to learn my studying area. Huge number of data and information will be collected and analysed during this process. Based on them, several design models and strategies will be developed. They will be applied and evaluated in the studying area. The most suitable design models will be applied and developed into a plan. Thirdly, it is for the concrete design in local scale. It includes four steps: site selection; site analysis; design and evaluation. The design strategies and principles will be applied and tested in the concrete design. Finally, I come to discussion and conclusion. In this part, I will analysis and sum up what I learned in the whole studying process, give an overview of the research flow and answer my research questions. My personal experiences during this process will be presented and some discussions about new insights on this research subject will be expanded

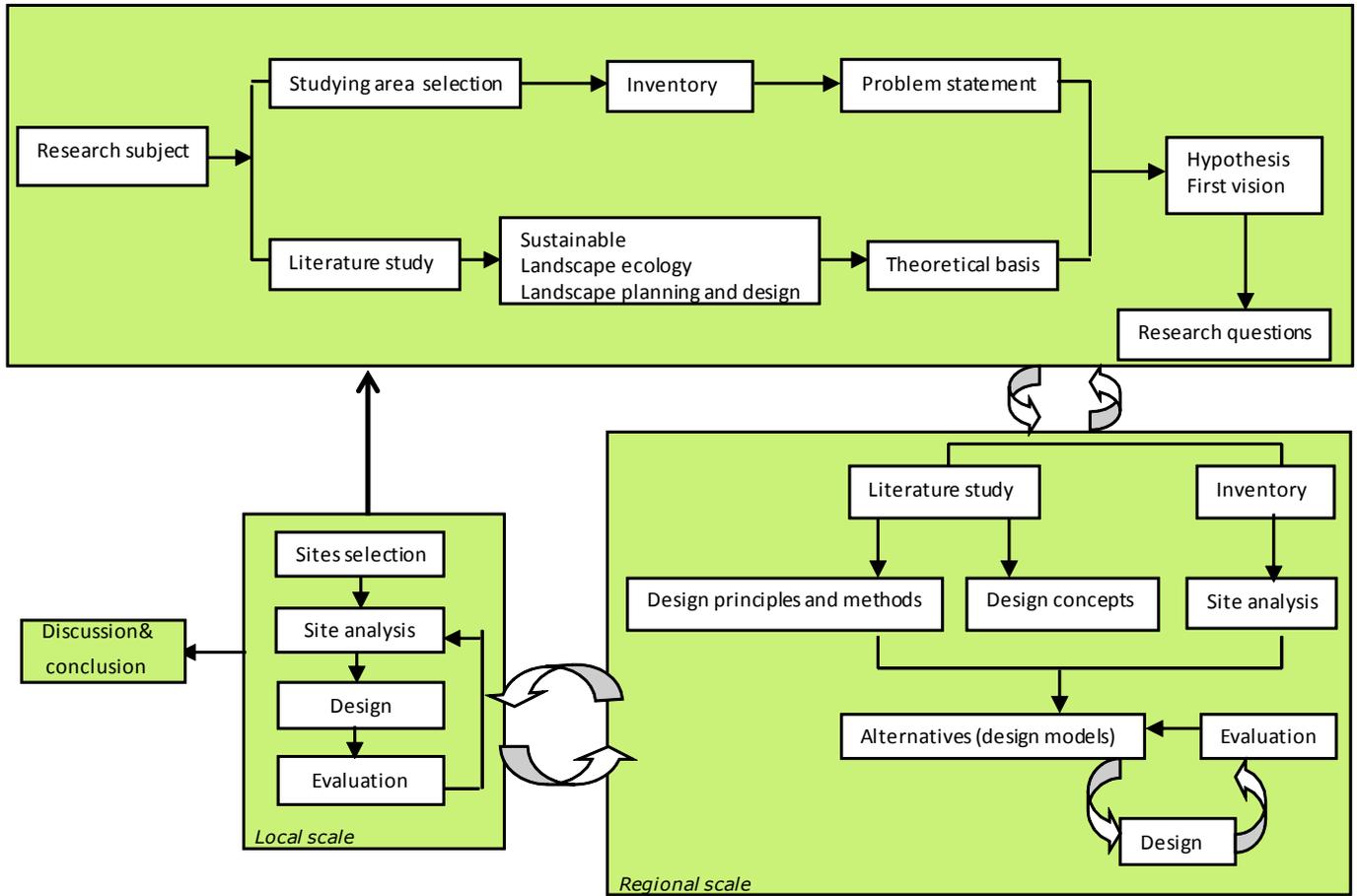


Figure 4.1 Research flowchart
Source: by author

4.4.2 Research Methods

Different sub-questions require various methods to collect data and answer. To ensure research close to my research objective, a short description of expected results will be presented at the same time. In the following part, I will present the methods used to answer research questions and the expected results.

- a. How was landscape in the studying area developed in the timeline?
- b. How does landscape in the studying area work nowadays?
- c. What are major problems related to my research objective and what are the results of them?

Based on sociophysical organisation model, site inventory and analysis should cover natural organisation, social organisation and the interaction between them. According to this system, I build up the framework for my research methods. Then, the layer approach, which is lay particular emphasis on natural organisation, will be integrated in the system to do analysis.

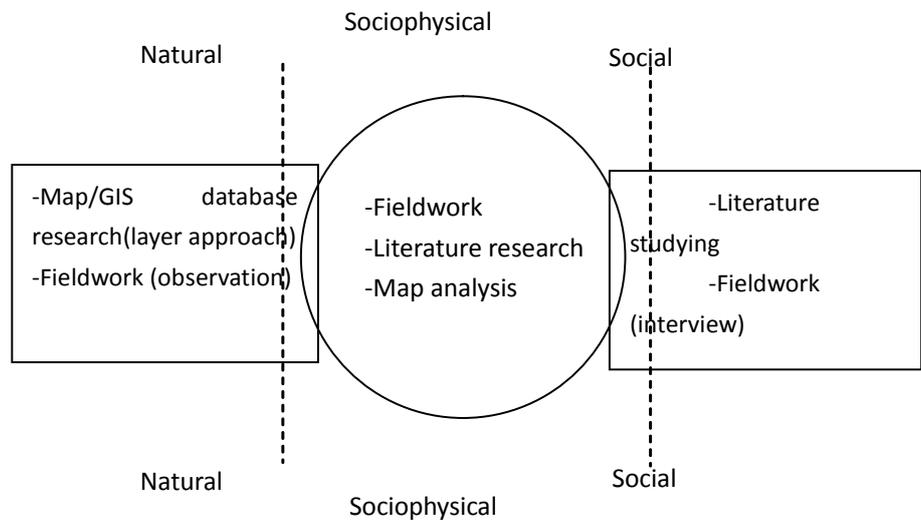


Figure4.2 Research methods
Source: by suthor

Natural organisation

Methods	Expectations
Map/ GIS database research (Layer approach)	Analysis on abiotic and biotic subsystem: maps of landscape development in history; water system, soil system, biotic system; networks; human occupations. Analysis of current main landscape functions.
Fieldwork (observation)	Observe, understand and feel place in spatial and aesthetic qualities

Social organisation

Methods	Expectations
Literature studying	Newspapers, novels, websites and books about the historical and current development of the region; find out urgent issues and local people's opinions about the region development
Fieldwork (Interviews)	Do interviews with local people for their ideas about the spatial and aesthetic qualities; their expectations and wishes for the region development.

Socialphysical organisation

Methods	Expectations
Fieldwork	photos and texts about visible interactions between landscape functions
Literature research	Find out the urgent conflicts between natural and society
Map analysis	Analysis on the conflicts of landscape patterns on maps and try to find potentials to solve them

d. What sustainable and innovative design principles and methods can be applied to solve problems and develop landscape functions?

Methods	Expectations
Literature review	Overview of design principles and methods related to my research objective; summarize and develop them to guide my work

f. How to plan and design for the studying area as a showcase to verify aforementioned principles and methods?

Methods	Expectations
Alternatives	Several design models will be developed according to different landscape functions. Then in the order of their significances, they will be integrated into landscape pattern one by one. The overall impacts of them will be considered.
Research driven design	Following the selected design model, plan and design for the studying area to test design principles and methods.

Chapter 5

Landscape development and analysis

5.1 Geological underground

5.2 Human occupation and development

5.3 Today's landscape

5.1. Geological underground

The inclusion in a historical geography text on the early geological and physiographic history of the studying area is significant. It is important, because as a non-native designer it can help me understand physical geography of the studying area. It carries the story of the primeval landscape down to the close of the Pleistocene. Man first appeared in Netherlands.

5.1.1 Pleistocene Period

The Gelderland Valley, was formed in the Pleistocene period. For all practical purposes, the Pleistocene in the Netherlands can be divided quite simply into pre-, pleni-, and post-glacial phases (Audrey M.Lambert 1985). The Gelderland Valley was mainly formed in the last two ice-ages. In the pre-glacial period, climate was one of the alternating colder and warmer phases as the distant ice-sheets waxed and waned (Audrey M.Lambert 1985). The Rhine and Maas areas received great number of sediment and the first traces of mankind have been found near Rhenen.

In the pleni-glacial, the ice-sheet advanced as a series of lobes which both gouged out deep basins and pushed up high ridges on their flanks (Audrey M.Lambert 1985). Such push-moraines or stuwwallen have occasional summits exceeding 100m NAP, while the basins underlying the valleys of the Gerlderseljseel, Eem and IJ reach similar depths below sea-level (Normaal Amserdam Peil, the mean summer high-water level in Amsterdam harbour; Weele 1971). These push-moraines today form a striking element of the central Netherlands landscape (Audrey M.Lambert 1985)(figure5.2). The Utrecht hills are included. The Gelderland valley is bordered to the south by the lateral moraine of the Utrecht hills and the north by three smaller moraine, namely Emmikhuizerberg, the GroteVeenloo (the Vendel) and the Oude Kerk (the Kleine Veenloo). The distance between the hills and the northern moraine is

approximately 3 km. The deepest point of the valley is 4.9 meters above sea level.

After interglacial period, a new ice age was coming: the Weichselian. Weichselian is of great significant for the higher part of the netherlands. Most deposits were from this period and they are still located on the surface. Wind became the main landscape creator during this period instead of the ice. "If the country was a boggy wilderness in summer, in winter it became an arctic desert swept by dust-laden gales and blizzard (Audrey M. Lambert 1985)". Most parts of the country were covered with aeolian cover sand and loess, which may now act as semi-confining layers. There were elongated sand ridges here with intermediate lows. This gave the sand ridges with height of 1-2 meters over short distances. In this way, the wavy character of



Figure 5.1 Ice sheets in glacial
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html

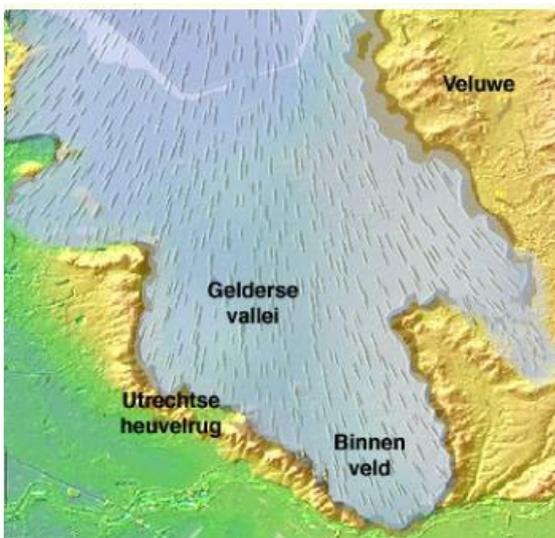


Figure 5.2 Ice movement in glacial
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html

large parts of Gelderland Valley arose. The ridges are therefore often too dry during the growing season due to sand is bad for water retention. The lower parts are much wetter and sometimes there is even talk of flooding. The slight climatic amelioration of the late Weichselian times allowed first mosses and lichens, then low-growing shrubs, dwarf willow, and birch, and finally a fully developed tundra vegetation to spread across the land (Audrey M.Lambert 1985). The sprays sand was soon retained by denser vegetation. *Betula*, *pinus*, *salix* and *populus* were occurred in this period. These alternations attracted man into the region and the primeval landscape transformed into the cultural landscape.

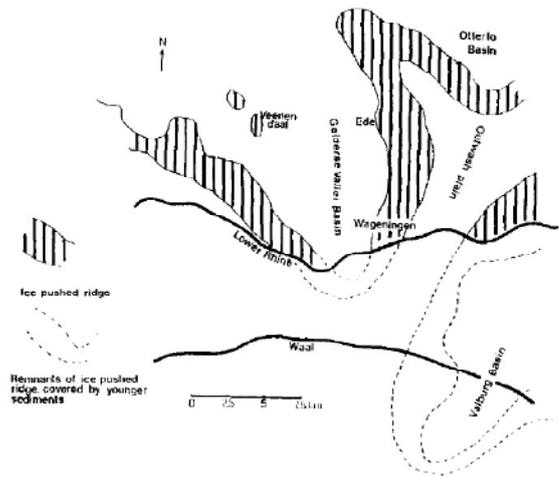


Figure 5.3 Geological underground
Source: Audrey M. Lambert 1985



Figure 5.4 Soil formation
Source: Audrey M. Lambert 1985

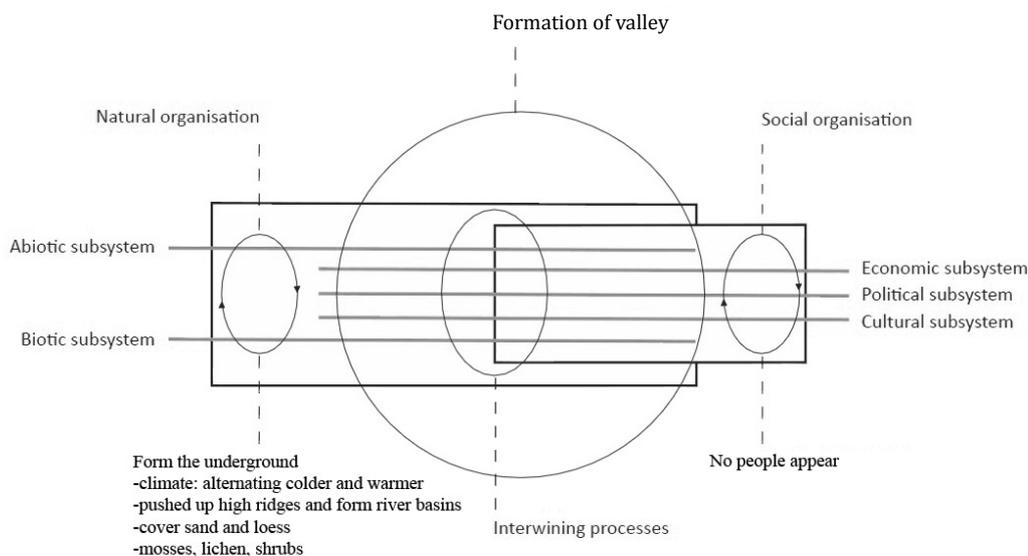


Figure 5.5 Sociophysical model for Pleistocene period
Source: illustrated by author

5.1.2. Holocene times

Man first settled in the Netherlands during the Pleistocene and Scattered middle Paleolithic. Implements have been found in river deposits at the southern end of the Utrecht hill ridge near Rhenen (Audrey M.Lambert 1985). In this period, sea-level was lower than nowadays and this continent was linked with the Britain. Most of humankinds are the isolated bands of adventurous hunters.

The Holocene times is the final phase in the physical evolution of the Netherlands (10,000 years ago) and since then over half the surface deposits of the country have been formed. Clay and peat layers are the mainly sediment in this period. During this period, a rapid rise of temperature began and lead to great changes of vegetation. Most of the higher Netherlands were covered with deciduous woodland. In Gelderland Valley, small lakes or patches of bog occur since the poor drainage. With the change of climate and vegetation, the ocean level rising is more apparent. The threatened population began to move to the higher parts. As the sea-level rose, the ground water table was also rising. The

coastline was driven eastwards, a broad belt of marsh and bog spreading before it over the Pleistocene surface to form a basal layer of peat (Audrey M.Lambert 1985). By late Atlantic times, the basal peats had stretched to the foot of higher sands areas. When the rise of the sea level began to decelerate, peat formation slowed down too.



Landscape zone	Utrecht Heuvelrug	Gelderse Valley	Veluwe
Height	+30NAP	+10NAP	+40NAP
Soil	Cover sand	peat	Cover sand
Drainage	Well	Bad drainage	well
Vegetation	Deciduous woodlands	Deciduous woodlands	Deciduous woodlands

Figure 5.6 Topography
Illustrated by author

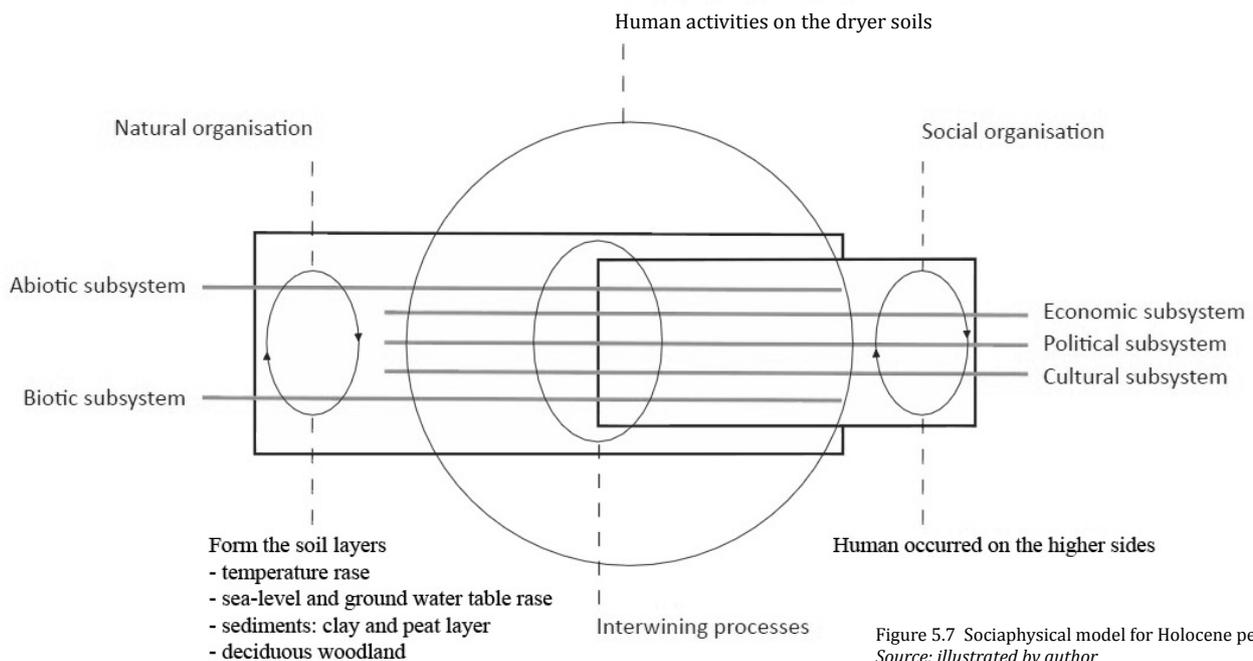


Figure 5.7 Sociophysical model for Holocene period
Source: illustrated by author

5.2. Human occupation and development

Human influence on the landscape is generally believed to be small until the Neolithic, when forests were cleared and agriculture began on the natural levees and on higher Pleistocene sands (Audrey M.Lambert 1985).

5.2.1. C.4000-700B.C

In this period, climate became to more continental and drier. Large areas of deciduous forest grew and reached their peak. Warm-loving beech and hornbeam appeared. Human started to modify their ways of life to suit changing environment. Heath species and weeds were cultivated. Human tried to work on metals and various tools were available in this period. Hunting and fishing were expansion in the region. In the late Neolithic times, agriculture and livestock husbandry proceeded. They cleared large tracts of forest by slash-and-burn methods to provide pasture for their herds of cattle and plots for their crops (Audrey M.Lambert 1985). Their activities, and the drier Sub-Boreal climate, caused the forests to open out, and by the close of the Neolithic much woodland had been transformed into open health (Audrey M.Lambert 1985). Later in bronze age (C.2100-700B.C), physical environment had been more stable. Besides the deciduous forest, deciduous woodland began to expand. At the same time, human’s burning and overgrazing turned further from forests to health. Human lived in the farmsteads which were dispersed and consisted by clusters of two or three houses with isolated farms.

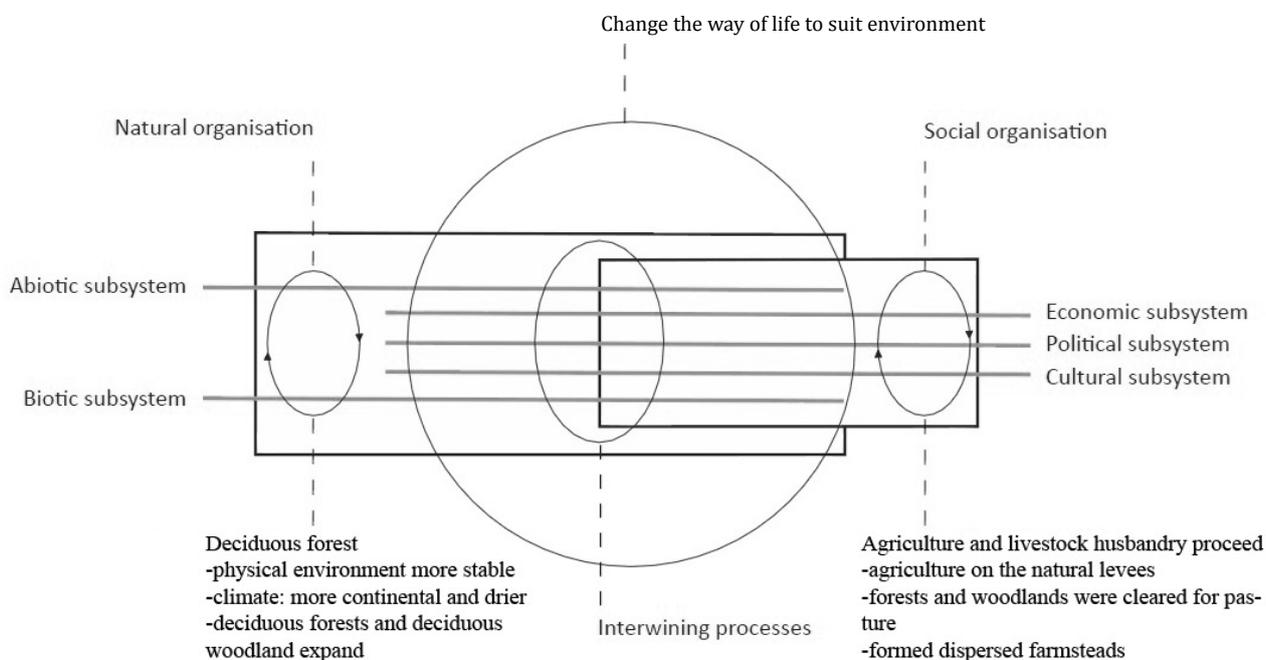


Figure 5.8 Sociophysical model in C.4000-700B.C
 Source: illustrated by author

5.2.2. 700 B.C-1000A.D

The start of the Iron Age coincided with the onset of a phase of climatic deterioration, the Sub-Atlantic, when cooler, moister, and probably windier conditions set in (Audrey M.Lambert 1985, P38). In this phase, population began to extension and pressures on land increased. Cultivation systems and small villages had been formed. The development of them left imprint on the landscape. The dominant pattern of cultivation system was Celtic fields. Celtic fields (a name sanctified by usage rather than accuracy, since there was no exclusive association with the Celts) were small, sub-rectangular or squarish plots, with sides 50-70 m long, enclosed by low earthen banks (Audrey M.Lambert 1985, P38). They were found on the Ede and the region along Utrecht hills.

Later in the roman times (50B.C – 400A.D), Netherland experienced a quite marine conditions and cool humid climate. Isolated communities were developed along the southern hills of the Veluwe and Rhenen. Due to needs of military, roads were developed for transporting military supplies. When it came to 1000 A.D, a girdle of villages ringed the higher sand, includes Dieren, Neder Rijn, Wageningen, Leersum and Bussum. In this period, villages had a green stock or brink and developed in time their arable open-field enken(Audrey M.Lambert 1985, P76). Human developed livestock in the way of depasture on the hills. Colonists resettled in the wet areas in the sands, companying with arable enk. The similar kind of settlements was flourished along small streams. Human divided enk from the wastes by oak copse and deep ditches. It formed a protection against both depredations of wild animals and drifting sand, and is traceable from Wageningen, past Bennekom and Ede, to Lunteren and the Goudsberg. People began to dig away peat and sale them. Elongated houses were developed from the villages into the peatlands.

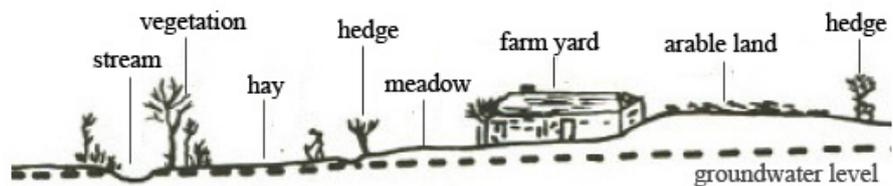


Figure 5.9 Cultivation pattern
Source: according to W.Vos 1987

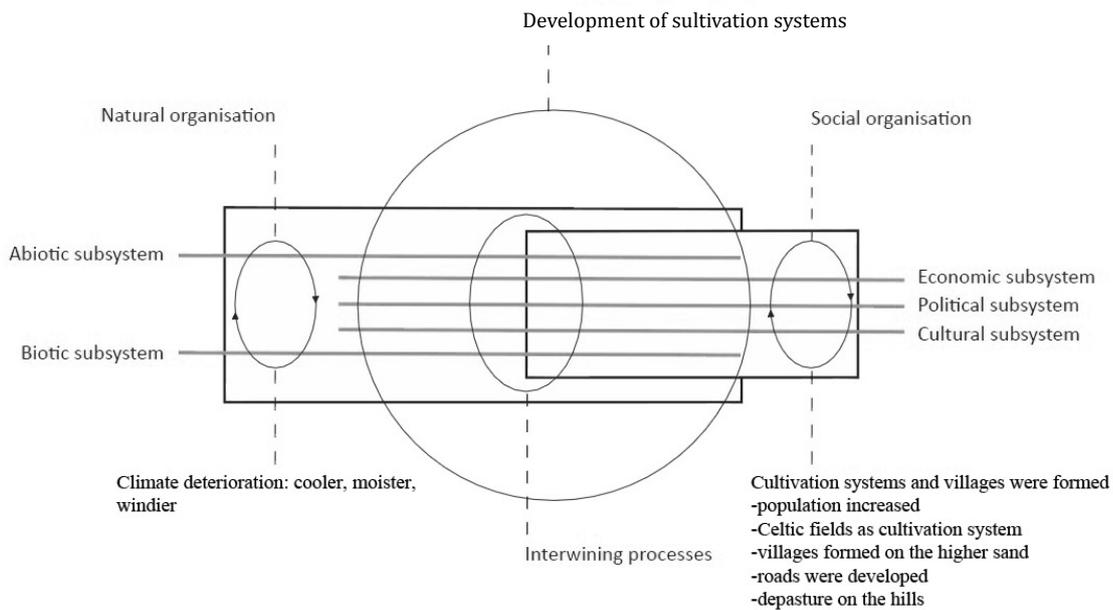


Figure 5.9 Sociophysical model in 700B.C-1000A.D
Source: illustrated by author

5.2.3 1000A.D – 1650 A.D

Till around 1000 AD, humans accepted the existing landscape situation and try to occupy suitable sites for settlements, such as dunes, higher ground and riversides. However, with the increasing of population, human occupations and influences on the land and water system were increasing. Population growth led to extensions of villages. In this phase, People began to seek self-sufficient in the open fields. Specialized dairying brought technical changes (Audrey M.Lambert 1985, P180). People used fertilizer, cow-dung, and night-soils on the pastures. Livestock developed fast and trade grew noticeably. Industrialization of crops was also increased widely.

In the peat-filled lowland of the Gelderland Valley and the marshy areas, people began intensive peat mining. In 1429, peat in the southern part of the current Veenendaal has been mined for sale. Village of Veenendaal was founded as a peat colony. Human began to develop waterways for peat transportation and inland water change. Between 1473 and 1481, people graved the Bishop David Grift which was not only for the removal of peat with ships to the Rhine, but also for drainage of excess water from the peat. Also, the ground level of the valley was two or three meters higher than present. In this period, the drainage techniques had been improved and reached a higher standard. People had active draining systems in lakes and wetlands for the settlements. In the meantime, due to the growth of population and towns,

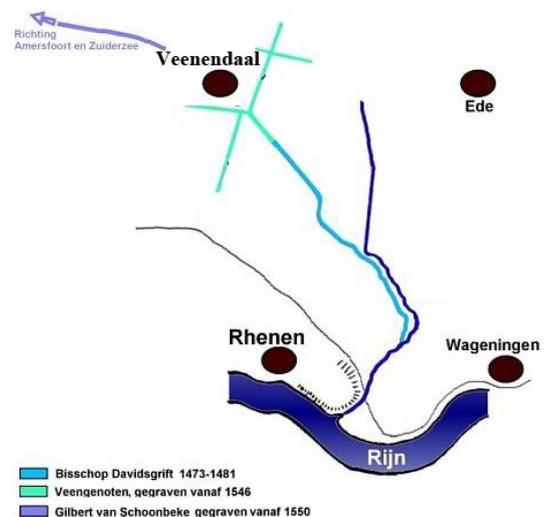


Figure 5.10 Drainage system
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html

5.2.4 . 1650 A.D – 1900A.D

People began to consider transporting water to the northern side to solve the problem of flooding. Around 1714, Bishop David Grift was associated with Schoondergang Beekse Grift (1545-1549). Almost all the surplus water discharged in a northwesterly direction.

In 1745 , the Republic of the Seven United Netherlands started the construction of the Holland Grebbelinie to protect against invading enemies. And it was almost entirely built in the 18th century – the second half of 1799. There are still some landscape and cultural heritages left there nowadays. In the spring of 1855, Veenendaal suffered the worst flooding in its history. The devastation was enormous, only the market and some other high-lying areas around New Mill and the Great Veenloo stayed dry. Eleven people drowned and a significant part of the building was lost. The population was collected in the Geertekerk in Utrecht. This included closet van Dijk a painting, which the town is visible. Drainage systems were developed and an increasing number of artificial fertilizers were used in the region. People developed commercial arable, cattle farming and largely self-sufficient husbandry.

Agriculture experienced an increasing prosperity until 1880. Thereafter, the Netherlands, together with much of Western Europe, underwent a period of severe agricultural depression (1880-1895) (Audrey M.Lambert 1985 P240). The sandy areas, due to self-sufficient cultivation system, suffered less influences. To fight with agricultural depression, government involved in agricultural affairs. Tobacco- growing used to be a dominant trade around Wageningen in the sixteenth century. However, it was as a replacement for horticulture in this period.

In this phase, government in Netherland began to build railways around the country. In 1863, railway line connected Amsterdam, Apeldoorn and Rhenen was built. It increased the accessibility of the region. More people were attracted to set in the region. Some original clusters of colonists' turf hovels were transformed into villages. The beautiful and quiet rural landscape had been attractive. More affluent businessmen and retired officials were attracted to live here, where were easy to reach with railway (Audrey M.Lambert 1985). Then, the use of cars became popular and highways were developed as well. It increased the accessibility of rural areas. In 1876, the Landbouwschool was established at Wageningen, which aims to introduce scientific experimental methods into the region of traditional farming techniques. The school accelerated the development of region on the food production and agriculture.



Figure 5.14 Peat mining
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hogtekrtdetail.html

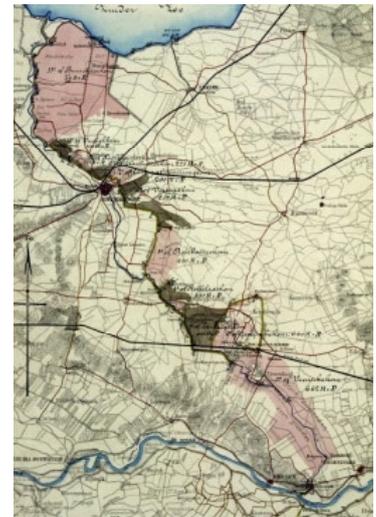


Figure 5.15 Grebbelinie water defence line
Source: <http://www.woudenberg.net/index.php?mediumid=4&pagid=434&simaction=content>

Figure 5.16 Map of Binnenveld (1802-1812)
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hogtekrtdetail.html



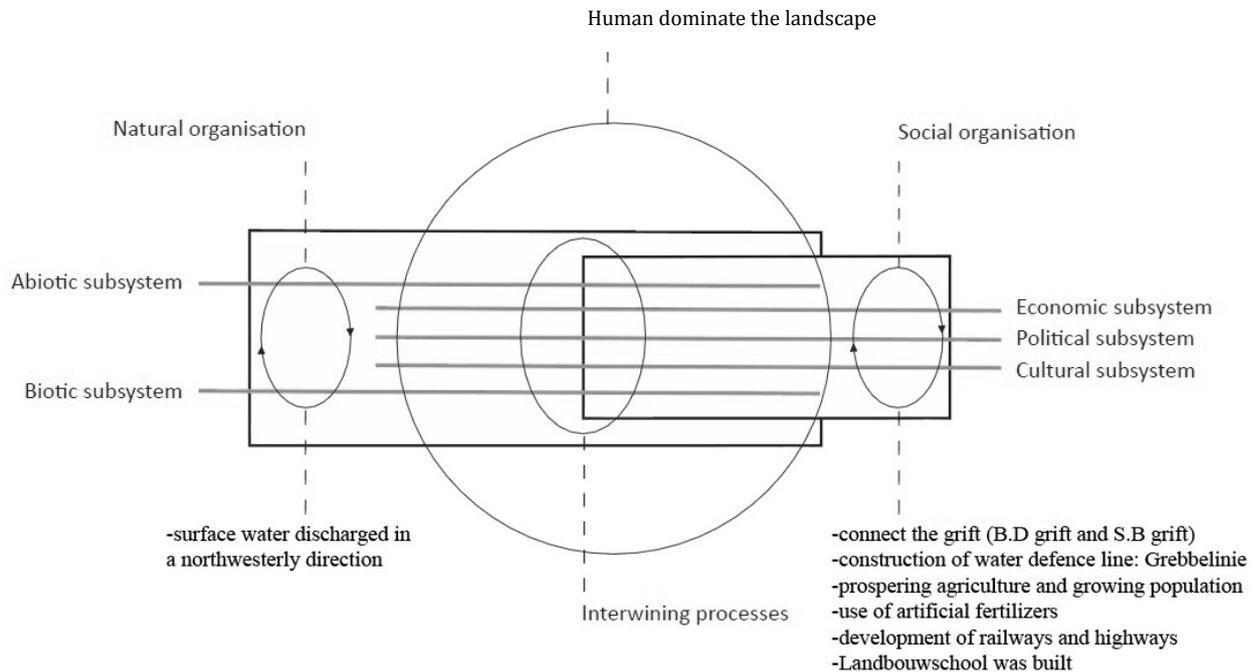


Figure 5.17 Sociophysical model
Source: illustrated by author

5.2.5. 1900 A.D till nowadays

Railways became an important feature of the countryside. Meanwhile, government put emphasis on the improvement of transportation network, includes waterways and motor transport. Several major rivers were straightened and canalized and canals have been built. In 1935, people began to dig Valleikanaal and finished it in 1941. Between 1958 and 1970, Rhine was canalized for the great volume of traffic. Since 1945, growth of the highway network has had a major impact upon the Dutch landscape (Audrey M.Lambert 1985, P308). With the development of transport networks, urban began to expand. Population growth and urbanization were so fast in the region that cultivated areas has shrunk since 1949. In the region, land use had been intensification and agriculture had been industrialization. Mixed farming used to be traditional in the region. However, with the industrialization and improvement of technology, an increasing number of them was specialization. They were transformed into a highly intensive pig and poultry farming. During the 1960s, it was increasingly realized the values of aesthetic, natural conservation and recreation in rural landscape (Audrey M.Lambert 1985, P312). People began to develop tourism in the region. The bicycle routes were planned in the region and some walking routes were made near the Rhenen as well. At the same time, canal was used for canoeing and fishing. In 2004, the region was created as Food Valley. The development of agri-food industry was supported by



Figure 5.18 Dug Valleikanaal in 1904
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/index.html

Wageningen University and Research Centre.



Figure 5.19 Pasture in the Kraats

Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hogtekrtdetail.html



Figure 5.20 Engen landscape

Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hogtekrtdetail.html

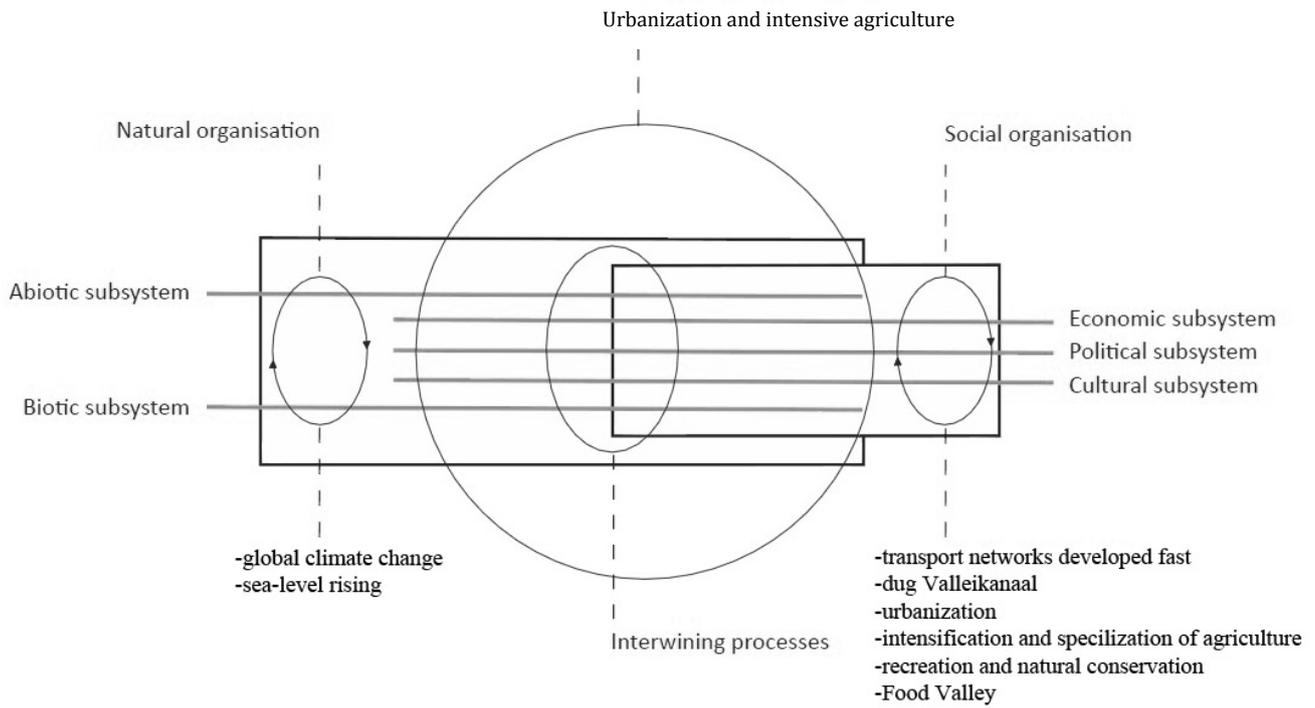


Figure 5.21 Sociophysical model
Source: illustrated by author

5.3 Today's landscape

5.3.1 Social and economy

Include the four cities, the total number of population in the binnenveld is about 220,982. It includes about 26.53% young people (0-19 years old), 36.24% of people from 20-44 years old, 23.88% in the range of 45-64 years old and 13.35% old people.

It is a prominent agriculture region within the densely populated in the Netherlands. The size for agricultural land use occupied about 48.8% of the total areas. However, according to statistic data of job employees by activities in 2005, we can find that job opportunities from agriculture are very limited. There are only about 1.4% of the people work on agriculture, forestry and fishing. In fact, economy in Netherlands was contracted in 2003 and slightly recovered in 2004 (CBS). It led to a growing low employment rate. The loss of employment in industry is somewhat offset by job growth in the education and care. People working on the commercial and servicing sectors were growing since 2004. In my studying area, most jobs are provided in the commercial services and reach to 46.45% in 2005. Non-commercial business services were the second one and occupied about 35.07% in total.

The number of business establishments increased quickly in the period of 2003-2005 in Netherlands. There is a growth of 1.5 percent per year (CBS). Especially the number of branches in the commercial and non-commercial services had increased significantly. In 2005, they occupied about 53.9% and 15.4% separately in my studying area. At the same time, agriculture, forestry and fishing activities had 13.8% and mining industrial occupied about 16.9% in totally business establishment. The proportions of agriculture, forestry, fishing and commercial services are higher than the average level in Netherlands.

	Region		Netherlands	
	Abs.	%	Abs.	%
Total	220982	-	16305526	-
0-19 years	58651	26.53	3987957	14.04
20-44years	80077	36.24	5775548	35.42
45-64 years	52761	23.88	4253351	26.09
65 - older	29493	13.35	2288670	14.03

Table 5.1 Population by age in 2005
Source: according to CBS

	Region(%)	Netherlands(%)
Agriculture, forestry, fishing	1.45	1
Mining, industrial	17.03	18
Commercial services	46.45	47
Non-commercial business services	35.07	34

Table 5.2 Job of employees by activities
Source: according to CBS

	Region		Netherlands	
	ha	%	ha	%
Total	13275	-	3216727	-
Constructed areas	4381	33	318330	9.4
Forest and nature	2039	15.4	483462	14.3
Recreation	379	2.8	88877	2.6
Agriculture	6476	48.8	2326058	68.9

Table 5.3 Land use percentage
Source: according to CBS

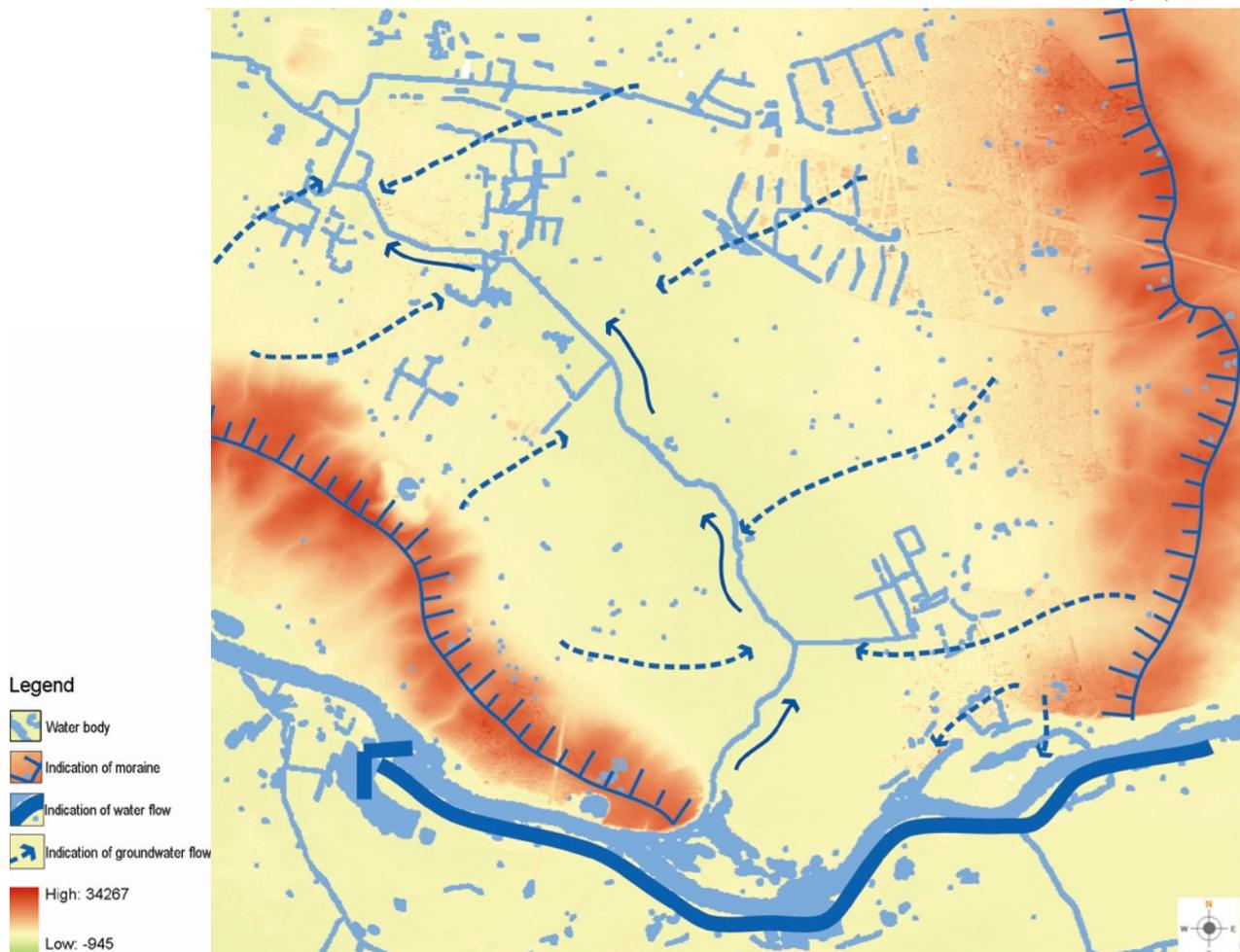
5.3.2 Abiotic landscape

The layer for abiotic landscape is the most stable one and was formed back to Pleistocene times. The analysis about this layer includes topography, water systems and soil structure.

Topography

The Gelderse Vallei was formed by the Scaninavian land ice sheet during the Saale glacial as a glacier tougue basin with associated ice-pushed ridges (the influences of water). These push-moraines today form a striking element of the central Netherlands landscape (Audrey M. Lambert, 1985). The Binnenveld lies between the Utrecht hills on the west and the Veluwe moraine on the east side. The levees and flood plains along the Lower Rhine forms the southern boundary. Binneveld is relatively low, only a few meters above sea level.

Figure 5.22 Height map
Source: adapted from GIS



Surface water

In Gelderse Vallei, dozens of streams flow from the moraines of the Veluwe to lower parts of the Valley and finally out into the Eem. Then water drains from Eem into the Zuiderzee. The course of the streams was largely determined by the sand ridges (dark yellow in the figure) in the Valley and on the flanks of the hills.

Groundwater

In the low-lying field, there is a sandwiched layer structure, which is between two hills and affects the drainage of rainwater. In the valley, rainwater flows partly superficial along the hills down to the low areas, for another part sinks away into the ground. The groundwater moves to lower positions and its flow determined by the composition of the substrate. In the substrate, there are the aquifers where water moves easily, lying between hard permeable layers, the water separating layers. Then through this structure, groundwater breaks from these layers to the surface in the lowest parts of Binnenveld. The lowest ones are along the Grift and therefore they are always the wettest areas.

However, agricultural activities cause nitrogen and phosphorus pollution on the surface water and various developments reduce the seepage into the groundwater. Agricultural activities, construction of housing and industrial estates in Binnenveld decrease penetration of rainwater into soil layers. Dug and deepening of ditches and channels led to rainwater drains faster. They all cause less seepage flows.

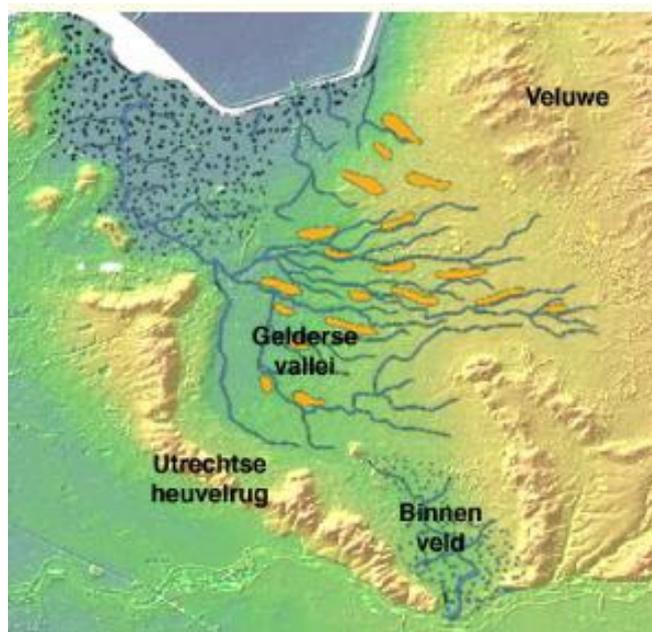


Figure 5.23 Water courses in Gelderse Vallei
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html

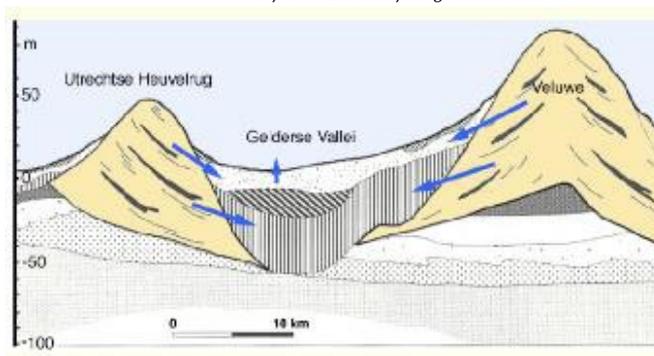


Figure 5.24 Groundwater flow, cross section
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html



Figure 5.24 Groundwater flow illustration
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html

Soil structure

Topography, water and soil structure largely determine the development of nature and landscape. The soil map shows the variety of soil types. It is clear that in the low-lying parts of the field soil types are major peaty soils. The ice-pushed hills mainly consist of sands and formed in the Weichselian period. In the southern sides of the Binnenveld, river flooded these zones regularly, clay soils are major soil type. In the Holocene time, as ocean level rising, the coastline was driven eastwards and a basal layer of peat was formed. The figure on the left side shows a somewhat schematic cross section along the line Veenendaal-Ede. The first deposit of importance is a lacustrine clay of up to 6 and locally 12m thick (Verbraeck, 1984). Above them is the "fluvioglacial deposits", which are consisted of fine and coarse sands. The thick of this layer is about 5-12m.

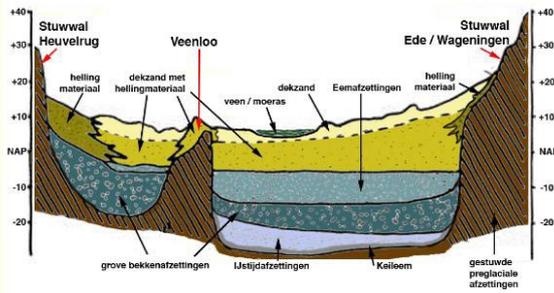


Figure 5.25 Soil deposition
 Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/hoogtekrtdetail.html

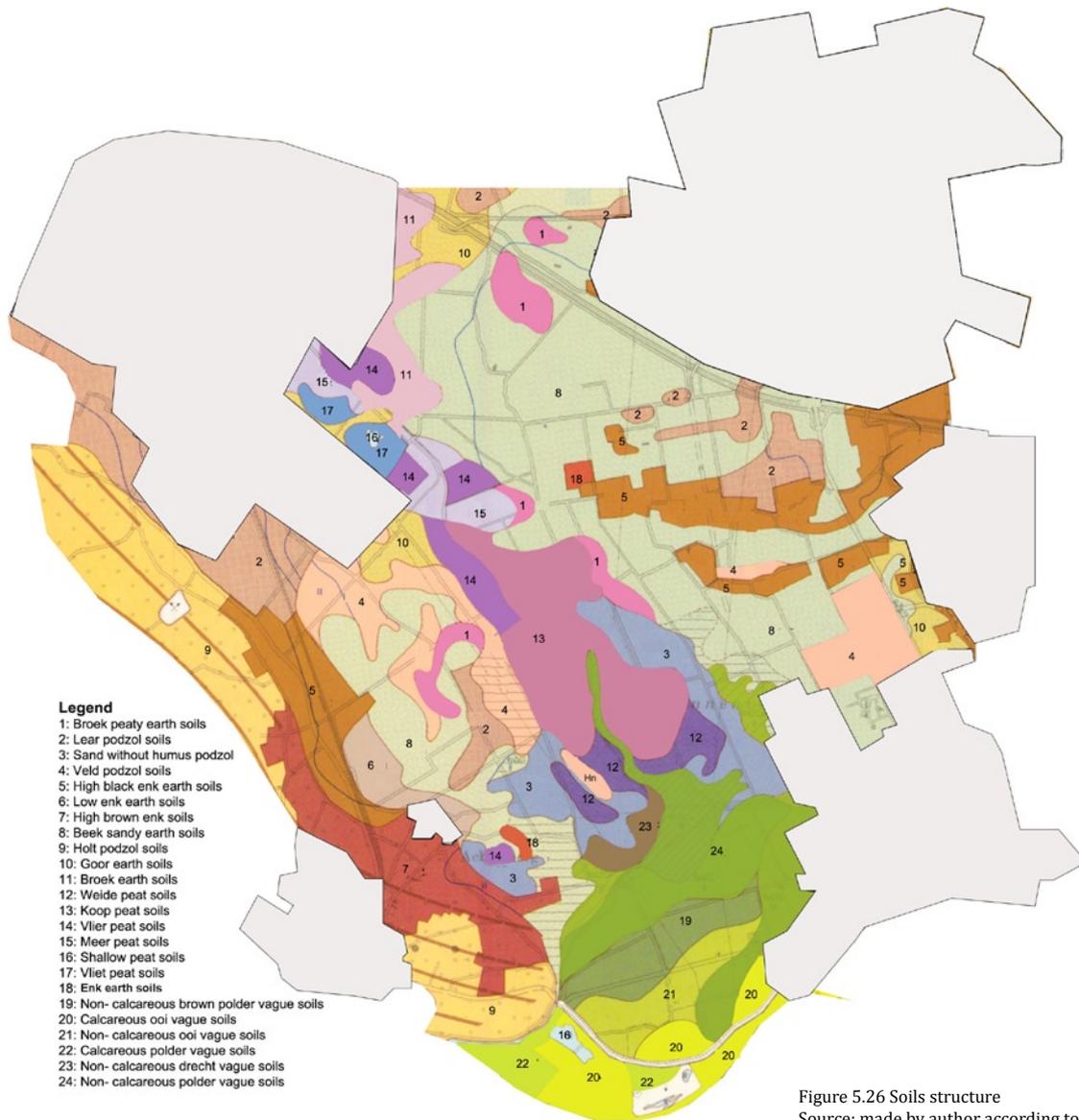


Figure 5.26 Soils structure
 Source: made by author according to GIS

5.3.3 Biotic landscape

Biotopes Pattern

Due to a long term of agricultural development, vegetation resources in the region has been destoried. Nowadays, the existing vegetation patterns can be grouped into: (1). Forestes on the surrounding hills, which formed boundaries in the western and eastern sides; (2). Agricultural vegetations: it includes arable land, which is mainly occupied by cornfields; Pasture with large size of grassland; Orchard, fruit farm and trees nursery; (3). Tree lines, along roads, streams and villages; (4). Aquatic vegetation types, mainly distributed in streams, drainage patches and surrounded areas.

The loss and isolation of habitat is a seemingly unstoppable process occuring throughout the modern world(Dramstad 1996), especially for regions were developed into mono function. In my studying area, because the quickly and intensive development of agriculture, these problems are becoming more serious. They presents at the fragmentation, shrinkage and attrition.

One of the main criterias for the ecological sound landscape is the landscape connectivity. Corridors in landscape can be used to form networks and interconnect with different landscape elements. However, from the biotopes map, it is easy to find out that it is lack of functioning corridors and networks in my studying area. Even we can find several tree lines along roads, they are consist of trees without hedgerow and groundcover. They can't normally work as corridors for habitat movements.



Mixed forests



Osier thicket



Arable lands



Pasture



Poplar stand



Orchard



Tree nursery

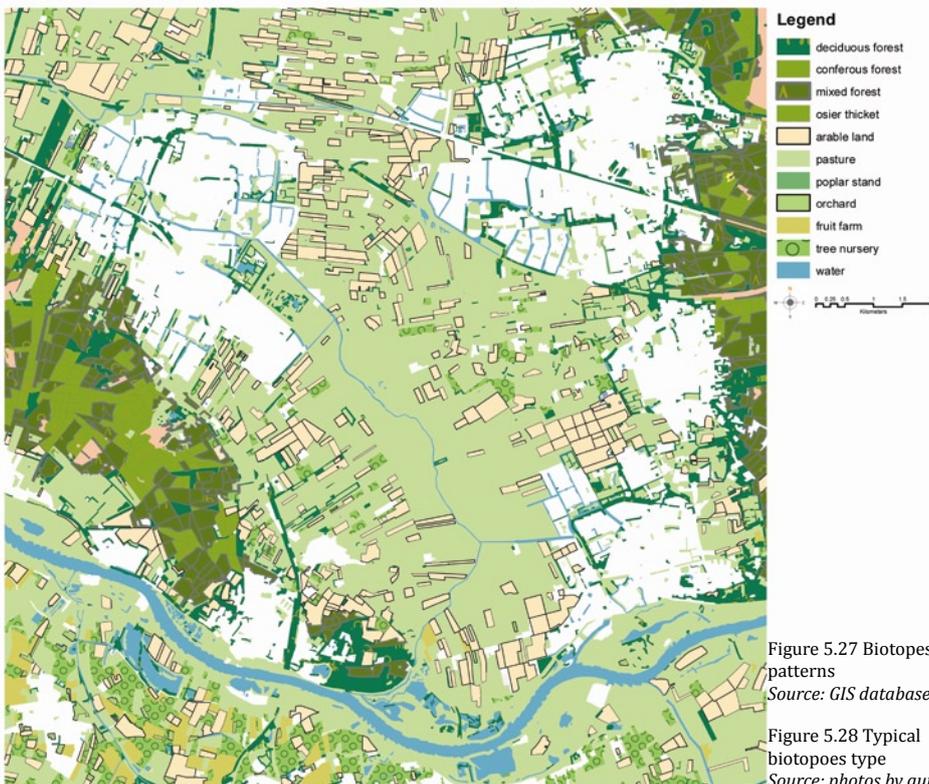


Figure 5.27 Biotopes patterns
Source: GIS database

Figure 5.28 Typical biotopes type
Source: photos by author

Biodiversity

In the region, most of areas has been relaimed as the agricultural lands. As a result, there is a decling in the (semi-)natural vegetation which was rich in species. Instead of them, species which will support productive needs are increasing, Even most of them have lower biodiversity. The original vegetation was conserved on the parts where are difficult to relaim. And most of them are surrounded by agriculture. In 1880 J.D.. Kobus walked through the Gelderse Vallei and besides the beauty of the area he described many plant species he came across, such as Parnassia palustris and Carex flava. Unfortunately, most of them have disappeared nowadays. These different ecotypes provide nature conditions for distinctive birds, butterflies, reptiles and mammals. The Grebbe is a beautiful area for birds. There are diverse kinds of birds can be found here, such as kingfisher, stork, woodlark and so on. In the open and flat landscape around the Gelderland, several birds nesting. Many songbirds hide in the bushes. The water line along the embankment attracts the interest of fishermen among birds, including blue heron and the kingfisher. The latter is often nest in the dike. Trees, bushes, bits of open space, gently flowing water provide suitable environment for them to live. However, human influences on the vegetation also put impacts on them. Fragmentation, shrinkage and attrition of patches and lack of connectivity in the landscape led to decrease in the number of birds diversity.



Figure 5.29 Flora species
Source: collected by author

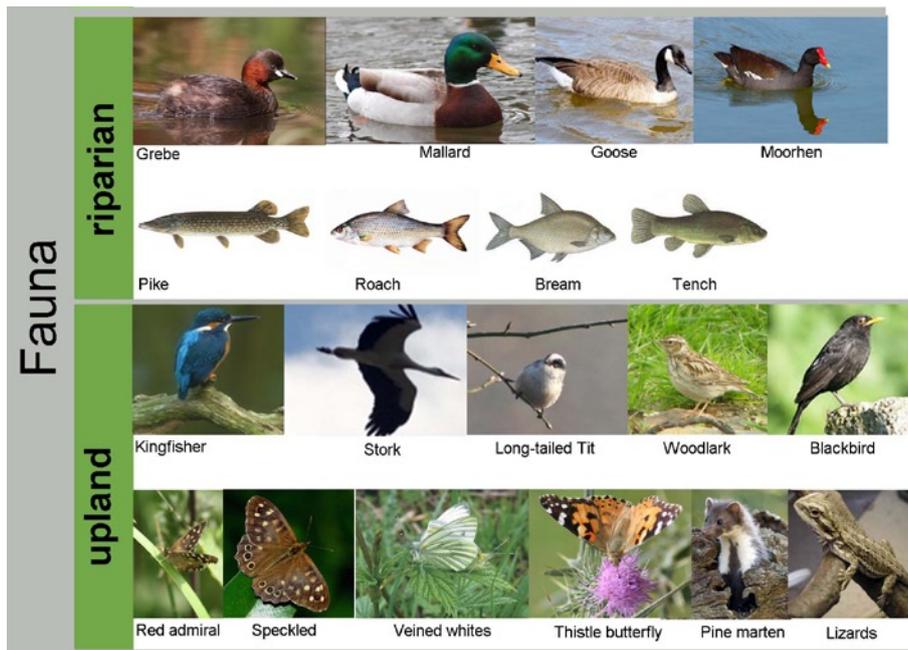


Figure 5.30 Fauna species
Source: collected by author

5.3.4 Anthropogenic landscape

Infrastructure

This layer of networks is very important in my studying area, which connects the region to other parts of the Netherlands. The networks that cross the region are mainly motorway and main roads, as showed on the map below. The railways cross the cities of Ede, Veenendaal and Rhenen. From west to east, the highway A12 and N225 are very important. Main roads of N233 and N781 connect the cities from north to south. Focus on the connection with outside, A12 connects Ede and Veenendaal with Utrecht and Den Haag in the west side, Arnhem and Germany in the eastern side. You can go to Apeldoorn from Ede on N304 and Bareveld from Veenendaal on A30. Meanwhile, waterway in the Rhine is important as well. It can connect Binnenveld with Rotterdam and Germany.

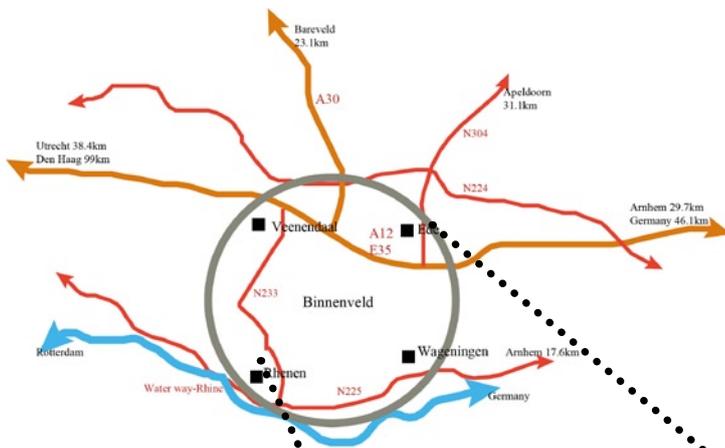
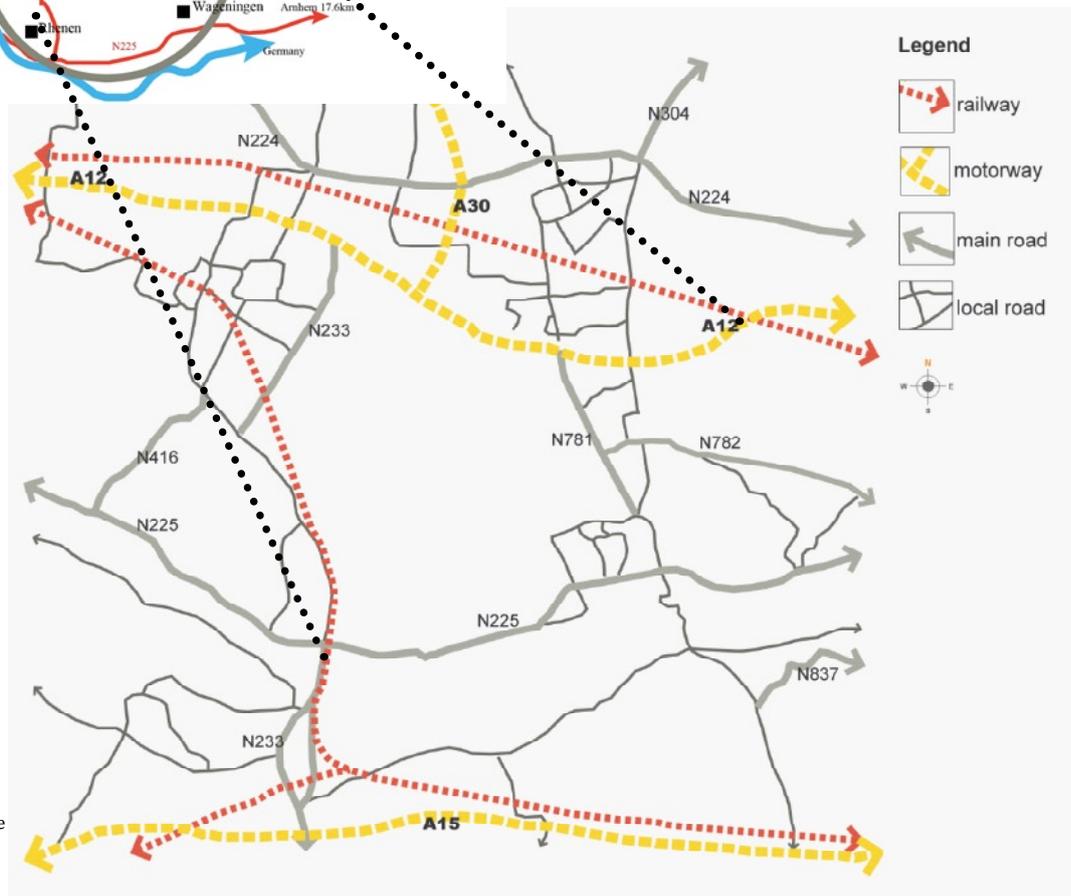


Figure 5.31 Roads system
Source: illustrated by author according to google map



Legend

-  railway
-  motorway
-  main road
-  local road



Figure 5.32 Roads system in the regional scale
Source: illustrated by author according to google map

Human occupation

The landscape in the region has been modified largely by human activities. These human activities put impacts on the landscape functions. Nowadays, main land uses in the region are made up by constructed areas, forest&nature, agriculture and recreation. As the figure 5.33, it is the land use map according to gis database and google map. In total, the size of this region is 13275ha. There are about 49 percent is agricultural land, 33 percent is constructed areas, forest&nature takes 15% and recreation is 3%. Agriculture occupied nearly half of the region. Constructed areas are five cities in the region and some small villages located here. Forest& nature represents forests in the western and eastern sides and several fragmented original nature resources. Recreation mainly distributed in the surrounding forest and along the water line.

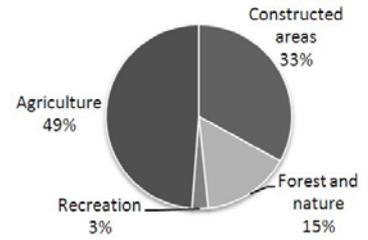


Figure 5.33 Percentage of land use
Source: CBS

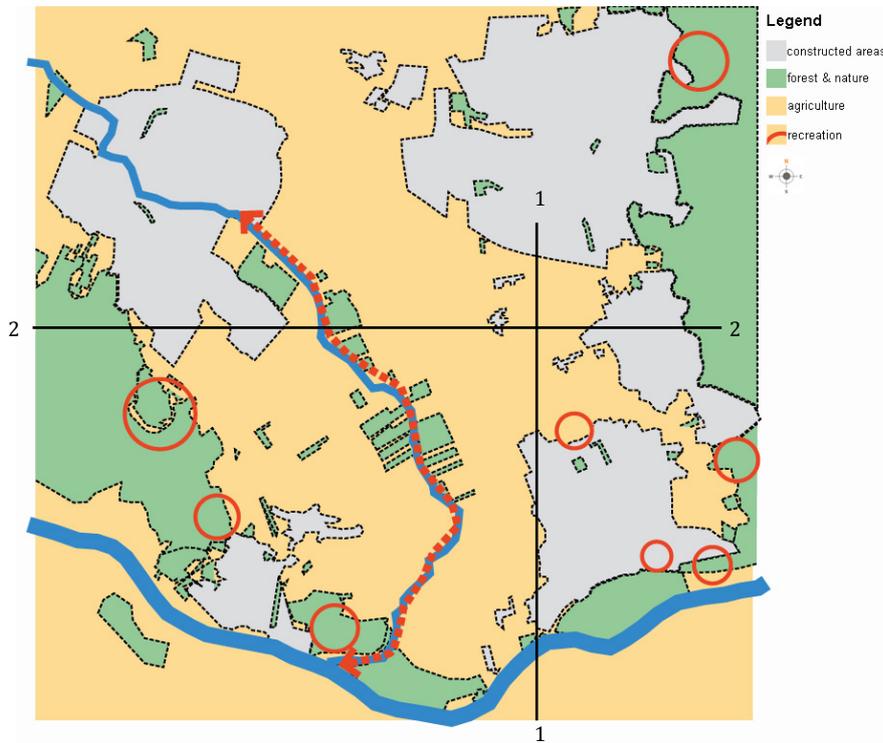


Figure 5.34 Land use map
Source: illustrated by author according to GIS

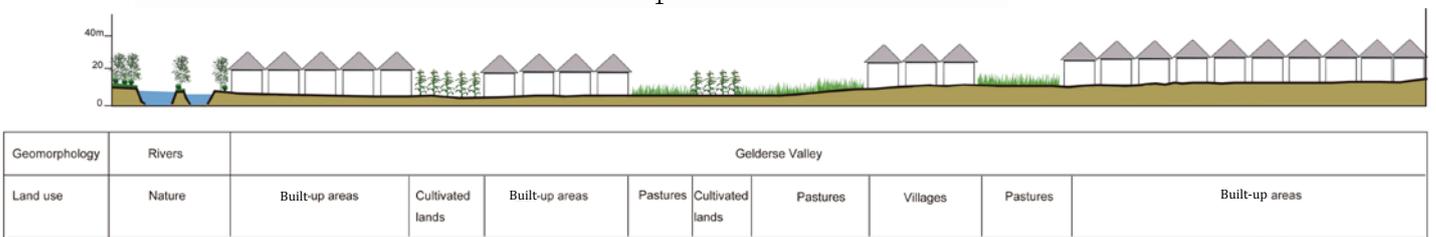


Figure 5.35 Cross section 1-1
Source: by author



Utrecht Heuvelrug		Gelderse Valley						Gelderse Valley		Veluwe moranie	
Sloping	Gently sloping	Nearly level				Nearly level				Gently sloping	Sloping
Holt podzol soils	Enk earth soils	Velt podzol soils	Sandy earth soils	Peat soils	Sandy soils	Sandy earth soils	Velt podzol soils	Earth soils	Holt podzol soils		
Forests	Villages	Cultivated lands	Pastures		Pastures		Cultivaed lands	Villages	Pastures	Towns	Forests
Mixed forests Shrubs	Lines of trees Hedgerows	Crops Sparsely trees	Grasses Sparsely trees		Grasses Sparsely trees		Crops Sparsely trees	Lines of trees Hedgerows	Grasses Sparsely trees	Lines of trees Hedgerows	Mixed forests Shrubs

Figure 5.36 Cross section 2-2
Source: by author

5.3.5 Fieldwork

The fieldwork is based on my studying in the historical development and today's landscape in the region. They help me to learn and understand the binnenveld well. The major method of fieldwork is field observation. They aim to identify different cultural landscape with diverse landscape characters and landscape quality in the studying area about the current situation.

Purposes

The primary purpose of the fieldwork is to assess the landscape quality and identify the variations in quality that exist across the landscape of the region. It will be helpful for problem analysis, understand local cultural context and developing appropriate strategies for plan and design.

Considerations

-The evaluation is based upon the existing quality of the landscape as observed during this study and does not take into account past or potential landscape quality.

-It is important to stress that this evaluation is based upon an assessment of the intrinsic quality of the different landscape types, rather than a relative assessment of one against another, since such comparisons are generally unhelpful and highly subjective.

Methods

-Classify the survey units on the basis of their overall similarity
According to my learn in historical development and today's landscape analysis, landscape in the region will be divided into several groups. The division is accorded to appearance of landscape.

-Take photos of various landscape units
Large number of photos are took and were intended to cover the most important land uses within each unit.

-Open interviews with local people
I will do several open interviews with local people to discuss about their opinions of the living environment. The interviews will concentrate on my research purposes and help me to learn local requirements.

Landscape units

Within the landscape in the field has different periods it has been cleared for agriculture. The period of reclamation and how the grounds have been extracted from the image given the current appearance of the Binnenveld. The higher, dry soils were first put into use. As technology progressed and thus became possible to lower, wet areas to be mined. Greater parts of the Binnenveld mined.

For layout of buildings, it mainly includes rectangular, block-shaped and strip-shaped lots.

It is difficult to classify Binnenveld into groups due to a smooth transition between different cultural landscapes. Moreover, by development of agriculture in the field, distinctive character of cultural landscapes became increasingly weak. Hence, classification of landscape will not only maintain the cultural landscape boundaries. Current use and the appearances of the landscape will also be taken into account. The appearance, or the morphological characteristics, serve as a basis for classification in scenic areas.

Analysis of current form and the morphological properties of landscapes is based on four elements:

High and dry <-> Low and wet

This characteristic largely determines the appearance of the landscape. Low, wet areas are mostly open areas with many ditches and erect little green. As the higher and drier areas, there is also more upright and mostly green besloten character of the landscape.

Closed <-> Openness

By these different levels that distinguish the experience and appearance of the landscape. I distinguish:

- closed;
- small-scale landscapes;
- half-open landscapes;
- open landscapes.

Rational subdivision <-> capricious allotment

The later use of the land is closely related to wet or dry conditions. The wetter areas are mostly mined in strips. The transition from wet to dry, have a more blocky arrangement and the highest allotment land has a capricious allotment. I distinguish these three types of subdivisions:

- strips allotments ;
- block-shaped allotments;
- irregular subdivisions.

Plantation

The pattern of plantation plays a major role in the appearance of the landscape. Forms of plantation create different layout of landscape. They can not only form the edges of landscape, but also affect the orientation of buildings. Analysis on plantation mainly consists of vegetation along the driveways, surrounded the buildings and pastures.

According to these four elements, there are five different landscape types distinguished in the Binnenveld that differ in outward appearance:

- The engen scenery (brown)
- The kampen landscape (green)
- The levees landscape (beige)
- The peat mining landscape (light green)
- The broekontginningen landscape (yellow)

Legend

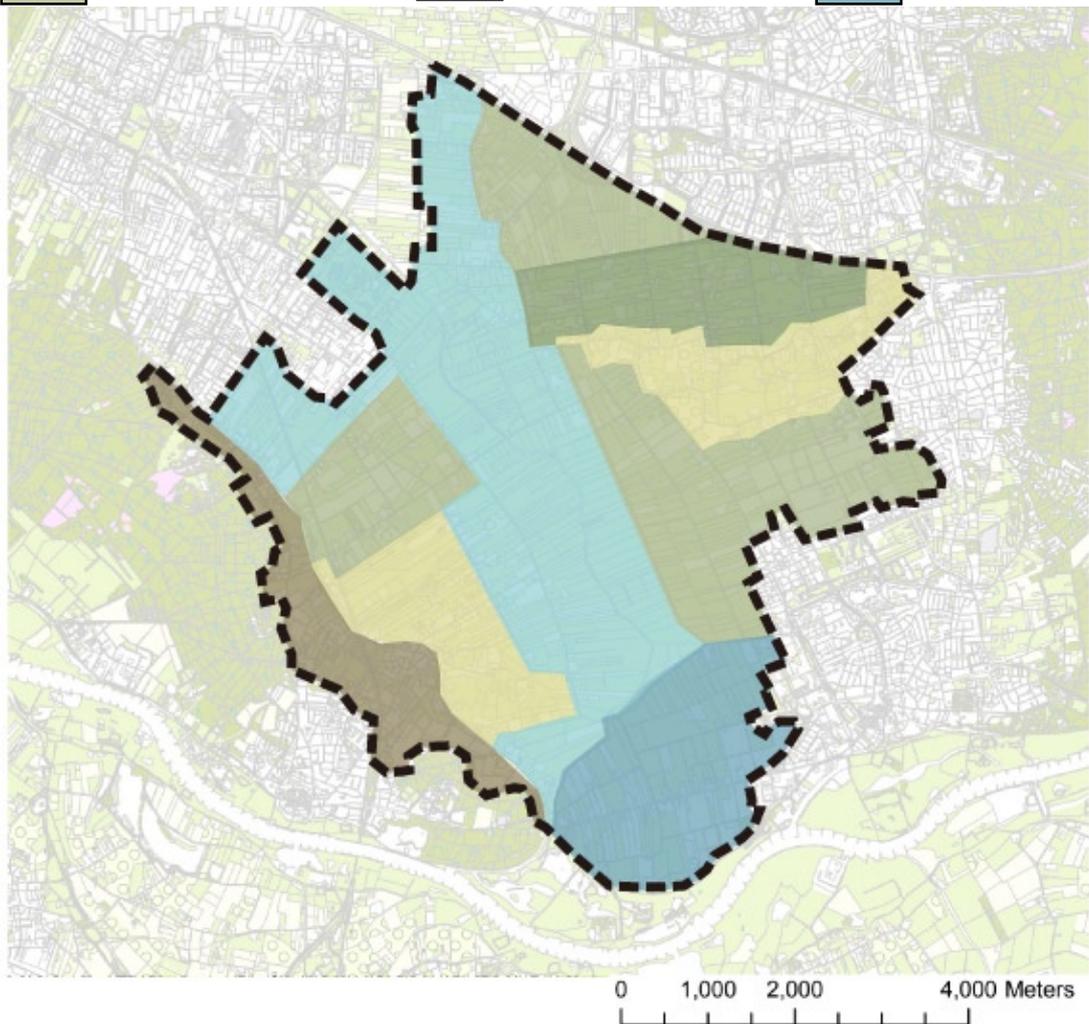


Figure 5.37 Landscape units
Source: by author



(1). Engen landscape

a. High, dry soils, topography rich

The Utrecht hills consist of three zones: high and dry on top, not too wet or too dry on the slopes, wet on the base layer. The engen landscape at the edge of the Utrecht hills is greatly limited by the woodland on the moraine. Because of the steep height over the moraine flank, size of the region is limited. The landscape is characterized by a strong slope of the fields. The engen landscape lies at the foot of the Utrecht hills and its openness determines the view of the moraine.

b. Private openness

Characteristic of the narrow landscape is the limited openness. That means an open landscape (eng) with sharply defined edges (forest edges, woodlots, hedgerows and tree-lined streets). New and larger farms located in the region have a major impact on the openness of the landscape.

c. Irregular allotment

Because the narrow landscape mainly follows the contours and a small width, the old buildings are often located on a main road (ribbon). This road is planted with trees and is often the transition from the high to the narrow low-lying pastures. The distance between the roads is quite large. These farms disrupt the openness.

d. Plantation

Along the driveway is a double row of trees (lane), consisting of oak. Also the yards and a few orchards surrounded by thorny hedges. Between the yard and the road are hedges. The oak grove at the side of the yard is very typical in this type of landscape. The backyard is surrounded by wide hedgerows or windbreaks (willow oak). In addition, planting used as the property boundary, has been visually dominant.

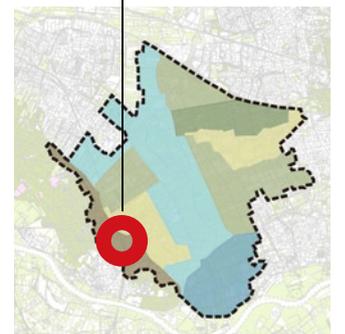


Figure 5.39&40 Location of engen landscape
Source: by author

Figure 5.38& 41& 42 Images of engen landscape
Source: Beeldkwaliteitsplan
BINNENVELD. 2010

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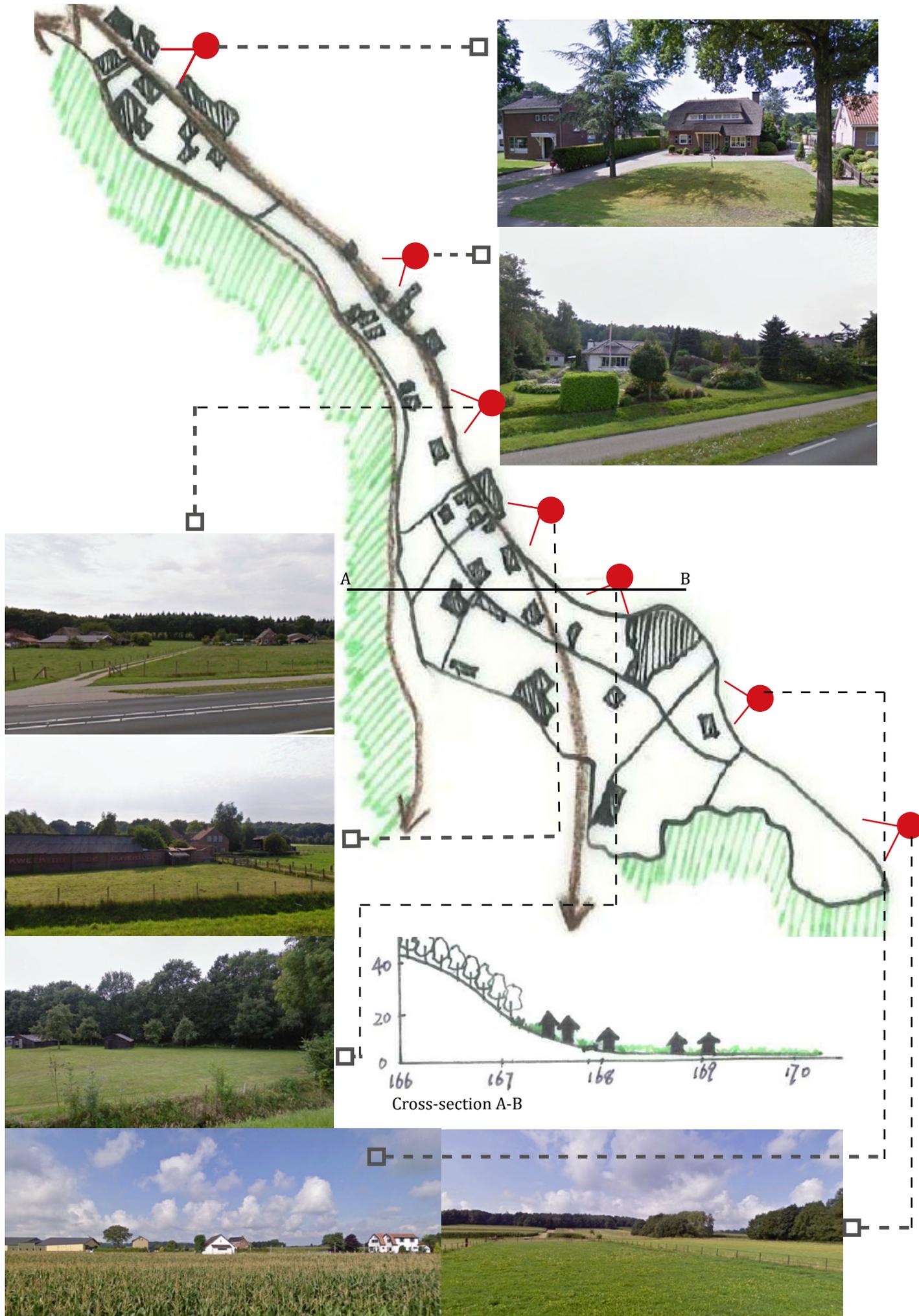


Figure 5.43 Images of engen landscape
Source: by suthor

(2) Kampen landscape

De kampen

a. High, dry soils in low wet soils

With highly variable topography and a large variation in hydrological conditions, here is the kampen landscape. It is characterized by the strip-shaped plot types, rather than whimsical forms. This strip plots is the result of a fairly high water table. The Utrecht hills have a steep height gradient, allowing the water table in this camp close to the ground level.

b. Small-scale

One typical image of camp landscape is small scale openness. Plot planting are very characteristic of this type of landscape. Plantings accented the image of strip plots, by defining narrow open plots. The small plots, depending on the water level, are suitable as a field for pasture.

c. Strip Allotment

The buildings are mainly located in north-south current mining ribbons and some east-west running roads. For the north-south alleys, these farms are mainly located at the Weteringsteeg and the Cuneraweg. Hedgerows and windbreaks planted on the boundary of farms.

Achterberg: The village has a special position in this area. It lies at the transition from the engen landscape to the kampen landscape. Also represents the transition of different plot directions.

d. Plantation

The cultivated plots have a distinct east-west direction, which used to be more perceptible by lines of plantings (windbreaks and hedgerows). Along the driveway is a double row of trees (lane), consisting of oak. Nowadays, the strip structure is still present, but the plantings are heavily in decline and integration between estates and landscape is losing.

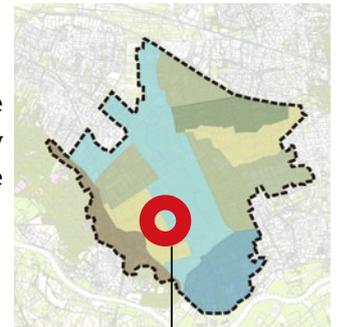


Figure 5.44 Illustration of Kampen landscape
Source: http://www.protozoa.nl/Binnenveld/binveld_start/Site%20Folder/kampen.html

Figure 5.44 Images of kampen landscape
Source: google map

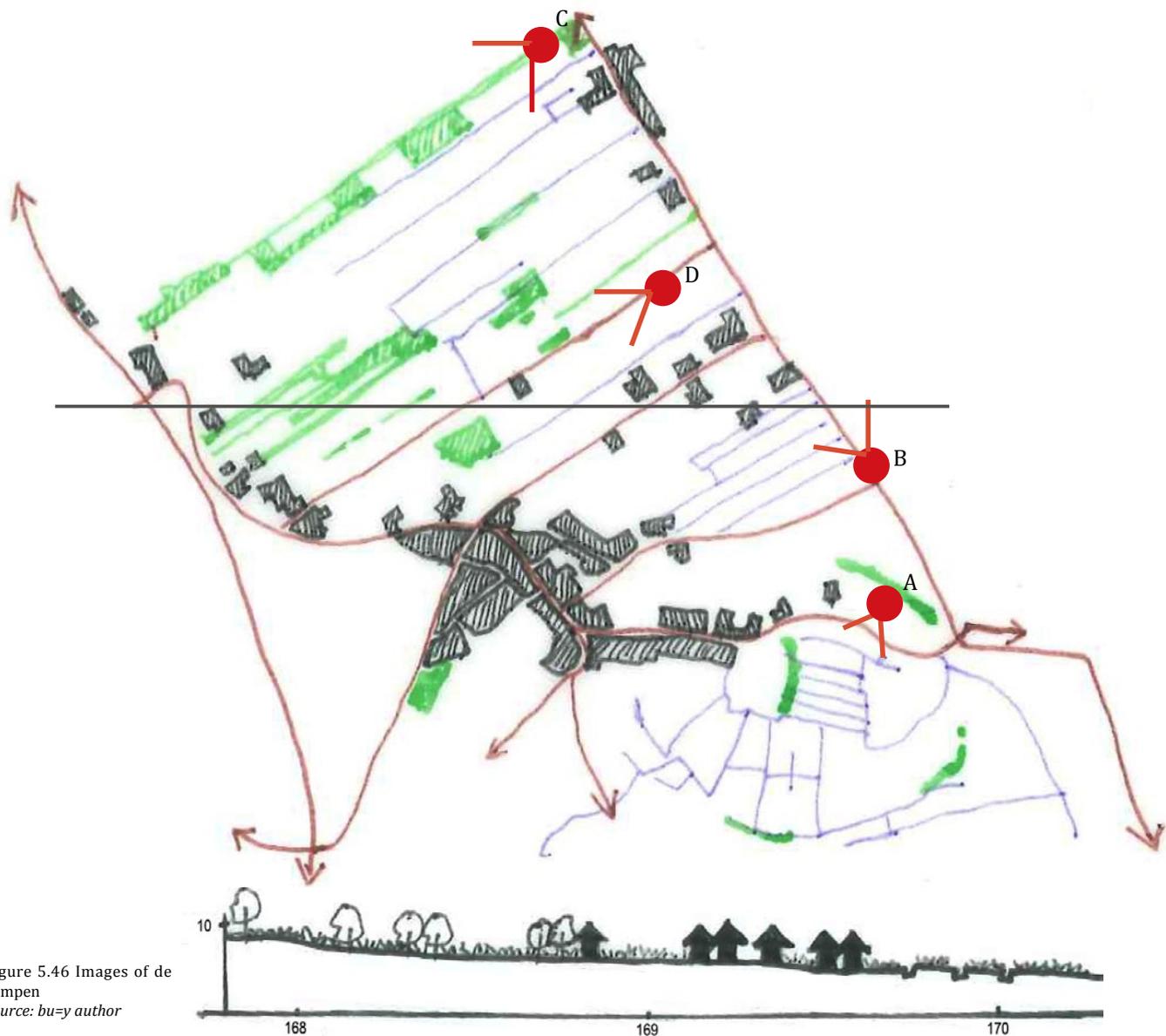


Figure 5.46 Images of de kampen
 Source: bu=y author



Photo from view A



Photo from view B



Photo from view C



Photo from view D

DE NERGENA

a. High, dry soils, topography: steep edges

This area has a traditional kampen landscape. It has irregular allotment forms, roads adapted to the topography, slopes in the landscape and small border plantings on the plots. It is close to the Veluwe moraine and has steep edges.

b. Small-scale openness

With the typical small scale openness landscape, plot planting are very typical in the area. Border plantings on the small plots formed small openness landscape. These small plots are suitable for pasture. Hence, a large number of livestock are developed here and led to ammonia pollution.

c. Irregular allotment

The largest difference between landscapes here with “de kampen” is the form of allotment. The houses here have developed in different directions, with also cultivations differences in orientation. Buildings are frequently close to the road. Due to the irregular lot subdivision, houses have varying forms.

d. Plantation

The Nergena is a valuable area for the particular historical and landscape structure. However, over the years, many landscape structures have lost. Particularly woodland and hedgerows have fallen into disrepair or disappeared.

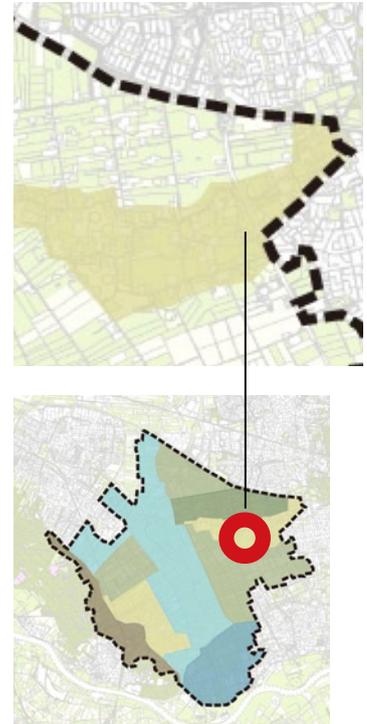


Figure 5.47 Bird views
Source: google earth 2012



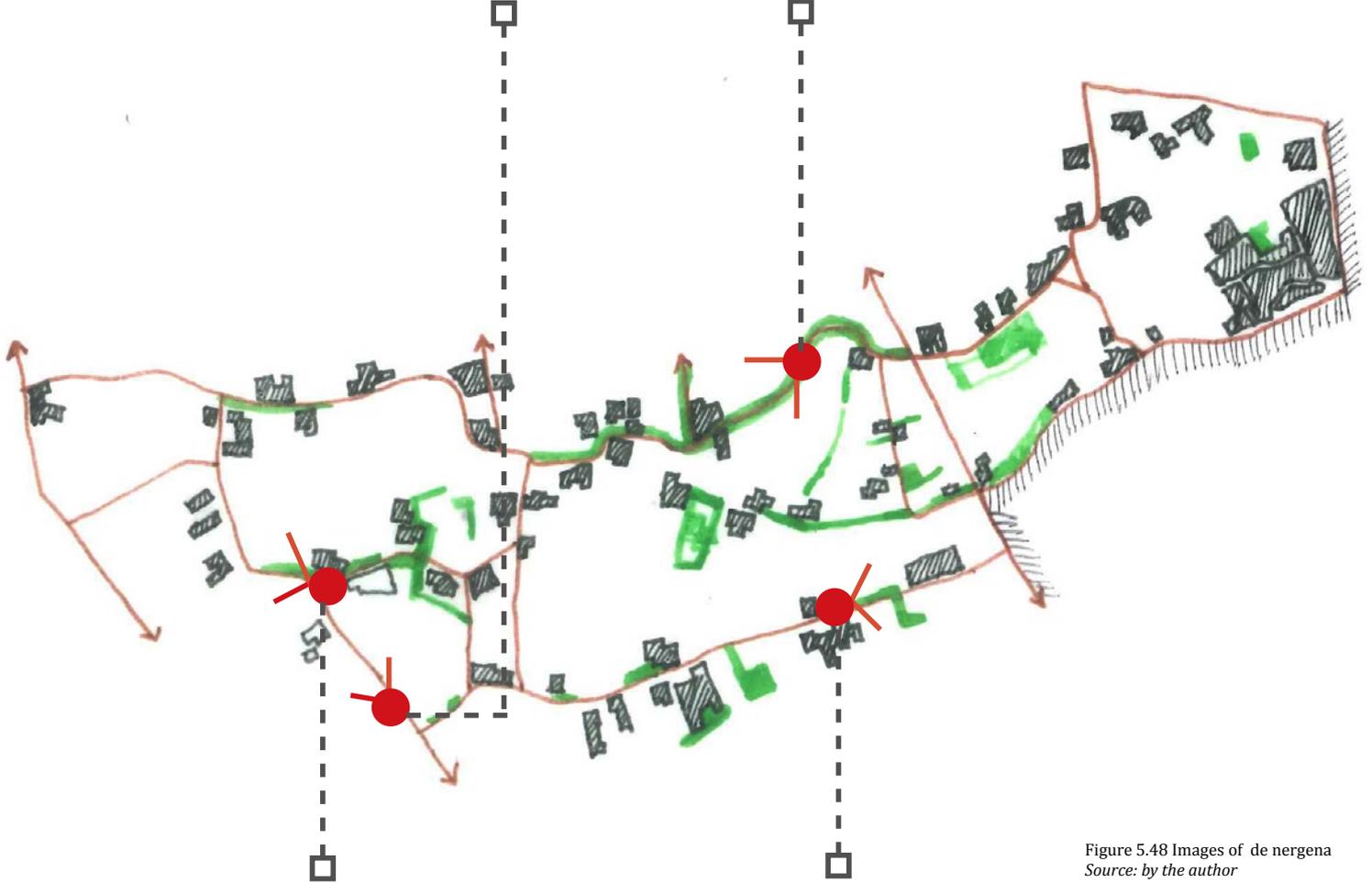


Figure 5.48 Images of de nergena
Source: by the author



(3). Peat mining landscape

The peat mining landscape in the region mainly distribute in three parts: south of Veenendaal, South of the nucleus Achterberg and along “the Grift”.

a. Very wet soils, high groundwater

The Grift was built to tackle the flooding, the drains and to extract peat. It drains toward the northwest. Due to intensive peat mining, land surface in the region subsidence. The ground-water levels to be lowered. Nowadays, these areas have very wet soils and high groundwater level. The main soil components are various peat and polder soils.

b. Half-open landscape to openness landscape

In the south of Veenendaal, the possibilities from the main road to see the landscape behind are little. For the south of Achterberg, it is generally a fairly large opening. It owns large open countryside. The area along the Grift is characterized by its openness.

c. Battle Allotment

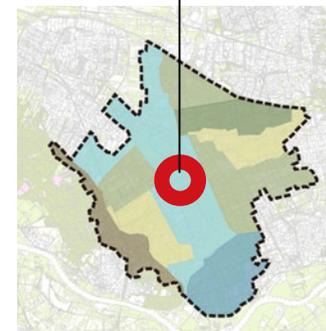
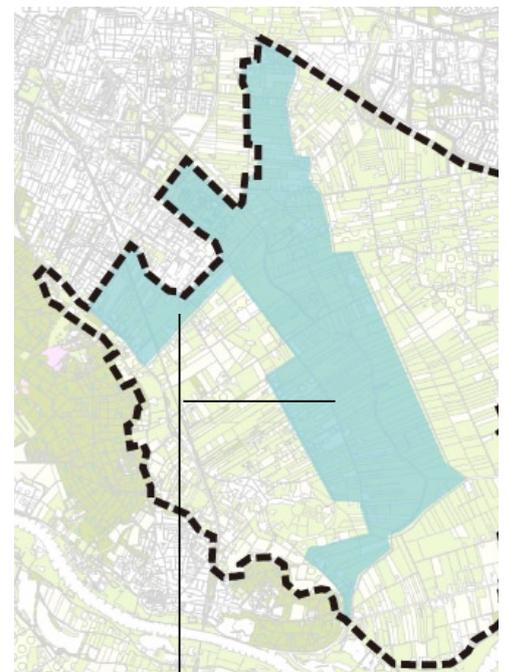
The peat mining landscape owns a strong east-west oriented strips allotments. Buildings in the south of Veenendaal are located directly along the roads. But in the south of Achterberg, they are often linked to Cuneraweg, making the property an angle relative to the strip plots. The distance from the yard to the road has some variation.

Along the Grift, buildings are located on main roads running north-south. They are perpendicular to the watercourse “The Grift”. Most buildings are located on the west side of Grift. To the east side of the Grift, there are nearly no buildings located in actual. Hence, there is a vast openness.

d. Plantation

The peat mining in the south of Veenendaal has a smaller character through some trees along the narrow lots and these tree lines cuts through the area. The peat mining areas in the south of the nucleus Achterberg, which located the Grift, are characterized by great openness. In the area there are a few solitary trees, especially along the course of Grift (poplars).

Along the Grift is an open landscape. In few places, thicket edge realized for wind protection. Some groups of poplars are there to mark a place, such as a bend. These plants are strategically planted so that the characteristic openness kept intact. A large number of reeds is cultivated. The vegetation patterns in the areas are rows of trees, pollarded trees, thicket edges, lumps of trees and reeds.



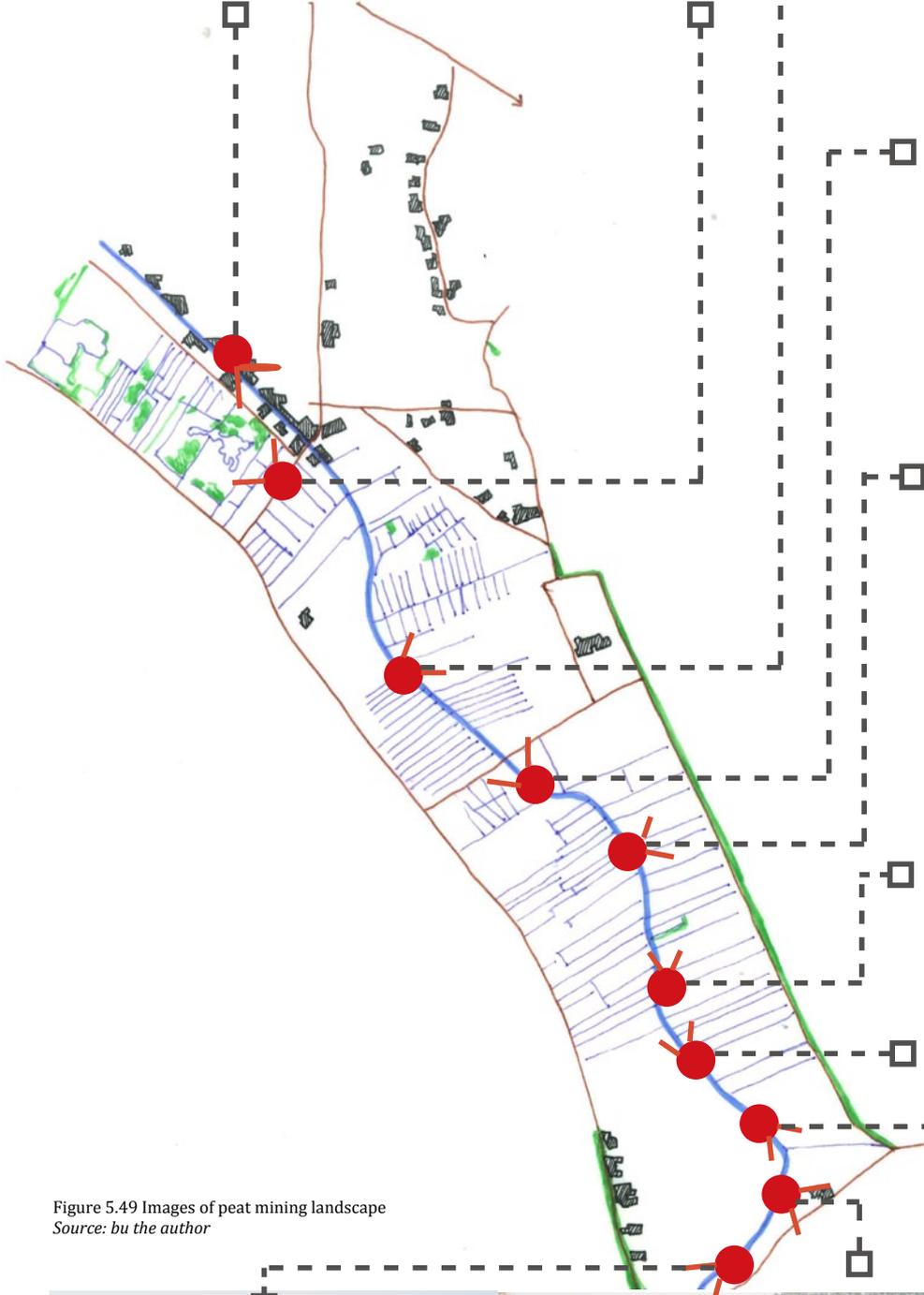


Figure 5.49 Images of peat mining landscape
 Source: bu the author

(4) Broekontginningen landscape

DE MEENT

a. Low wet ground

b. Openness

Formerly, this area was largely from an open heath, De Meent. The openness is clearly reflected in its landscape. The openness of these allotments block is intersected by tree-lined avenues. However, by the dispersion of the buildings, the openness of the area is affected.

c. Block Parcel

The area is mined in a block allotment structure. The tree-lined avenues are the most yards. A few yards further lay on the back of plot so the buildings get a relatively dominant position in the landscape. The development direction of the buildings is diverse.

d. Plantation

The area is situated in woodland at the head of an estate. The woodland edge is strong and gives a pleasant change to the existing openness of the area. Alternation of the openness of block allotments and seclusion of the buildings strengthens the amenities of the area.

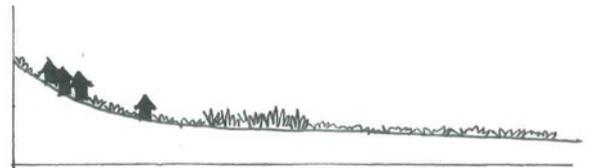
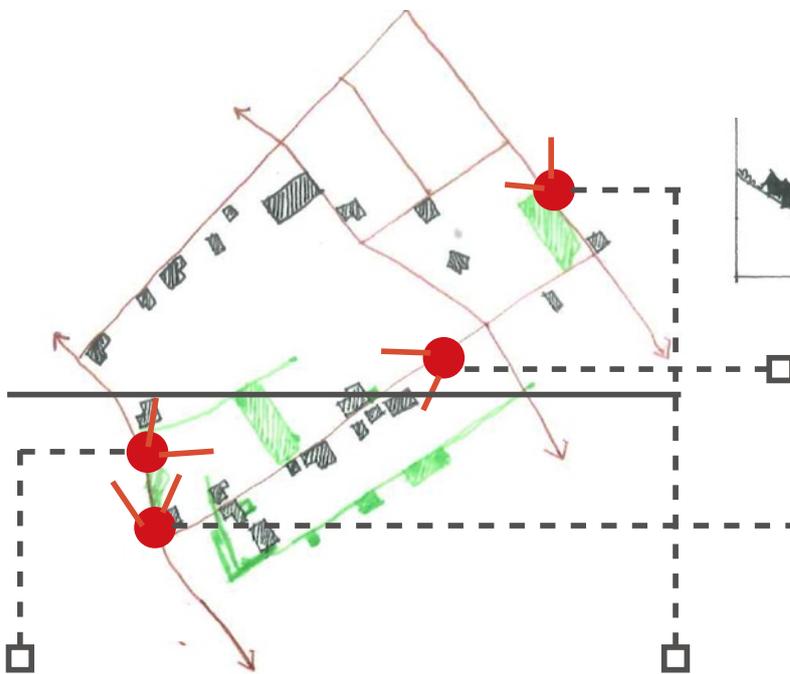
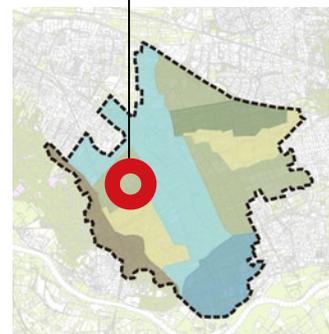
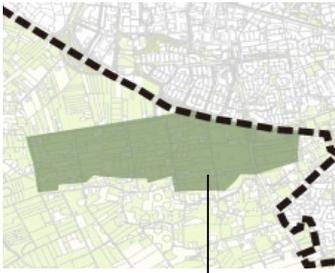


Figure 5.50 Images of De meent
Source: by the author

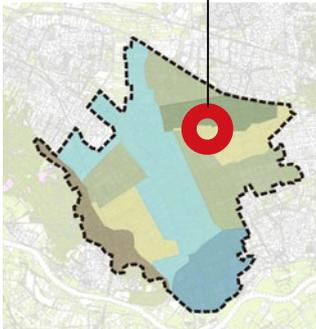


DE KRAATS



a. High, dry soils; wet soils low
The area "The Kraats" is on the transition from dry to wet soils.

b. Small-scale openness
Unlike most parts mining area, this part is not characterized by its openness, but its small size openness.



c. Strip Allotment
Buildings in this part are not only developed along the north-south current mining roads and motorways, but they are also appeared deeper in the plots.

d. Plantation
"The Kraats" a strong east-west structure of cultivated plots and accompanying plantings. This is good landscape framework capable of scaling to accommodate developments. There are many linear vegetation elements such as hedgerows singles, which can be found in the yard and field boundaries.



Figure 5.51 Images of De Kraats
Source: by the suthor

Maanderbroek and Born

a. Low wet ground

b. Openness

Traditionally, Broekontginningen landscape has mostly open landscapes, with a strong rational allotment.

c. Strip and block shaped allotments

The orientation of buildings are diverse. In Maanderbroek is easy to see how different plot directions meet. The plots are generally perpendicular to the main roads. However, in the Born, plots have different orientation. Their locations are not limited to roads orientations. These can be located deeper in the plots.

d. Plantation

Landscape in this area is characterized by its open landscape, where largely tree-lined avenues are located. In the square fields of the Born were traditionally much woodland to be found, but these are gone.

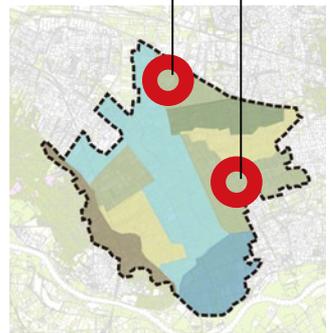
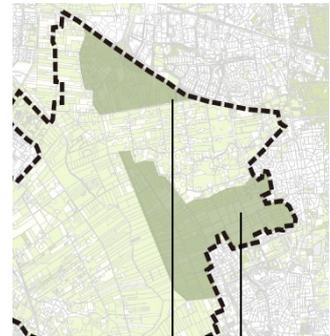
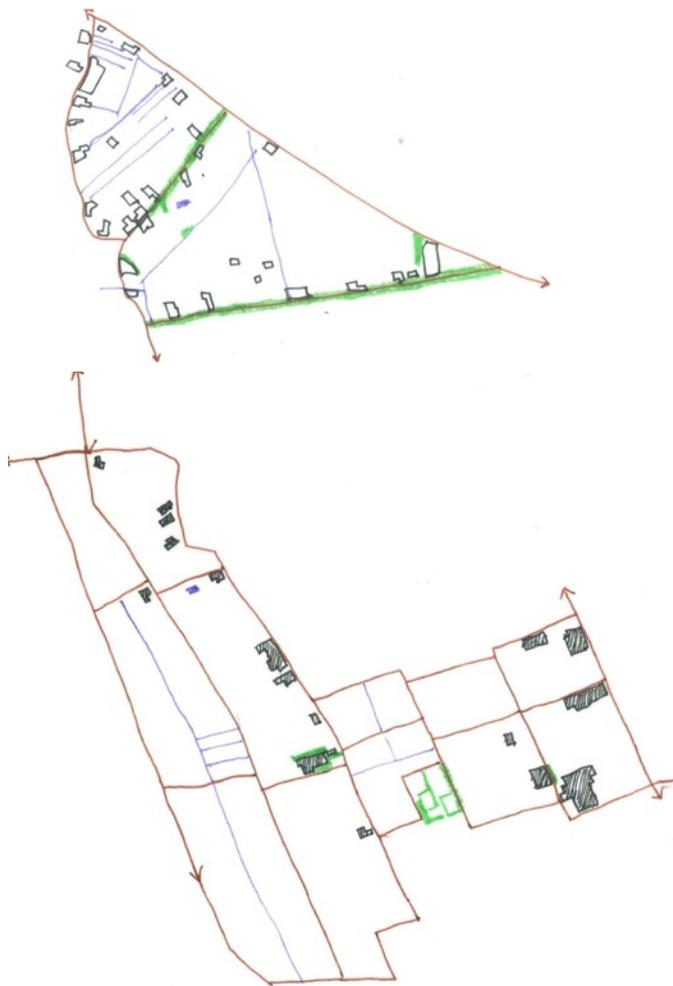


Figure 5.52 Images of Maanderbroek and Born
Source: by the author

(5) Levees landscape

a. Clay, high groundwater

It consists of very heavy clay. These lands are very difficult to work and are only suitable for pasture, because of the limited capacity of the soil, and especially by the high water table. Drainage is not possible. But very fertile soil of the levees landscape is perfect for orchards (including cherry trees).

b. Compartmented open landscape

The levees landscape is an open landscape primarily because high rising plantings have been limited to the tree-lined avenues. The orchards and shrub borders, the public sector into compartments.

c. Strip Allotment

The building is usually located on main roads, at the head of the plot. The business is separated from the living area and located in deeper place. The residential area is mostly planted with high upward plantings. The buildings therefore located along the tree-lined avenues and generally have a relatively private character.

d. Plantation

Hawthorns were often used as plot divisions. It functioned primarily as a wind barrier to protect the orchards. The buildings are mostly surrounded by lower plantings, such as thicket edges (hawthorns) and orchards.

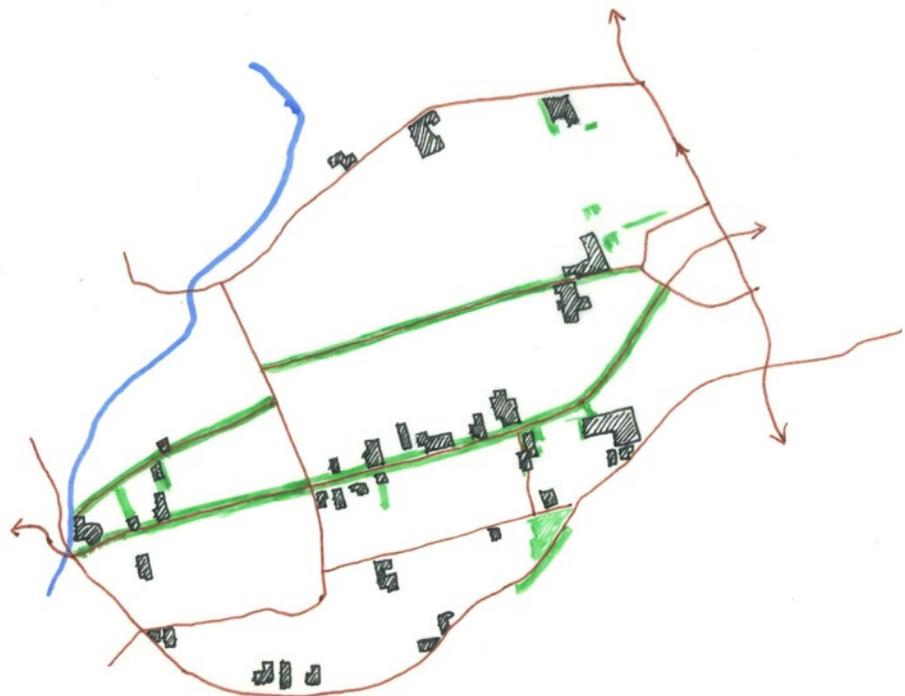
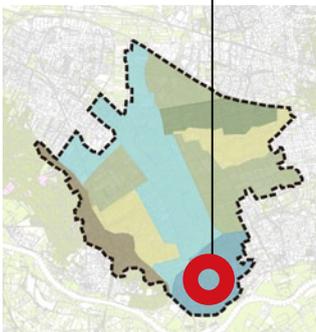


Figure 5.53 Images of levees landscape
Source: by the author

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Chapter6

Problem analysis

6.1 Urbanization

6.2 Mono and intensive agricultural land use

6.1 Urbanization

There are about 2.6 billion people living in the urban areas in 1995 all around the world and it is expected to be doubled in the year of 2025. For the first time in history, there is larger urban population than the rural ones (United Nations Centre for Human Settlement 1996). Generally speaking, urbanization can be defined as a complex process that is characterized by the transformation of landscapes formed by rural life styles into urban ones (Marc Antrop 2000). Human life-style will change the way human uses their environment and results in the different spatial patterns. Nowadays, urbanization gradually spreads over vast areas, puts impacts on their traditional landscape patterns, and creates highly dynamic landscapes. The new landscapes overlay on the traditional ones and make traditional landscape fragmented and lose their identity.

6.1.1 Introduction

The binnenveld is the region surrounding by Veenendaal, Rhenen, Wageningen, Bennekom, and Ede. Looking back upon the historical development in the region, urbanization plays a significant role. Urbanization change human's life styles and gradually changing the landscape patterns in the region. Urbanization processes in the region are developing very fast. Take Veenendaal as an example, it is a town in the central of the netherlands and belong to the province of Utrecht. The original village of Veenendaal was developed in the 16th century and it was formed as a peat colony. After World War II, it was a small community with only a few thousands citizens. However, the population has grown rapidly in the last fifty years and reached to above 60,000 residents today. The municipality has an area of 19.81 square kilometers and nowadays most of which is covered by built-up area.

6.1.2 Driving forces

Urbanization is a complex process with diversity driving forces. It is mainly controlled by social and economic factors that exceed the local conditions. In my studying area, the driving forces for urbanization are mainly consisting of industrialization and economic growth, transportation networks and globalization.

(1) Industrialization and economic growth

Start at the 18th vcentury, cities began to grow and spread. There are fast population growth due to the development of industry and commercial. Fast developments of technology speed up the development and led to a better geographical situation for human activities. The urban came to the stage of fast growth, which caused congestion in the old urban scale. Hence, Residents began to build settlement in the surroundings and the urban extension formed.

In the region, on one hand, there was an innovation on the technology for peat mined since the Golden Age. With the development of economy, the peat dug was increased. Between 1500 and 1600, there were intensive peats mined and wind- driven watermills being used. Villages and towns along the peat mined areas and waterways, which were used for transport of peat, were expanded quickly. Village of Veenendaal was founded as a peat colony and suffered from the population growth. On the other hand, in the fifteenth century, specialized dairying brought technical changes and fertilizer, cow-dung were used in the large scale. Human started the stage of industrial crops. Due to the growth of population, land values increased. Agriculture started to prosper. The commercial arable and cattle farming developed fast and trade grew noticeably.

(2) Transportation networks

Urbanization is a complex process and caused by diversity driving forces. Development of transportation network is one of the main driving forces as well. The development of transportation infrastructure relate to the accessibility of places. It will change the physical structures and relations between urban and rural areas. Accessibility became one of the most important factor in landscape change and even in the rural areas. When one region disclosed by accessible roads system, urbanization processes can be noticeable. (Marc Antrop 2004).

Since 1950s, human began to develop inland waterways in the netherlands. Canals have been dug or enlarged and the major rivers straightened and canalized (Audrey M. Lambert 1985). Between 1958 and 1970, the Rhine was canalized for the greater volume of traffic. The waterways led to the fast growth of places along the access routes. In the nineteenth century, railways developed as vital transportation networks in the country. They were important arteries for the region development. "The railway induced a selective disclosure of the countryside (Marc Antrop 2004)." Villages and towns, such as Veenendaal, Ede and Rhenen, that have stations developed rapidly into urban-like centers and their surroundings changed accordingly. Later, especially after the Second World War, the highway network and motorway network were built and developed, which not only links more closely all parts of the country, but ties the Netherlands into the motorway system of western Europe. The increasing car use and accessibility of places led to rapid urban sprawl, the formation of suburbs and metropolitan villages (Marc Antrop 2000).

(3) Globalization

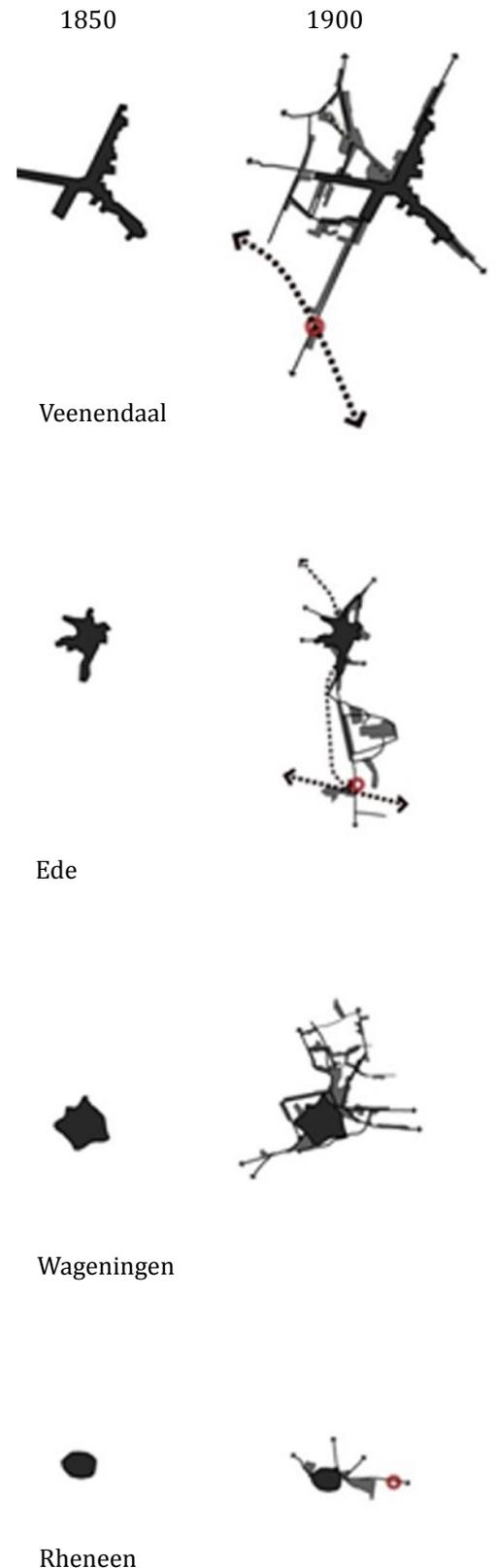
Globalization has been described as the increasing interconnectedness of people and nations. The influences of globalization on the progress of urbanization largely on the cultural and economic aspects. The growing globalization increases the acceptance of human of changing minds and life styles. So that most of changes caused by activities and decision-making of globalization are difficult to handle by the people living there (Marc Antrop 2004). It is difficult to cope with these processes. The economic globalization also speed up the concentration of population in the urban regions all around the world.

The influences on the process are its consolidating economic effects. In history, urbanization was enthused by economic development. The economic development formed a transformation of economic patterns, from an agricultural-based economy to an industrial-service-based economy. The industrial-service-based economy will be more concentrated in the cities. Globalization plays a vital role here depending on their functions on the global economic development.

6.1.3 Process of urbanization

As a complex process, urbanization will operate in a different way in various sites and at different scales. "The process of urbanization is largely influenced by communication networks and accessibility and described effects mostly upon the dynamics of the population (Marc Antrop 2000, P262)." Research on the process of urbanization helps us to understand social and economic changes in the region. It can also reflect historical development in a place.

Binnenveld is a region surrounded by four cities. Urbanization of four cities creates huge pressures on the rural area. The processes of urbanization in the these four cities are similar. From figure on the right side, we can see that urbanization isn't so fast in the first one hundred year (from 1850 to 1950) and reaches to peak since 1950. In 1850, these cities have only their core areas. Veenendaal was still a small town as peat colony. Wageningen and Rhenen were walled towns. There are some houses in the rural areas for peat workers. Most of them were built along canal, which was used to transport peat. Afterwards, city walls were pulled down. Human developed peripheral roads on the location of walls. Cities began to expand outwards. In the industrialization period, factories and new houses were



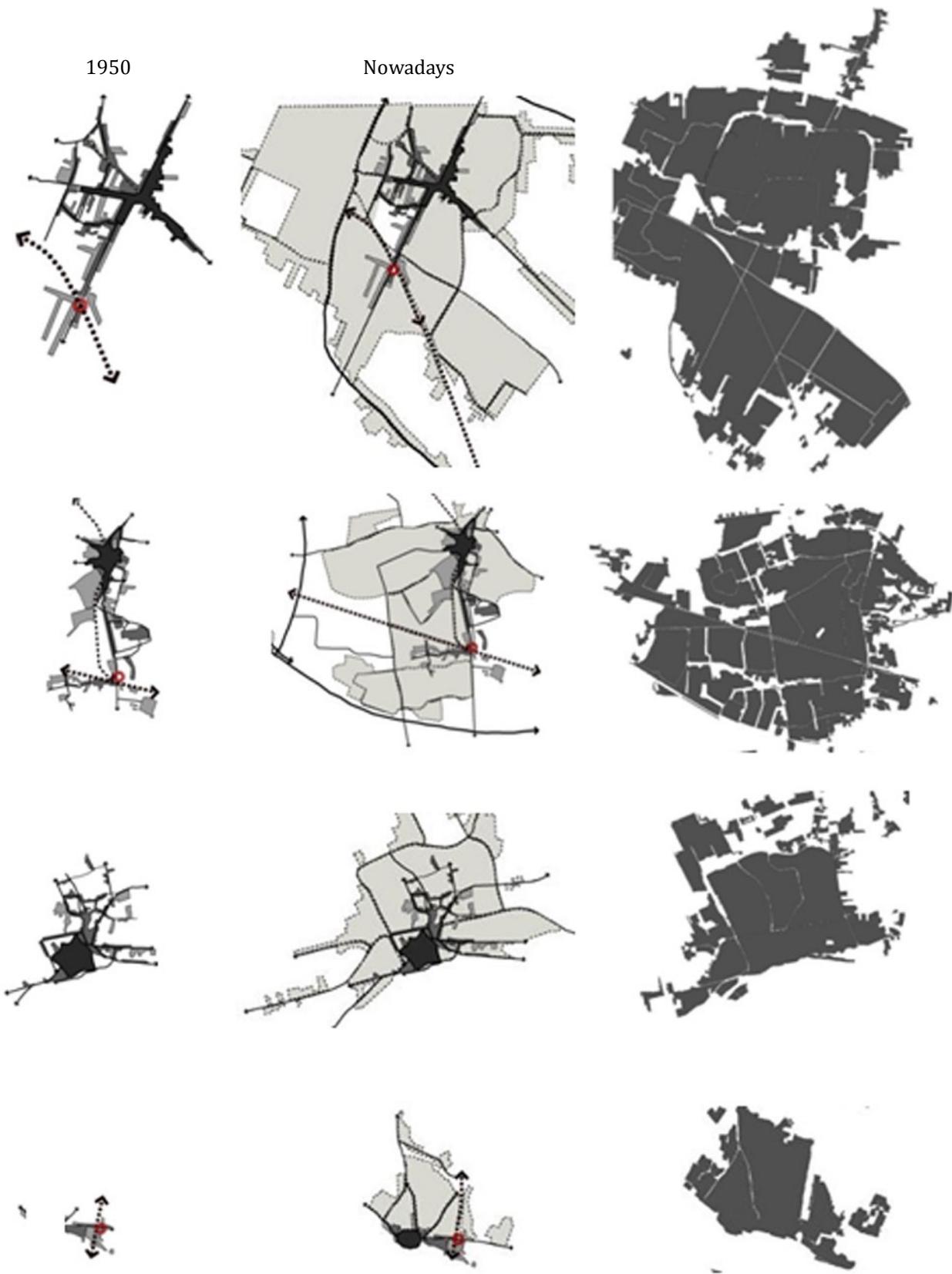


Figure 6.1 Process of urbanization
Source: illustrated by author

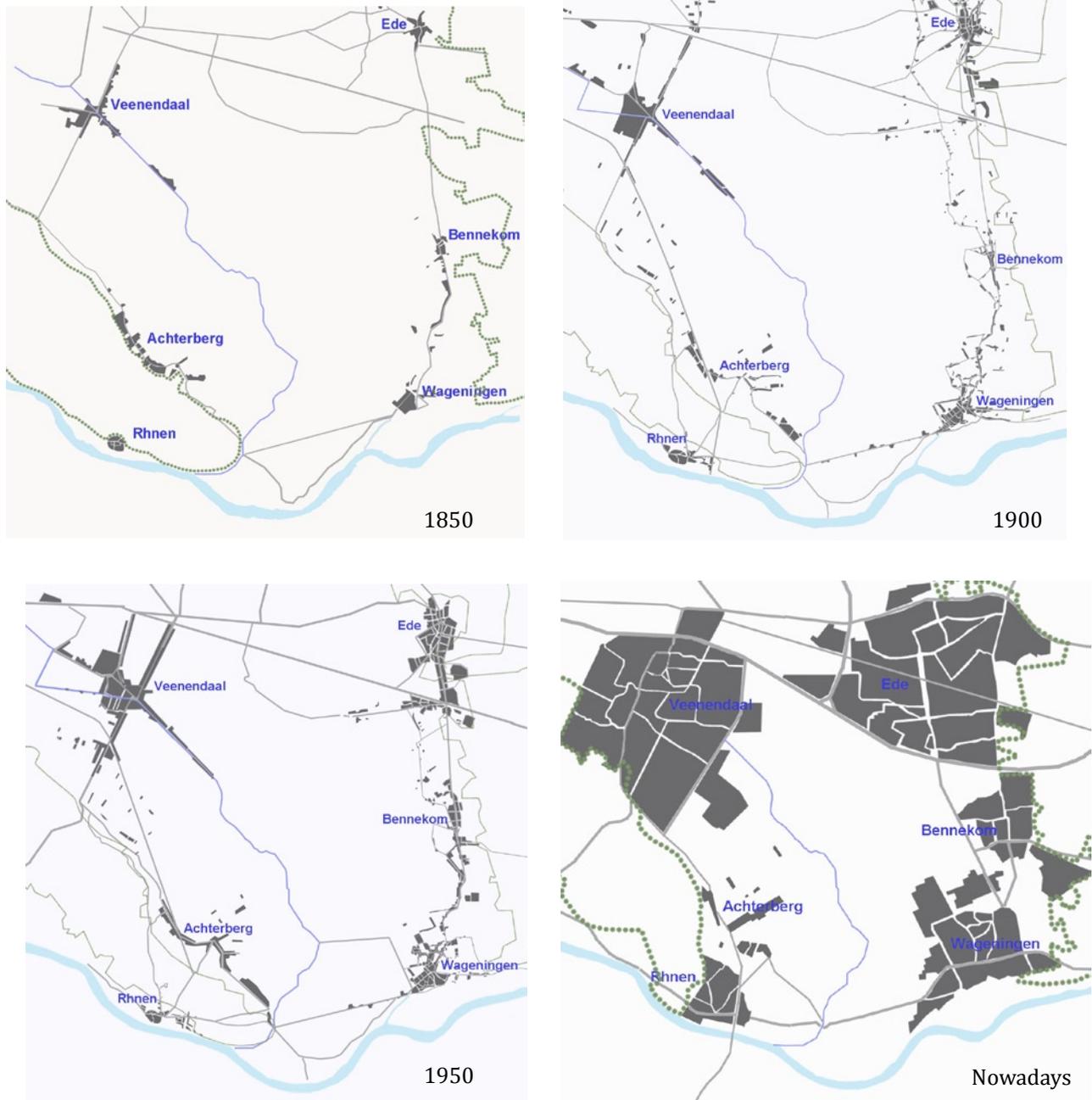


Figure 6.2 Urbanization pattern
Source: by the author

built along the spreading roads. Small villages close to cities were included into the urban scale. During this period, government paid much attention to develop railways in the country. Train stations were built in Ede, Veenendaal and Rhnen. The railways connected the region inside and outside. In the region, Veenendaal and Ede, Veenendaal and Rhnen were connected by the railways. In a larger scale, the region was connected with Utrecht, Amsterdam, and other big cities in the Netherlands. Development of railways led to extension of urban districts. From analysis of urban fabric in 1950, it is clearly that urban extension prone to rail stations in Ede and Veenendaal. After 1950, use of cars had been

popular in the Netherland. The motorways and highways were developed fast. The suburbs got better connection with core areas in the cities. Recreation, commerce and agriculture were flourishing in the urban fringe zones and create a mixture of different land use. Large numbers of residential settlements led to fragmentation of agricultural landscape. The highly dynamic landscape was created. The rural areas were under the urban networks. Though they still have the rural landscape, but the way of life has been urbanized. They are under the shadow of urban.

6.1.4 Rural-Urban gradient

There are four dominant zones can be distinguished in the region from urban to countryside. They are core areas, urban inner fringe, outer fringe and rural areas under the urban network. The landscape character and functions are different in these four domains.

	Landscape character	Functions
Core areas	Highly dynamics; intensive mobility and accessibility; local identity; full of built-up areas,	Administrative, commercial, financial and cultural functions
Inner fringe	Densely build areas; little parks; lack of historical, cultural and aesthetic values; no identity of the place	Residential function is foremost
Outer fringe	Mass landscape with mix of urban and rural character	Interface with rural areas; new industrial and commercial activities
Rural areas under the urban networks	Fragmented and homogenization agricultural landscape; intensive livestock and arable lands; valley landscape	Food production; residential and recreational functions embedded in farms and agricultural land.

Table 6.1 Landscape characters of different zones



Figure 6.3 New commerce in rural areas
Source: photo by author



Figure 6.4 Neighborhood development in rural areas
Source: photo by author



Figure 6.5 Urban-like town centre
Source: photo by author



Legend
 ■ Core areas ■ Inner fringe ■ Outer fringe \ Rural areas of the urban network
 ← Main roads — Local roads ····· Boundary

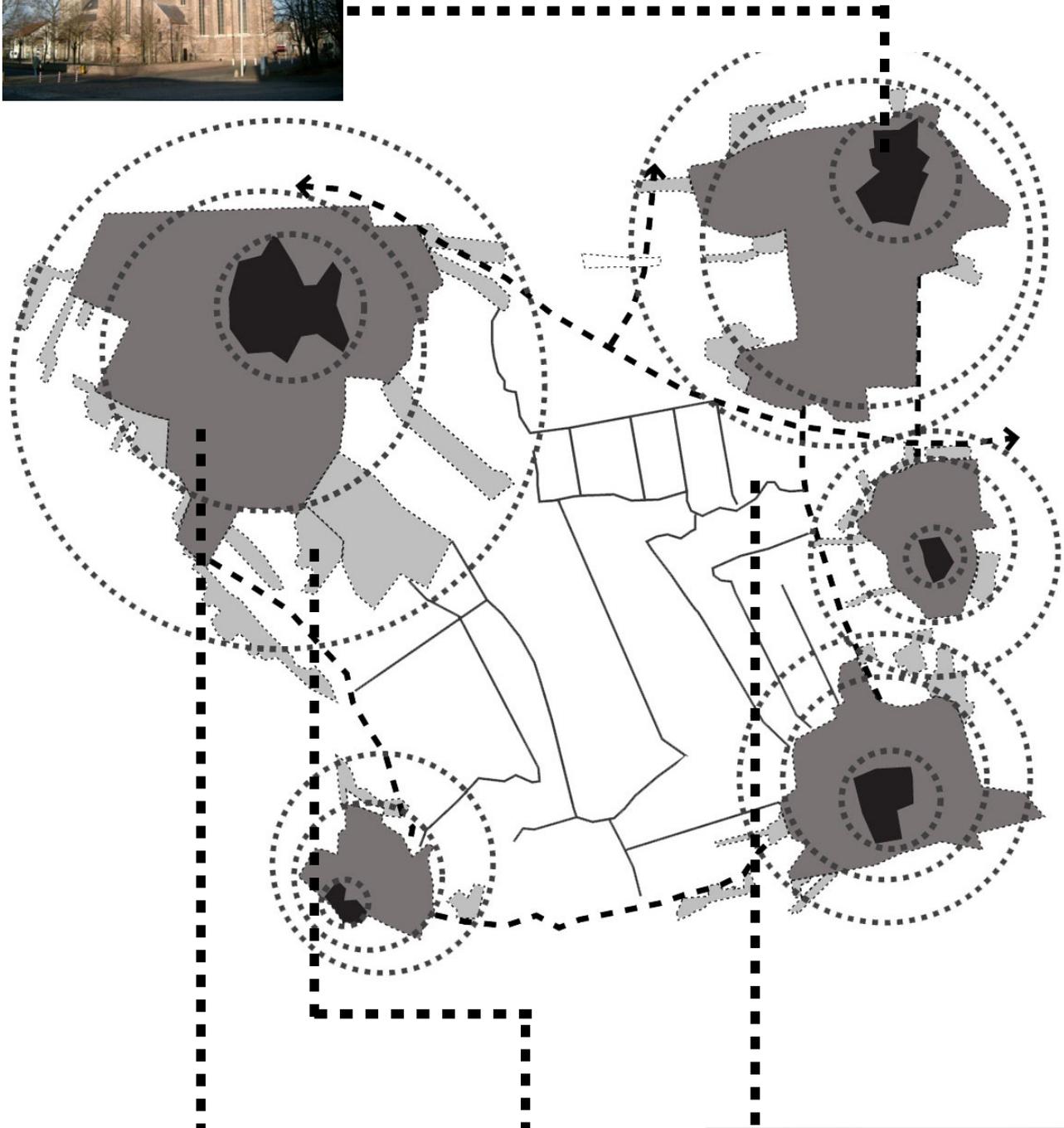


Figure 6.6 Rural-urban gradient
 Source: made by author

6.1.5 Results of urbanization

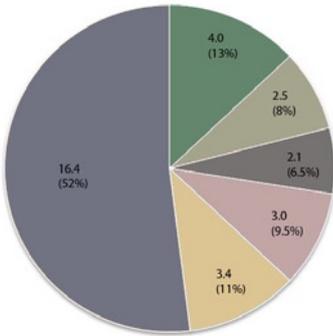
(1) Landscape fragmentation

The fast development of transportation provide more accessibility for people. However, it also has some negative effects. They will produce negatively ecological effects on the local flora and fauna. The large extension of infrastructure cause effects on nature in three steps: (1) physical qualities and mechanisms: impacts on the abiotic environment by the presence of infrastructure facilities; (2) relevant ecological aspects: loss of acreage and the decreasing quality of habitat indicated by the effects on the biotic environment; and (3) ecological processes, such as change of species-configuration, decrease of population size, and local extinction (Jaarsma and Willems 2002). Hence, we can find that the negative impacts of networks are destroying the habitat and forming barriers and disturbance. It will cause landscape fragmentation and populations fragmentation.



Figure 6.7 Landscape fragmentation
Source: GIS database

The negative effects of fragmentation caused by roads can be explained by the island theory. According to the island theory, the ecological health of a landscape is the overall connectivity of the natural systems present (Dramstad, Olson et al. 1996). The connectivity means ecological elements of landscape are interconnected for species to move among them. Fragmentation is a landscape pattern which is often associated with the loss and isolation of habitat. Once the landscape has been fragmented, the chances of extinction for small subpopulations, separated by roads from populations, will increase.



Percentage of fragmented lands by roads

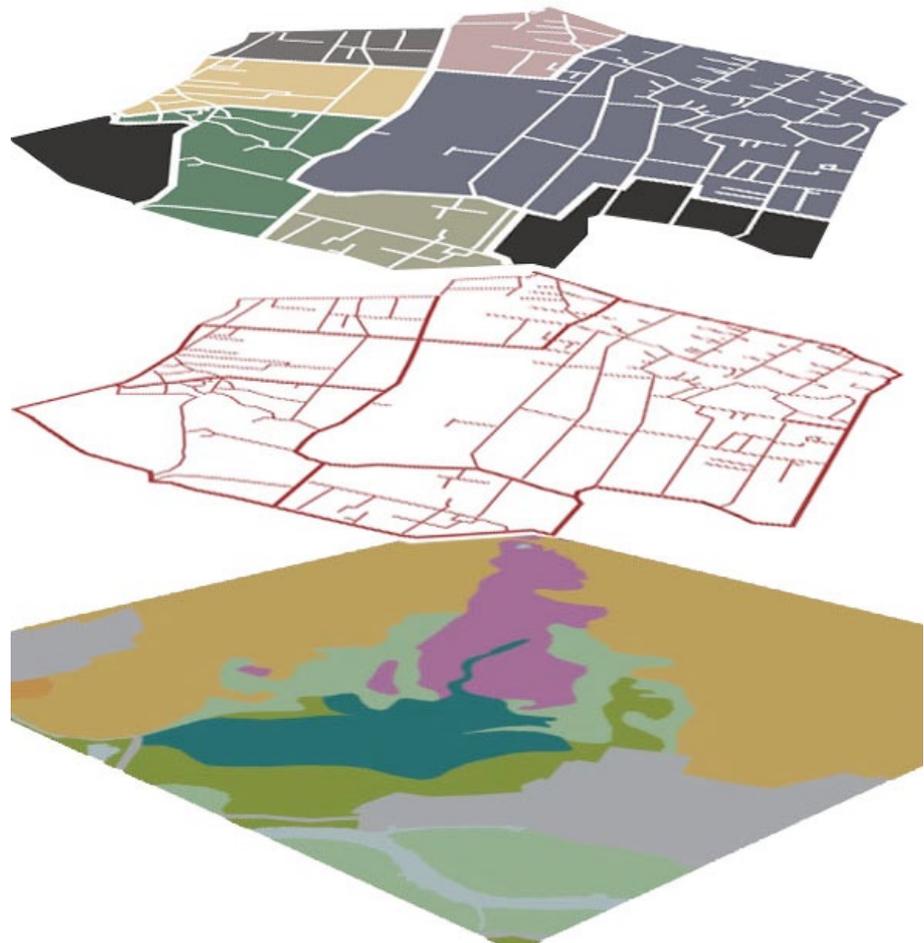


Figure 6.8 Fragmentation by roads
Source: according to GIS

(2) Lose of identity and landscape qualities

The Binnenveld is characterized by the combination of wet and open grassland, bordered by themoraines of the hills and the Veluwe and restrained by four urban centers, the A12 and Lower Rhine. It has high landscape values. It has cultural-historical importance of the Grebbelinie. The mountains are scary places with a valuable landscape. Grebbeberg is important for its important geological and cultural values. The rest of the forests on the moraine are often part of an estate, important landscape and cultural history. The combination of history, buildings, and plants makes it a cultural history and valuable landscape completely.

Urbanization reduces the distance between urban and rural areas and led to cultural and historical landscape heritage in the rural areas vanishing. The urban fringe or suburban landscape has a variety land uses and create a highly fragmented and homogenization landscape, with densely infrastructure. Several industries and commerce moved out from the city centre to urban fringe zones. New residential allotments were developed in the outer fringe areas. Villages were developed rapidly into urban-like centres and surroundings changed accordingly (Marc Antrop 2004). These processes are mainly controlled by social and economic factors that exceed the local conditions and these changes are characterized by a generalized homogenization of the existing traditional landscape diversity and the creation of largely chaotic patterns (Marc Antrop 2004). The essential different between urban and rural areas are not only on population and morphology, but also various activities and culture. However, these differences are reducing.

In Europe, suburbs developed in a short time period and are typical for special middle class culture (Marc Antrop 2004). These houses allotments are very special. They related to old traditional settlements and built on the ecological process of land formation. They have amenity open space, close to nature and rural land, and good accessibility to urban areas. These are the important characters and strong attractive points in these zones. However, urbanization led to filling of urban fringe in these zones. Large number of houses and gardens were built and reduced the quality of rural scenery. The aesthetic quality and walkable environment degrades the living quality of these zones. The character of living in the silence, rural and naturalness land were lost.

(3) Change the way of life in rural areas

Urbanization is also a cultural and sociological change caused by the transformation of rural life styles into urban like ones (Marc Antrop 2004). Change in the life styles will form different opinions and activities of human on their environment. Hence, it will change the spatial pattern of the place as a consequence. A main change in the rural areas is diversification of human activities and economic incomes for local people. Recreational activities and residential areas are embedded in the farms and agriculture. In 2005, the Dutch Agricultural Research Institute (LEI) did a research about the farm

diversification in the region. They sent a survey to all 1821 farmers in the region and about 258 (14.2%) were returned (Pfeifer, C. 2011). In the survey, they inquired about what activities have been adopted by farmers and their attitudes towards diversification. As a result, there are 34% of the farmers had taken up at least one activity apart from agricultural production (Pfeifer, C. 2011). Most of activities are related to agri-environmental schemes and account for 32 percent in total. Then, recreational activities were popular as well. They include farm shop, renting out space and horse-riding.

Table 6.2 Percentage of diverse activities by farmers

Source: Pfeifer, C. 2011

	sample
A. diversification	83 (34%)
B. agri-environmental schemes	76 (32%)
C. recreation including horse-riding	28 (12%)
Of which daily recreation	22 (9%)
D. other services (e.g. on farm shop, direct selling, renting out space)	62 (25%)
B+C agri-environmental schemes and recreation	10 (4%)
B+D agri-environmental schemes and other services	26 (11%)
B+C+D agri-environmental schemes, recreation and other services	21 (9%)

6.2 Mono and intensive agricultural land use

6.2.1 Agricultural land use in the region

Industrialization and specialization of agriculture is a main economic activity in the region. With the development tendency of agriculture in Netherlands, it suffered a curve of changing. In the nineties, the total economic volume of production of all farms in the area is even more grown up by 33%. However, only between 2000 and 2002, the total production shrank 4% (CBS). This is due to deteriorating market purchase conditions and the intensive livestock reduced the manure surplus. Nowadays, of the total economic output size in the area, the grazing livestock (especially dairy) is the largest one and shares about 59% (CBS). The specialized dairy farms in the area have a high density per hectare, particularly in the sandy areas, with 2.6 to 3.3 livestock units per hectare. Meanwhile grazing livestock uses approximately 70% of the total agricultural area. Organic farming occurs in 1.2% of companies with 2.3% of the total agricultural area.

In the region, most of the companies specialized on intensive dairy farm, the rest are mixed and other businesses. The numbers of very large (Greater than 100 gs) and very small companies (less than 20 gs) are both increasing. While the latter group mainly focus on a small area land use with maize and grass pasture and sheep. The total agricultural production is expected to drop much less than the number of businesses, by scaling towards fewer, larger companies. In larger scale, Gelderse Valley, we can find other data show the number of dairy cows is expected to decrease by 20%, the number of pigs by 25% and

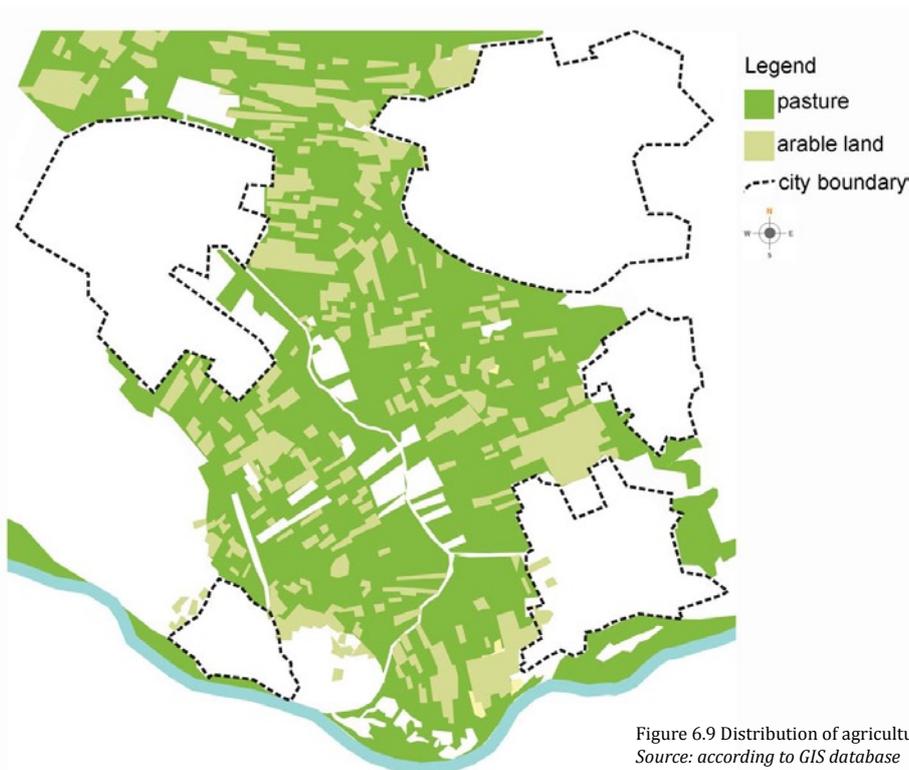
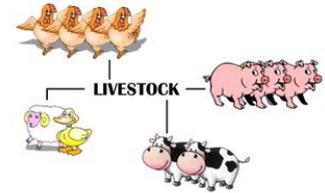


Figure 6.9 Distribution of agriculture
Source: according to GIS database

the amount of poultry by 20%. The future level of intensive farming, however, mainly determined by international market conditions, because of the Dutch animal production should be exported half to two thirds. A rough estimate indicates that the area used for agriculture balance decreases by about 14%. The development of agriculture in the region is restricted by several environmental issues, such as manure production and odor regulations. The intensive livestock cause largely environmental problems: water eutrophication, emissions and soils pollutions. The physical environment in the region is under the norms in Europe. The manure surplus is an important issue. Through a stricter standard and declining in the manure surplus of livestock, it is expected that there are still approximately 44% of the region suffer from this problem in 2015. Nowadays, manure in the region must be transported to other areas, and constitute a cost of manure disposal and an unfavourable factor in competitiveness.

6.2.2 Results of mono and intensive agricultural land use

(1) Water eutrophication

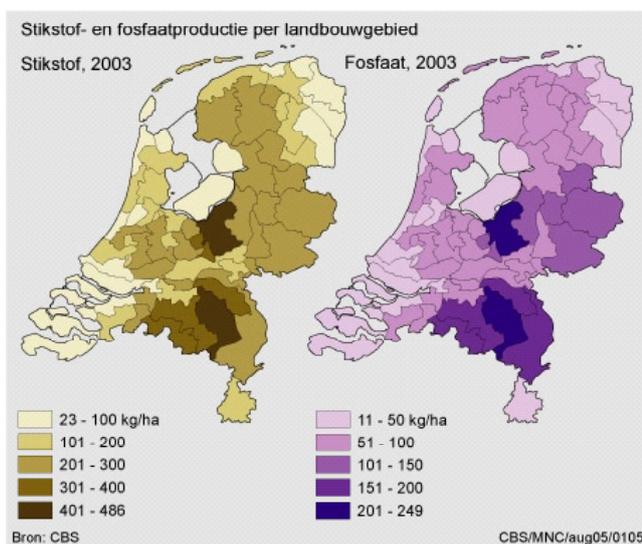
In general, we describe pollution caused by agricultural activities as non-point source pollution. Non-point source pollution causes by the pollutants in air, ground and soil. They are leaching and erode by rainfall runoff, flow to rivers, lakes and other water bodies and lead to water pollution. The non-point source pollution caused by agriculture mainly refers to agricultural soil particles, nitrogen, phosphorus, pesticides and other organic and inorganic pollutants. It will finally lead to ecosystem change.

Eutrophication has been among the main water quality issues for decades. It is caused by excess loads of nutrients (mainly N and P) and organic matter in surface waters (Steinfeld 2010, P153). The increased use of fertilizer and the growing input of minerals in the form of concentrates will finally end up on the land. Eutrophication of the soil and of ground and surface water is stimulated by this process, and so not only agricultural areas but also natural sites are influenced (Wolman, Fournier et al. 1987). Eutrophication leads to

excessive growth of phytoplankton and subsequently to decrease of water clarity and biodiversity, oxygen depletion, fish kills, and odor problems, while harmful toxic algal blooms may develop more frequently (Steinfeld 2010, P153). In global, agriculture contributes about 50% nitrate and phosphorus in the total loading of surface water. Due to intensive agricultural activities in Netherland, the percentage is even higher.

Binnenveld, as a region occupied by arable land and livestock, problem of water eutrophication is quite serious. CBS did analysis about the level of nitrate and phosphorus production in the Netherland in 2003. It illustrates how many nitrate and phosphorus were

Figure 6.10 Nitrogen and phosphorus pollution in the netherlands
Source: CBS



produced in per ha agricultural land. We can find (figure 6.10) that the central and southern part of Netherland occupied the highest percentage. There, eutrophication is a main threat and problem to natural environment in the studying area.

The amount of nitrogen and phosphorus can be used as indicators of the environmental pressure. According to environmental analysis by Alterra for Gelderland and Utrecht Oost, the oversize for the stream basin in Binnenveld is 11627ha and in average, the amount of NO₃ concentration is 78 mg/l, phosphorus loads is 14719 kg/jr, and nitrogen loads is 202975 kg/jr in the stream basin.(Schoumans 2003)

The water board Vallei & Eem has been measured the water quality in the Binnenveld for a long time as well. The measurement was taken in three points along the main stream in the region – de Grift. They collect data from the upstream, centre part and also the downstream from 1995 to 2005. The data set includes various parameters, such as PH, SO₄, t-P, NO₃, O₂ and also the standards for freshwater quality as MTR-norm. Here, I will emphasize on the PH, t-P and t-N. The table below illustrates the various results of measurement from three points. The parameter PH doesn't have largely variation in the different locations and they all meet the standard. For the parameter t-P, the standard in MTR norm is <0.15 mg P/l. But both in the centre and downstream, the amount of t-P is more than 0.15 mg P/l. About the t-N, amounts in three locations went beyond the limit. In the upstream, the amount was highest and reached to 5.36mg N/l (Wijnker 2006).

Table 6.3 Water quality measurement for PH, t-P and t-N

Source: Wijnker 2006

parameter	upstream	centre	downstream	MTR norm
PH	7.57	7.56	7.87	Range: 6.5-9.0
t-P mg P/l	0.127	0.178	0.19	<0.15mg P/l zg
t-N mg N/l	5.36	2.4	2.3	<2.2 mg N/l zg

- Non-point nitrogen pollution

Plants and animals require nitrogen for life. However, their uptakes of applied nitrogen are not efficient. Between the applications of fertilizer to a cropland used to grow feed and the consumption of an animal product there are numerous steps where N can be lost from the production system and released to the environment (Steinfeld 2010, P88). One atom of nitrogen released to the environment will contribute to most environment problems of today and can remain active in the environment for years to decades (Steinfeld 2010, P83). The loss of agricultural nitrogen can cause eutrophication, degradation of surface water, excessive levels of nitrate in the groundwater and other serious environmental problems. Agricultural non-point nitrogen pollution poses the greatest threat to the deterioration of water quality. These impacts come from fertilizer in surface water but also nitrogen flush to the ground like NO₃ in some circumstances. An excessive amount of nitrate in surface water has usually a negative influence on the presence of rare vegetation. In the Netherland, the

target for surface water is 1.0 mg N / l and the maximum allowable risk is 2.2 mg N / l.

To confront the surface water quality standards, we need not only the nitrogen loads from agriculture (kg N/ha/yr). The concentration of nitrogen in the surface water is a significant factor as well. It depends on the water balance and the contribution of other sources such as sewage leave. It is possible to apply the standard leaching from agriculture. Hence, nitrogen level in the region will be analyzed by a matrix, which is consisting of nitrogen loads and also nitrogen

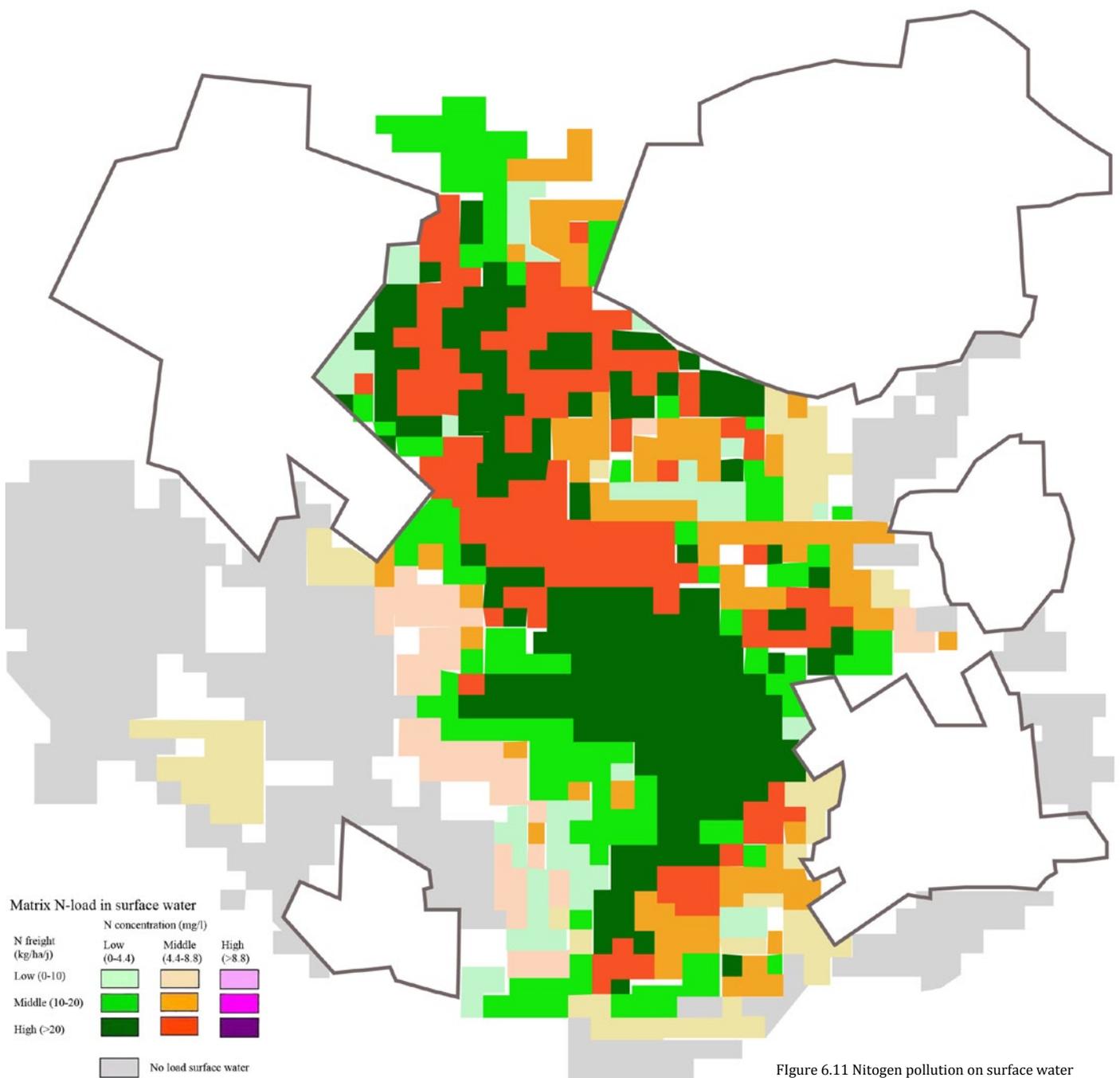


Figure 6.11 Nitrogen pollution on surface water
Source: according to Schoumans 2008

concentration leached from agricultural soils to surface waters. For analysis of nitrogen loads, a classification of 0-10, 10-20 and > 20 kg N per ha per year arrested with 10 kg N / ha / yr as the threshold is adopted.

The expected spatial distribution of the nitrogen load of surface water from agricultural soils is shown in Figure 6.11. Due to the higher water discharge in the discharge areas are nitrogen loads in these areas is relatively high. In addition, there are strong and fast leaching in seepage areas so that some soil processes such as denitrification, cannot fully proceed. Therefore, under these wet conditions, there are relatively high concentrations of nitrogen. The distribution of the nitrogen also related to the agricultural activities in rural areas. Regions can be indicated where the risk is high. The nitrogen discharge from agricultural soils ranged roughly between 0 and 40 kg N per ha per year (loss standards 2000). High nitrogen removal (20-40 kg N per ha per year) are mainly found in wet areas of high seepage (where the natural background affect on the loads of nitrogen on the surface water) and the transition from wet to dry areas.

- Non-point phosphorus pollution

Besides the nitrogen loads and concentrations, phosphorus loads from agricultural soils to surface water is calculated (Figure 6.12). As with the nitrogen load to surface water is not possible to directly confront the results with the surface water quality standards, phosphorus faces to the similar problem. Hence, we will have the standard applied to the leaching from agriculture and the standard concentration converted to cargo. Based on the MTR value of 0.15 mg / 1 P and a net precipitation of 300 mm per year can be fully rinse from the surface, a maximum allowable phosphorus load calculated to 0.45 kg P per ha per year (i.e. approximately 1 kg P₂O₅ per hectare per year).

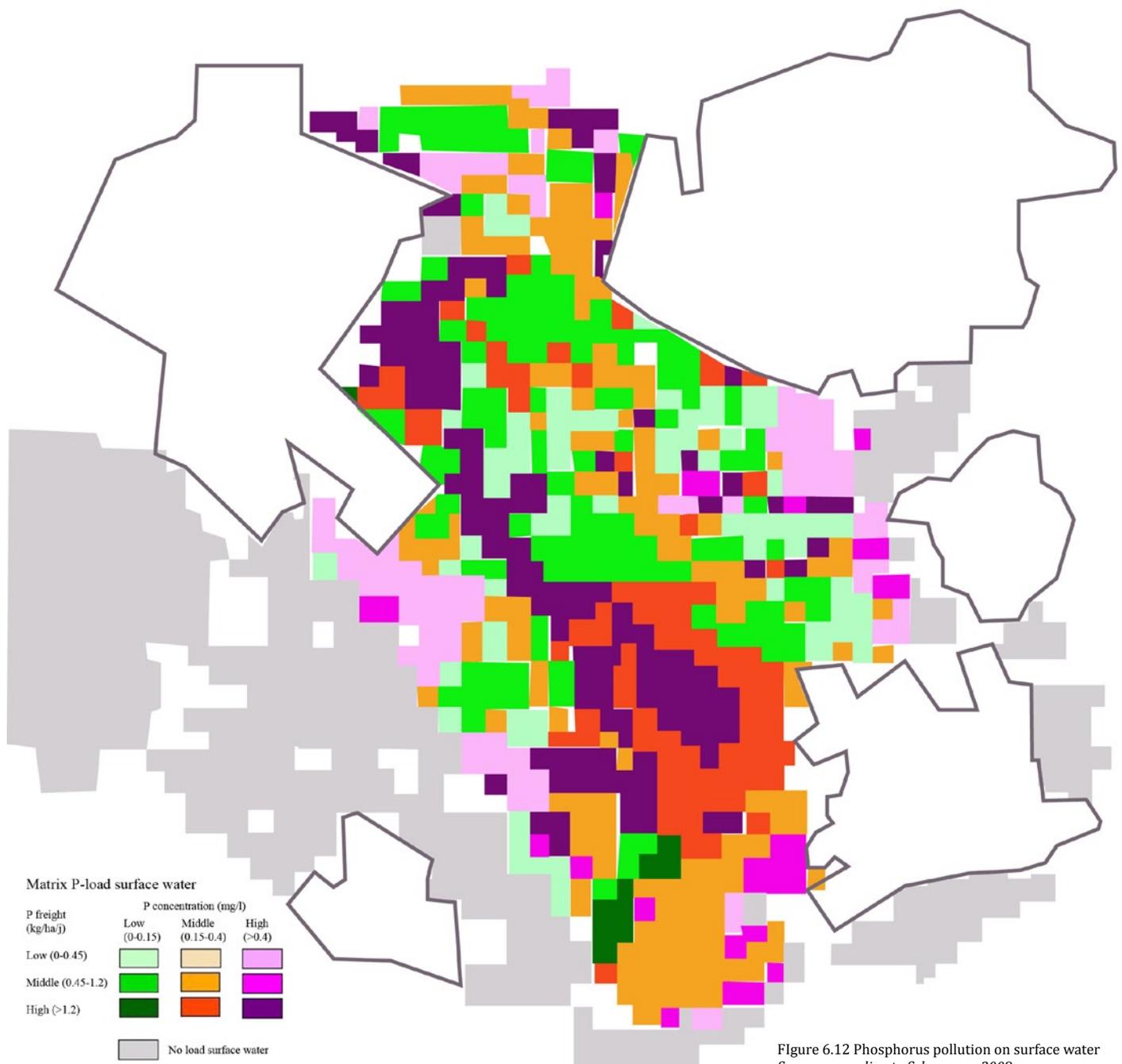


Figure 6.12 Phosphorus pollution on surface water
Source: according to Schoumans 2008

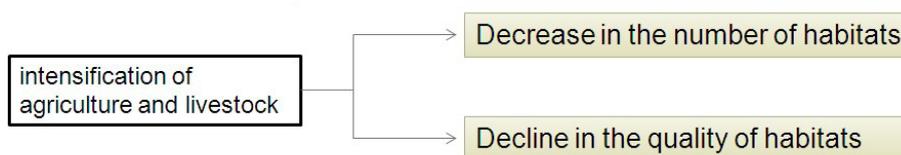
For the phosphate pollution of surface water is a key matrix composed of P concentrations from agricultural lands and store the actual loads calculated. The highest loads calculated in the relatively shallow groundwater levels and especially in those areas where seepage occurs. The total amount of phosphorus accumulation in soils is limited.

(2) Loss of habitat and decline in biodiversity

Binnenveld, as a moistly soil area with a stream (“de Grift”), is a beautiful area for special plant, birds and butterflies. The open and flat landscape around the stream is nice for nesting. Many birds hide in the brushes. The presence of trees, shelter or water affects the diversity of species. It owns high natural values. The meadow birds mainly found on the water line where a varied landscape character has. Trees, bushes, open space, gently flowing water and various birds make up beautiful images.

However, intensification of agriculture and livestock cause negative impacts on biodiversity. It will lead to decreasing in the number of habitats and declining in the quality of habitats. Traditionally, in the Netherland, almost all the land is cultural landscape created by human. In the previous, farmers reclaimed land and develop the agricultural system which have a diversity forms. They have diversity vegetation patches on their farms, such as woodlots, hedgerows, and home garden (Steinfeld 2010, P116). Various plants and animals can be attracted to live in the highly diverse landscape. It can support important biodiversity. But intensification of agriculture and transform to specialization change the situation. In the process of intensification, farming landscapes lose their previous complexity, many species began to disappear (Steinfeld 2010, P116). "The diversity that forms the foundation of Earth's life-support system is much diminished as these specialized systems spread, as landscape become homogeneous (Steinfeld 2010, P116)". Not only loss of habitats, but intensive systems exerts negative impacts on their surrounding environment. It includes emissions of greenhouse gases which cause climate change in the globe, pollution of waterways by heavy nutrients, drugs and sediments and damage aquatic species.

The influences of intensive agricultural systems on meadow birds in the Binnenveld are obvious. In Binnenveld, there are still reasonable numbers of meadow birds, but the amount is diminished due to decrease of the meadow positions and quality of landscape. In the region, there are various meadow birds, for example, lapwing, curlew, oystercatcher, stork and mallard. They distribute in the waterline and farmlands. However, number of them is decreasing and some of them even face to the possibility of extinction.



Lapwing is the most numerous waders, but both regionally and nationally declining species. They are scattered throughout the Binnenveld and especially maize land. The change in populations of lapwing is measurable to follow since 1996. The numbers of Binnenveld based on the number of nests found instead of the number of birds. Compared with national trends (Visser 2009), in Binnenveld number of lapwing increase from the mid-90s. Then in the continuation of much longer term, it is decreasing gradually. Since 2002, the population is fairly stable, even has a growth in the late of 2007.

Godwit as major critical kind occurs mostly in the north and central parts of the field. They live along the Grift, both in nature and surrounding agricultural land. It has largely alternation in the early period. The number of nests reached a lowest point in 2005 and got slightly increase from 2005 to 2006. Since 2006, it began to decrease slowly. Compared with the nationwide, change trend in the Binnenveld had been larger and not stable.

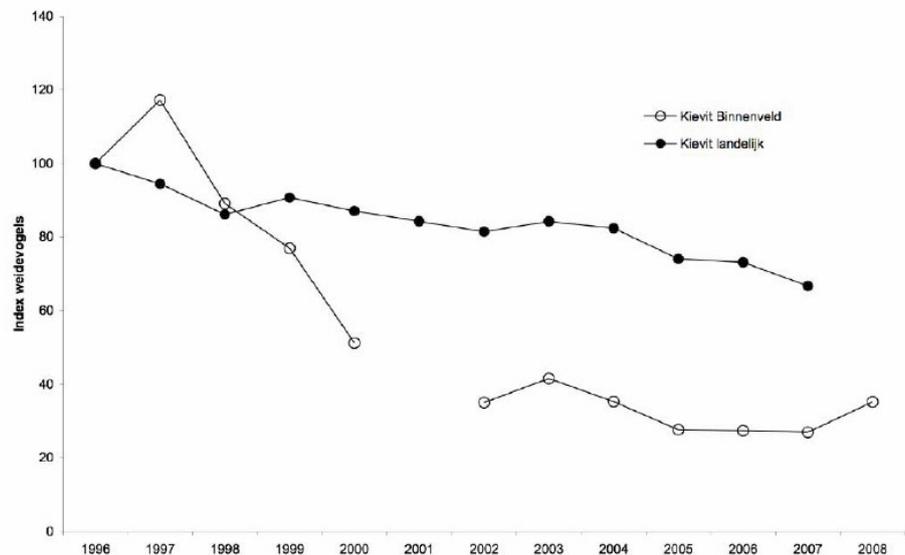


Figure 6.13 Change in the numbers of Lapwing from 1990 to 2008
Source: Visser 2009

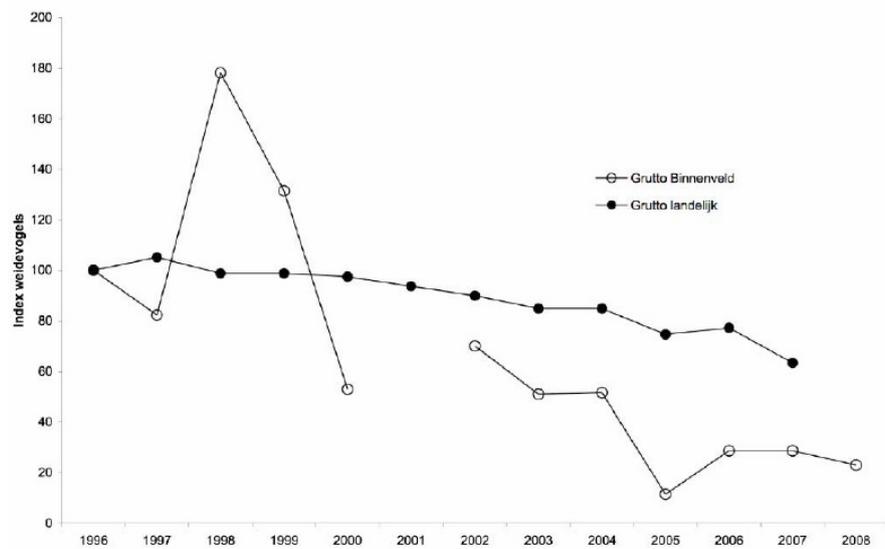


Figure 6.14 Change in the numbers of Godwit from 1990 to 2008
Source: Visser 2009

(3) Odour emission

Large-scale and high intensity livestock in the region form various types of odours and directly affect the landscape quality. The odour emission and air pollution have negative impacts on the public spaces, sensitive areas and people’s living environment. Nowadays, with the development of residential allotments and increasing public needs of clear and pleasant recreational environment in the rural areas, problems about odour emission are getting more attention and become more urgent. Odorants are of many types, but those of the current topic are foul smelling, malodorous compounds (Rappert and Muller 2005). In my studying areas, complaints mainly concentrate on the livestock odors, which affect in large scale and increasing with the extension of livestock operation. There are three primary sources of odor from livestock operations: (1) livestock facilities (animals housing facilities and the animals contained within, feed storage facilities); (2) manure storage structures; and (3) application of livestock manure to agricultural land (Rappert and Muller 2005). The intensity of the odor from animal housing waste air increases from cattle through hens to pigs; it is also further affected by the type of housing, the age of the animals and the purpose for which they are being kept (Rappert and Muller 2005). According to Alterra’s environmental analysis on the Gelderland Valley, the total emissions of ammonia (a volatile nitrogen compound) from agricultural sources in the area are around 8 kilotons in 2000. In current situation, about 99% of the natural deposition in the region is above the critical level (Wijnker 2006).

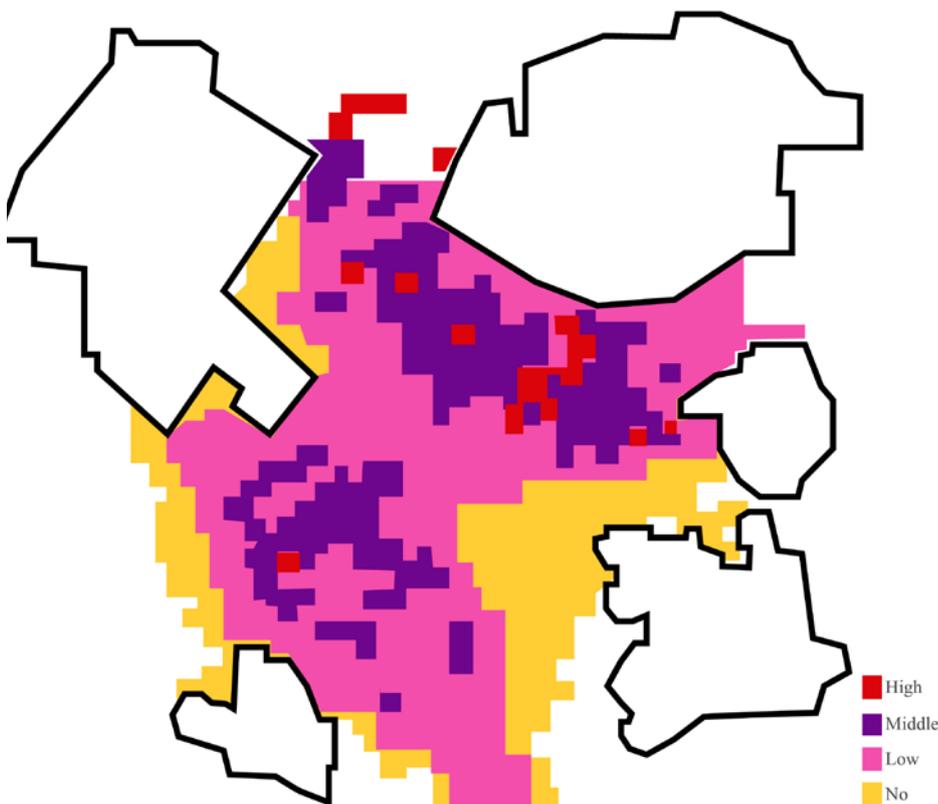


Figure 6.15 Distribution of ordour emission
 Source: According to Schoumans 2008

(4) Negative impacts on the landscape quality

Intensive agriculture cause several negative impacts on the landscape quality. Firstly , development of agriculture led to an increasing number farmstads in the rural areas and occupies large sizes of natural lands. At the same time, they introduce a lot of agricultural equipments to the landscape. These modern equipments can not be integrated into local landscape and environment. The rural scenery is sufferring from decling. In the second place, high density livestock in the region requires more open lands for pastures. As one crucial character of local identity, traditional small scale openness landscape in parts of the region is transforming into open landscape gradually. These small scale openness landscape has experienced long history and brought strong local identity. This transformation cause damage in space structure and local identity.



Figure 6.16-23 Photos of landscape in Binnenveld
Source: By author or google map

To conclude, the mainly problems in the binnenveld are defined as increasing human activities, include the urbanisation and mono and intensive agricultural land use. Major results of them are:

Urbanisation:

- (1) Landscape fragmentation
- (2) Lose of identity and landscape qualities
- (3) Change the ways of life in rural areas

Mono and intensive agricultural land use:

- (1) Water eutrophication
- (2) Loss of habitat and decline in biodiversity
- (3) Odour emission
- (4) Negative impacts on the landscape quality

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Chapter 7

Literature study and design principles

7.1 Water purification system

7.2 Green network

7.3 A meaningful landscape

7.1 Water purification system

Different between constructed wetland and natural wetlands

Natural wetlands (e.g., swamps, bogs, marshes, fens, sloughs. etc.) are being considered beneficial for food and habitat for wildlife; water quality improvement, flood protection and shoreline erosion control (I.H. Farooqi 2007). However, during the past several decades, constructed wetland has been approved as a more effective, low cost and sustainable approach to deal with non-point pollution in rural areas. Created wetland is a wetland established in an area that historically was not a wetland, and constructed wetlands are a subset of created wetlands which specifically for wastewater treatment (Jolly 1992). Nowadays, numbers of natural wetlands in the agricultural landscape are quite limited. Most of them are suffering from the risk due to the change in their hydrology and large number of input from agricultural runoff. Few existing natural wetlands own high conserving values and play significant roles in providing habitats for various plant and animal species. In addition, they have largely aesthetic and social values. They are important recreational areas. Anyhow, size and location of natural wetlands may not make them effective as sinks (Jolly 1992). Therefore, they should not be used to reduce rural nonpoint source pollution (Jolly 1992). Constructed wetland systems, which will mimic natural wetland system, utilizing wetland plants, soils and associated microorganisms to remove contaminants will be a suitable approach to deal with water eutrophication problem in my studying areas.

Locating wetlands in the landscape

There are two basic scenarios for the placement of wetlands in an agricultural landscape. Constructed wetlands can be situated in the base of the watershed. All water in this watershed will flow through it. In contrast, there are another design possibilities for wetlands in agricultural land use. It includes several small wetlands distributed around the watershed. They are located in the lower reaches of each sub-watershed (Jolly 1992).

Upstream wetlands: distribute in the first order drainage system and purify water from the sources. It includes several small wetlands.

Downstream wetlands: locate in the lowest point of the watershed, which aim to purify all polluted water together. It has larger size than upstream wetlands.

Source: Jolly 1992

Mechanisms of nutrient control by constructed wetlands

Wetlands can be seen as an ecologically sound ways to reduce the contaminants in agricultural landscape. They can form physical obstructions to decrease the inputs of contaminants to the water body. Trees, shrubs and other rough vegetation can restrict livestock access thereby reducing direct nutrient inputs (I.H. Farooqi 2007). In additio, they can add the distances between pollution sources and water bodies. However, the retention and removal of nutrients in wetlands relies largely on the key nutrient transformation. The system of nutrient transformation involves three major pathways- physical, chemical and biological (France 2002). The main processes affecting N dynamics are denitrification, nitrification, plant uptake, fixation, adsorption, bacterial assimilation and volatilisation (Maltby and Barker 2009). The key processes affecting P dynamics are plant uptake, bacterial assimilation, adsorption, sedimentation, precipitation and re-mobilisation under anaerobic conditions (Maltby and Barker 2009). These processes of transformation are shown in the following figure. These processes will be affected by the form of wetland, in terms of hydrology, soil, vegetation and size. Other factors will influence the retention and removal of nutrients as well. Climatic conditions will indirectly influence the hydrology, rate of biochemical transformations and etc. Local agricultural practices are also vital and affect the quantity and type of nutrient fluxes in the environment (Maltby and Barker 2009).

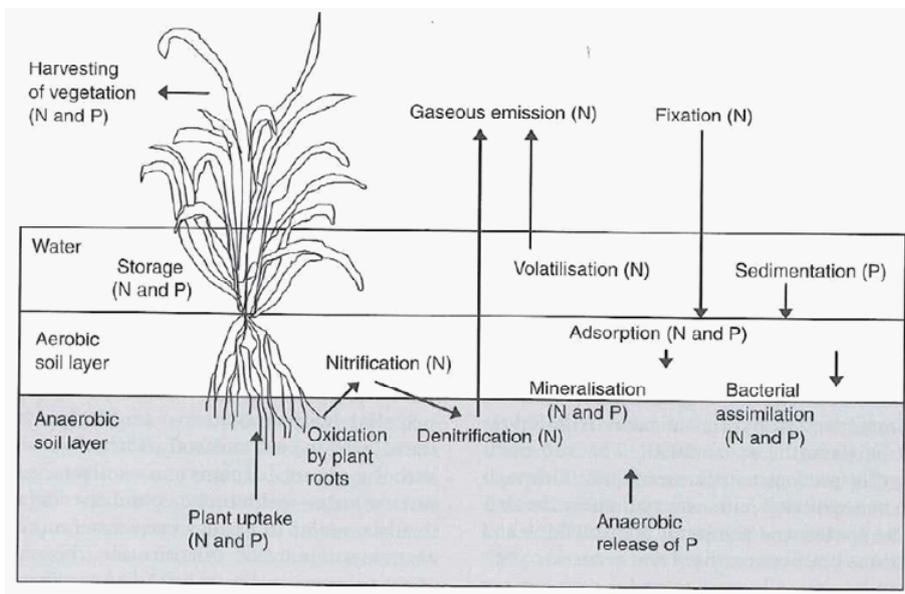
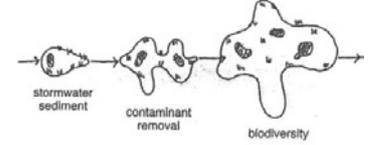
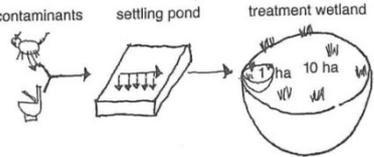
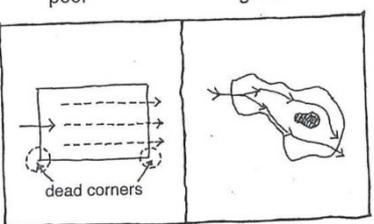
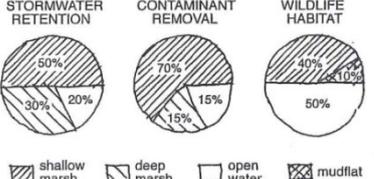
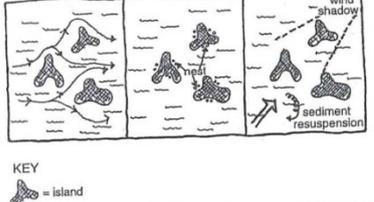
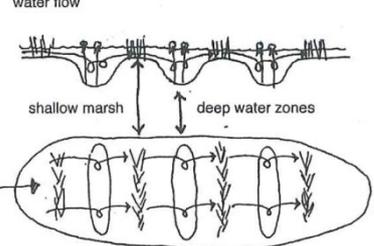
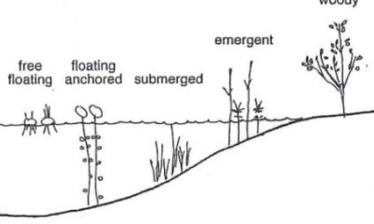


Figure 7.1 Generalised diagram showing spatial relationships of key nutrient transformation processes in a typical wetland. Source: Adapted from Mitsch and Gosselink 1993

Design guidelines for constructed wetlands

	Design guidelines	Modelling pictures																				
	Single wetland cannot provide all benefits, so that a combination of different types of wetlands can be used to solve complex problems.																					
Size	The size of a created wetland should be calculate based on the amounts contaminants produced, the amounts removed in pretreatment, and the estimated loading rates to the intended wetland.																					
Edges	Mimic natural boundaries on the wetlands can increase the time of water flow in the wetlands and avoid right angled corners.																					
Depth:	For contaminant treatment wetlands, it is recommended that very shallow (less than 6 in. [15 cm]) depths comprise up to 50-70 percent of the total surface area in order to promote even sheetflow.	 <table border="1" data-bbox="1043 999 1417 1178"> <thead> <tr> <th>Category</th> <th>shallow marsh</th> <th>deep marsh</th> <th>open water</th> <th>mudflat</th> </tr> </thead> <tbody> <tr> <td>STORMWATER RETENTION</td> <td>50%</td> <td>30%</td> <td>20%</td> <td>0%</td> </tr> <tr> <td>CONTAMINANT REMOVAL</td> <td>70%</td> <td>15%</td> <td>15%</td> <td>0%</td> </tr> <tr> <td>WILDLIFE HABITAT</td> <td>40%</td> <td>10%</td> <td>50%</td> <td>0%</td> </tr> </tbody> </table>	Category	shallow marsh	deep marsh	open water	mudflat	STORMWATER RETENTION	50%	30%	20%	0%	CONTAMINANT REMOVAL	70%	15%	15%	0%	WILDLIFE HABITAT	40%	10%	50%	0%
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STORMWATER RETENTION	50%	30%	20%	0%																		
CONTAMINANT REMOVAL	70%	15%	15%	0%																		
WILDLIFE HABITAT	40%	10%	50%	0%																		
Water flow	Multiple braided channels and islands promote water storage by increasing flow travel time which will improve water quality	 <p>KEY = island</p>																				
	Integrate deep water with shallow water in the created wetlands will promote establishment of a suite of different plants and thereby increase the contaminants that are moved																					
Vegetation options	Vegetation forms in the wetlands are diverse and related to their suitability for different planting areas.																					

Source: France 2002

Control runoff from dispersed farmsteads and arable lands

Besides pollution from concentrated livestock, there are large numbers of non-point pollution formed in the term of runoff in the pasture and arable lands. Dealing with them is a significant problem in the sustainable development for the agricultural landscape. There are two major methods to solve it.

Nutrient/sediment control system

The nutrient/ sediment control system is kind of constructed wetland, which is consisted of marsh or pond to removal sediment and nutrients from runoff. The main mechanism to do it is physical, chemical and biological processes. These control system are usually located in the downstream end of waterways or ditches before their flowing into streams.

Buffer zones along the stream

Buffer zones are "kind of corridors along the stream, with running water, moist and fertile soils, and well-developed vegetation" (Hellmund 2006). They form the interface between land and water; intercept nutrients and sediments from uplands.

Mechanisms of buffer zones for purification

Nitrogen removal:-uptake and storage in vegetation
-microbial immobilization and storage in the soil as organic nitrogen
-microbial conversion to gaseous forms of nitrogen

Phosphorus removal:-soil adsorption
-removal of dissolved inorganic phosphorus by plant uptake
-microbial immobilization

Source: Mander, Kuusemets et al. 2005

Design guidelines of buffer zones

Due to various ecological functions that riparian buffer zones provide, there are different design guidelines. Here, research focus on the function of riparian buffer zones for water purification. There are three elements affect the effectiveness of riparian buffer zones to improve surface water quality. They are the arrangement of buffer zones across a catchment area, the types of pollutants and the physical characteristics of them.

(1) Arrangement of buffer zones across a catchment areas

Possible locations of buffer zones to protect water quality are showed in the figure 7.2. They aim to improve water quality in largely catchment area and their abilities to control pollution are different. Arrangement of buffer zones like that described in the first one of picture, it can control more runoff in a catchment than the others and is more effective in improving water quality. Meanwhile, riparian buffer zones along streams can reduce water temperature, which is good for aquatic ecosystem. It is easy to find that the first one can provide more shading effect on streams. The first arrangement is the best choice for pollution control, however, our design of buffer zones will take other functions of them into account as well, for example, landscape corridors and recreational spaces. They will also affect the arrangement of buffer zones.

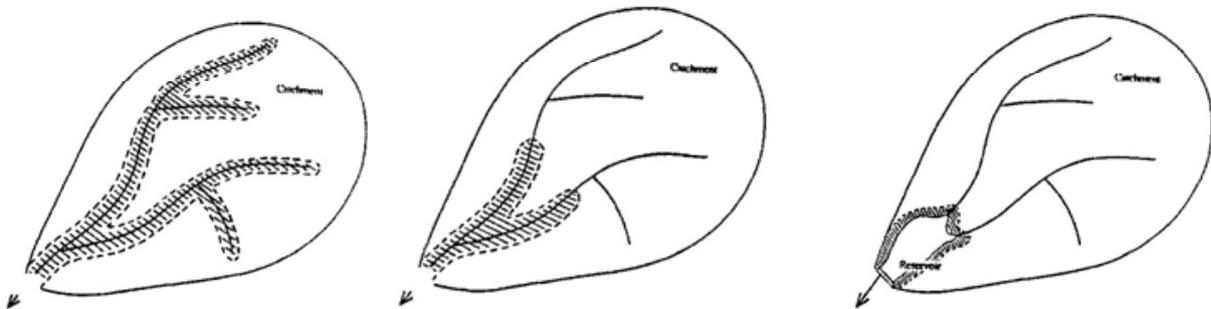


Figure 7.2 Possible locations of buffer zones
Source: Norris 1993

(2) Types of pollutants

According to mechanisms of control pollution by riparian buffer zones, we know that different types of pollutants have different controlling process. Hence, they will require different physical characteristics of the buffer zones. There are two major kinds of pollutants: one is sediments and adsorbed pollutants, and the other is dissolved pollutants.

-Sediments and adsorbed pollutants: Removal of pollutants which are transported in particulate form depends on the ability of a buffer zone to reduce the energy of overland flow, and hence allow deposition (Norris 1993). Related to physical characteristics of the buffer zones, vegetation types and surface texture are very significant. Compared to forested buffer zones, grassed buffer zones with more roughness textures, can reduce water flowing velocity. It can increase their capacity for sediment carrying and more effective in removal of phosphorus in shallow groundwater.

-Nitrates and dissolved pollutants: effectiveness of riparian buffer zones for dissolved pollutants control depends on the retention time they can hold runoff so that pollutants can be uptake and storage in vegetation, or conversion in microbial conditions. Forested riparian buffer zones are much better than grassed ones to deal with shallow concentrations of nitrates and dissolved pollutants. They can remove much of the nitrate in groundwater when it passes

through the riparian area under confined conditions (Todd 1997).

There are different physical characteristics of riparian buffer zones are required to remove each kind of pollutants. However, in most agricultural areas, both types of pollutants can be found at the same time. Riparian buffer zones are developed to remove both sediments and dissolved pollutants. Singly forested or grassed buffer zones are not enough to reduce water eutrophication and protect water quality. A reasonable structure of riparian buffer zone which will integrate forested and grassed ones will produce a more acceptable result.

(3) Physical characteristics of the buffer zones

Removal effectiveness of pollutants is site dependent. The pathways by which non-point source pollutants are transported into a riparian buffer zones as well as the potential for their interception by s buffer zones are affected by the physical characteristics of the buffer zones (Todd 1997, P5-1). The effectiveness of controlling pollutants by vegetated buffer zones is influenced by hydrology and topography, soils, buffer width and vegetation types.

-Hydrology and topography

As Correll described in his articles: Principles of planning and establishment of buffer zones, when planning the establishment of riparian buffer zones, the first concern should be to understand the hydrology of the site (Correl 2005). Stream order is a useful approach for us to understand relationship between streams and their watershed. In low-order stream, they are usually short, small size and less volume of water. In general terms, buffers have the greatest potential for control over water quality when adjacent to low-order streams. As we can see from the following diagram, values of buffers for nutrient removal and water temperature moderation are declining as stream order increases. It is because with stream order increases, the contributing area and volume of water available to the buffer area also increases, potentially diminishing the relative capability of the buffer to filter and remove pollutants as a percent of total loading (Todd 1997, P6-4). Likewise, with the increasing of stream order, stream sizes are also increasing at once. The shading effect of streamside trees are decreasing and values on water temperature moderation are declined. In addition, nowadays for most of low-order streams, there is no riparian vegetation. But unfortunately most of them are major sources of pollution. Using minimum size and cost on them can produce higher benefits for water quality. In this case, more attention should be paid on protecting them.

Topography has great influence on the pollutants removal and mainly reflected in the slope upstream of the buffer zones. Slope has the greatest influence over sediment removal and is a determinant in the

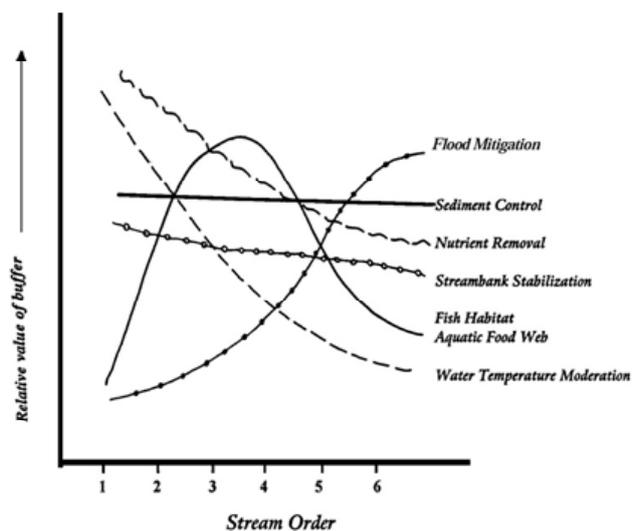


Figure 7.3 Generalized effects of stream order on variations in buffer function
Source: Todd 1997, P6-4

rate and nature of water flow (Todd 1997, P6-4). Generally, steeper slope will have much faster runoff velocity and create larger volume of water. They will bring more pollutants and flow through buffer zones fast. Retention time of water by buffer zones decreased and numbers of pollutants uptake and storage by vegetation and transformed by microbes decreased. Hence, steep slopes on small streams will be included into buffers or buffer widths are increased to provide a similar effect of the slowing surface runoff.

-Soils

As a major factor that affects the potential of buffer zones for pollutants removal, soils are a long-term result of the geology, hydrology, and biota. Primary considerations are soil texture, depth to water table, and organic matter content of soils (Todd 1997, P6-6). Soils, with low permeability, are difficult to infiltrate water that may flow into the buffers in the form of surface runoff. Therefore, wider buffer strips will be required in low permeability soils than moderate- to well-drained soils to take away sediments and related pollutants. Then depth to water table will affect the root penetration by woody plants and sustain uptake of nutrients and chemicals in solution below the surface (Todd 1997, P6-6). Organic matter content of soils plays important roles in the denitrification process. Since denitrification will happen in anaerobic conditions, soils need to be wet enough and allow oxygen depletion to occur (Todd 1997, P6-4). Organic matter content of soils is beneficial for denitrification and promotes the denitrification process.

-Buffer zone width

Numerous researches have been done to sum up the effective width of the buffers. However, due to various site conditions, different widths will be required. Even along one stream, variable widths are also necessary to remove depositions of sediment and pollutants like nitrogen. The width of a riparian corridor should not be defined arbitrarily and should increase in direct proportion to (1) the size of the area contributing runoff, sediment, and nutrients; (2) the steepness of both the adjacent slope and the riparian zones; and (3) the intensity of cultural activities and disturbances in the uplands (Hellmund and Smith 2006). Besides, desired buffer functions are also important design criteria for determining buffer widths under various site conditions. For different buffer functions, variable buffer sizes are necessary for satisfactory performance. Figure 1 demonstrates specific widths requirements for different buffer functions.

Processes of nitrogen removal in the buffers are chiefly: uptake by plants and denitrification processes. The uptake and storage by vegetation will begin at the upslope edge of the vegetation, whereas, processes of denitrification occur under a wide range of conditions, but will be most intense in the wetter streamside area (Todd 1997, P6-9). Woody plants can produce more uptakes and create a more suitable environment for denitrification. Hence, a suitable integration of forested buffer strips and grassed ones can reduce the width of buffers in total. In most of field studies, nitrogen will be reduced about 25%-90% of total loadings in the first 35 to 90 feet of forest (Todd 1997, P6-4). In the sites where have ideal conditions for water storage, vegetative uptake, and

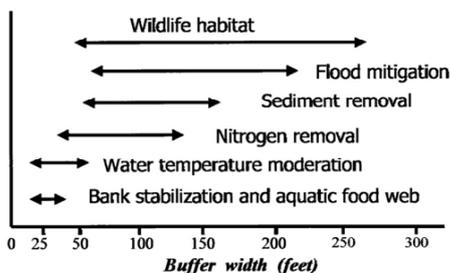


Figure 7.4 Range of minimum widths for meeting specific buffer objectives
Source: Todd 1997, P6-8

denitrification, widths as small as 35 feet will provide substantial removal of the nitrogen passing through the buffer (Todd 1997, P6-4).

Vegetated buffers can improve water quality not only by biological processes but also physical functions. They can form an isolation strip buffer aquatic system and upland. They can increase the roughness of water pathways and play a role in the reduction of water velocity which will increase retention time for runoff infiltration. Roots of plants can be used to support soil structure and avoid erosion. There are about 90% of phosphorus is carried to streams in the soil particles or organic matter (Todd 1997, P6-9). Reduction of sediments flow into streams is benefit for phosphorus loads removal. Large numbers of studies describe that buffer widths of 50-100 feet for adequate removal of sediments and phosphorus (Todd 1997, P6-9). Meanwhile buffer widths and amounts of sediments removal are not in the direct proportion. If the maximum effectiveness of removal has been reached, larger buffer widths are required for incrementally depositions of sediment removal.

-Vegetation type

A more scientific vegetation structure in the buffers can provide higher purification on water than buffers with single vegetative structure. To meet specific buffer functions, there are large number of vegetation types can be used. As bio-mechanical filters, which aim to remove depositions of sediments, a dense ground cover would seem to be the principal requisite (the use of buffer zones). It helps to infiltrate overland flow and intercept suspended sediments. In addition, forests along streams can provide the greatest range and number of potential environmental benefits, and therefore, should be promoted as the target vegetation whenever possible in a hierarchy of vegetation types (Todd 1997, P6-5). The benefits of forested buffers consist of protection from soil erosion, more removal of nitrogen and phosphorus, reduced water temperature, provided habitats for wildlife and so on. To conclude, complex plant communities' structure of buffer zones which includes grassed ground cover and forests will produce better results for nutrients removal. A combination of grasslands as wider buffer zones (10-50m) and forest/bush communities as buffer strips (5-10m) on stream banks is the most optimal structure of riparian buffer communities (Mander, Kuusemets et al. 2005).

Native vegetation is usually the most effective for maintaining water quality and requires little or no maintenance (Hellmund and Smith 2006, P146) . They are plant species which inherently local, natural distribution and growth in the local conditions. Exotic plants are introduced from foreign countries or other places. Native plants are best adapted to local natural conditions, and on behalf of the local culture and regional identity. Compared with exotic species, native plants, adapted to site specific conditions, have a higher seedling survival capacity and lower maintenance costs; they reduce the possibility of pests and diseases. Moreover, with high ecological values, they will help to protect local biodiversity and ecological balance. Meanwhile, they highlight local landscape features which cannot be replaced by exotic plants.

7.2 Protection in biodiversity

Biodiversity must be conserved as a matter of principle, as a matter of survival, and as a matter of economic benefit.

UNEP, IUCN and WWF in their joint report, Caring for the Earth, 1992

The movement of organisms across landscape is one of the most fundamental ecological processes (Hellmund and Smith 2006). However, urbanization led to landscape fragmentation, which damage landscape connectivity and affect movement of meadow birds. Intensively development of agriculture damages the quantity and quality of meadow birds' habitats. Therefore, to improve the living environment for meadow birds, landscape connectivity and suitable habitats are major points.

In the book of "landscape ecology principles in landscape architecture and land-use planning", authors believe that "principles of landscape and regional ecology can be applied in any land mosaic, from suburban to agriculture and desert to forest. (Dramstad, Olson et al. 1996, P14)". Here, three concepts are important to understand the structure of a landscape and judge the movement and flow of animals, plants and materials in the landscape.

Box

Basic concepts of island biogeography

Patch- do exhibit a degree of isolation, the effect and severity being dependent on the species present. There are several key references to analyse patches: a. size, b. number, and c. location.

Edge: Vegetative edges with a high structural diversity, vertically or horizontally, are richer in edge animal species.

Corridors in the landscape can act in the forms of wildlife movement corridors and stepping stones to resist habitat isolation. They can also act as barriers or filters to species movement.

Mosaics: The ecological health of a landscape is the overall connectivity of the natural systems present. Networks emphasize the functioning of landscapes and can be used to facilitate or inhibit flows and movements across a land mosaic.

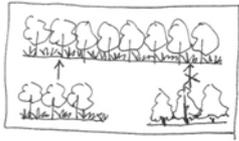
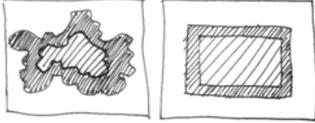
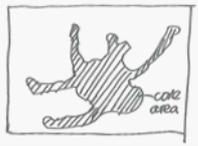
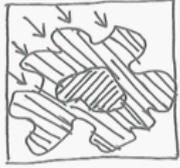
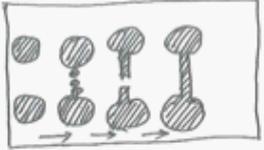
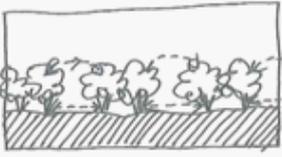
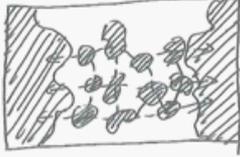
Network connectivity, combined with network circuitry provides an overall index of the effectiveness of linkages for species movement.

Fragmentation decreases the total amount of a particular habitat type and causes a much greater loss of interior habitat.

In landscape undergoing suburbanization and consequent invasion of exotic species, a biodiversity or nature reserve may be protected against damage by invaders using a buffer zone with strict controls on exotic species.

Source: Dramstad, Olson et al. 1996

Design guidelines

Principles	Modelling pictures	Principles	Modelling pictures
Similarity in vegetation structure and plant species between corridors and large patches is preferable.		Curvilinear edge has a higher proportion of edge habitat, more edge species and more interaction.	
An ecologically optimum patch includes rounded core, some curvilinear boundaries and a few fingers.		Vegetative edges with a high structural diversity, vertically or horizontally, are richer in edge animal species.	
Edge width differs around a patch, with wider edges on sides facing the predominant wind direction and solar exposure.		A row of stepping stones is an intermediate of interior species between species.	
Distances between stepping stones are determined by the ability of species to see each successive stepping stones.		Alternate routes can enhance effectiveness of movements for species and reduce disturbances.	

Source: Dramstad, Olson et al. 1996

Roles of corridors for wildlife movements

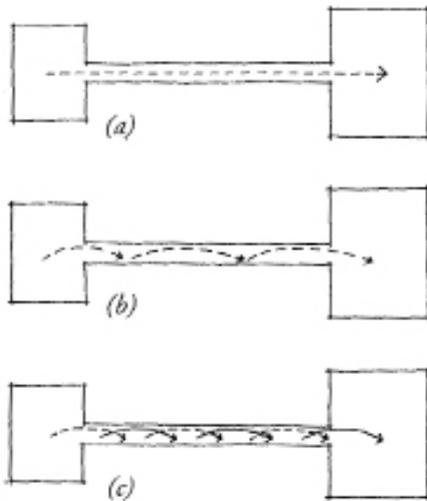


Figure 7.5 Three ways in which corridors may facilitate dispersal of individual animals and genes between habitats patches

Source: Hellmund and Smith 2006

Bennett described that as a method to provide functional connectivity, habitat corridors would be the best means under certain conditions, such as when (1) much of landscape is modified by human activity and inhospitable to native species; (2) the species in question are habitat specialists or depend on undisturbed habitat; (3) the species in question are unable to travel the distances between remaining patches of natural habitats, so must be able to dwell and breed in corridors; (4) the goal is to maintain continuity of entire faunal communities; or (6) maintenance of key ecological processes requires habitat continuity (Hellmund and Smith 2006).

Development of wildlife corridors is based on the theory of island biogeography. This theory describes that "small, isolated islands will experience higher extinction rates and lower immigration rates of species than large islands closer to a species' source" (Hellmund and

Smith 2006). And wildlife corridors can be habitats for plants and animals, and conduit for wildlife movements as well. Even narrow corridors of plants, which have well-designed vegetation cover, will be benefit for some species moving in the fragmented landscapes. For example, Wegner and Merriam note that several bird species preferred to fly along fencerows rather than cross open fields.

Greenways

Greenways are bands on the landscape, designated for their natural or recreational resources or other special qualities (Hellmund and Smith 2006). They exist in a range of landscapes, from cities to countryside. Generally they have a highest frequent to be created in suburban areas, where are suffering from pressures of urbanization or intensive agriculture. Forms and functions of greenways are quite diversity. Combine with different topography and landscape morphology, they will have different forms and function differently ecologically and socially. They can not only improve connectivity in the landscape but also can be used as buffer zones to purify water.

Figure 7.6 Upland greenways can be used to connect habitat patches

Source: Hellmund and Smith 2006



Greenways can provide diversity functions on social and ecology. In the social aspect, it can be major recreational space in high-urbanization landscape. Various activities, such as walking, jogging and biking can happened in this linear space. At the same time, it can enhance local landscape quality and aesthetic values. These linear landscape, usually follow natural physiographic corridors, such as streams, rivers and ridges that have historical and cultural significance and these significance will increase the sense of history and culture that is so important to people's experience of a landscape and their overall sense of place (Hellmund and Smith 2006, P19). Moreover, it will link different areas, such as city parks, historical sites, living parts and shopping centres together and form a continued experience from place to place.

Ecological functions of greenways primarily reflect in services for stream corridors and corridors for plants and animals. They can help to improve water quality, reduce soil erosion and protect from floods. They can also play roles as landscape corridors to increase landscape connectivity.

Greenways can benefit wildlife in many ways. Enhancing connectivity between habitat areas can increase the area available to wide-ranging species and can allow individuals to travel between

different habitat types to meet daily or seasonal needs. Enhanced connectivity may also increase the long-term health of populations by increasing genetic exchange and by maintaining natural demographic processes, such as recolonization following local extinctions. Greenways can serve as movement corridors for plant species as well, allowing for recolonization of disturbed areas or for long-term genetic exchange. Finally, broad corridors may help entire biotic communities adapt to long-term climate change by allowing plants and animals to migrate along latitudinal or elevational gradients. Without sufficient regional connections between habitat areas, both fauna and flora may become locked into locations whose suitability for their survival may gradually decrease (Hellmund and Smith 2006, P17).

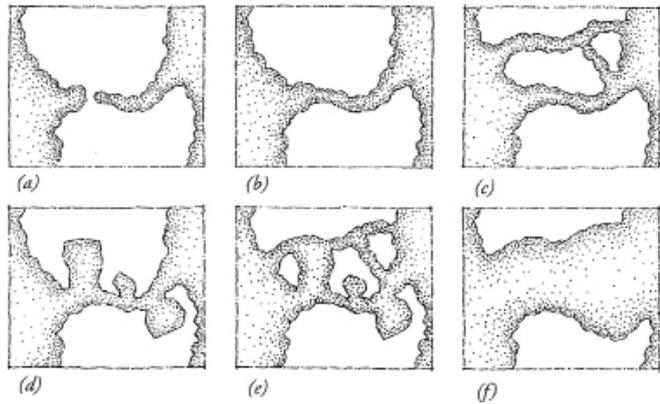


Figure 7.7 Options for corridor and network structure
Source: Hellmund and Smith 2006

Ecological design for greenways

Greenway is a practical approach to decrease negative impacts of development and integrate them into the environment, because it has various functions to control flood, reduce water temperature, conserve aquatic ecosystem and so on. In the fast-developing suburban areas, it can provide best ecological benefits within the limited space, which are not only for ecology, but also contribute to better landscape quality, sense of place and belonging, space for leisure activities.

A strategic framework to design greenways is proposed in five steps:

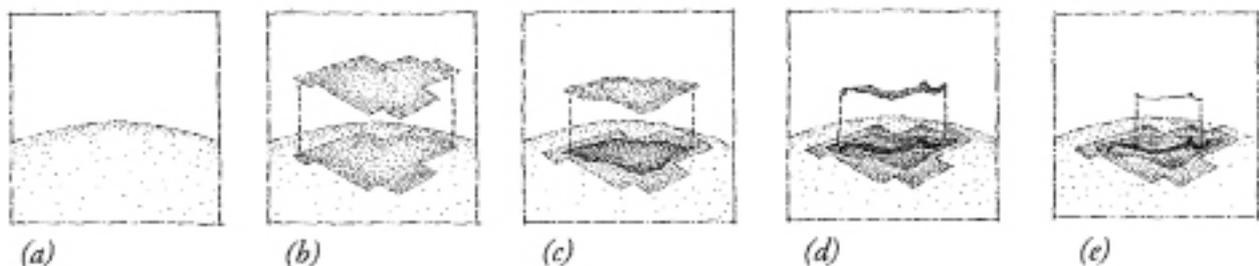


Figure 7.8 Summary of the five-stage ecological greenways design method
Source: Hellmund and Smith 2006

(1) Identifying potential issues, stakeholders, and preliminary goals.

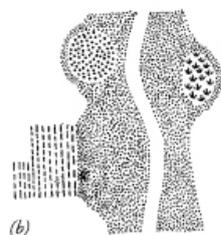
The purposes of this stage are to assess the suitability of greenways in the region and select possible scope for it. In this stage, we should learn about the region, which is consisting “by a complex of climatic, physiographic, biological, economic, social, and cultural characteristics.” Based on the knowledge on underground parts in the region, it is necessary to learn what parts have been conserved and “which unprotected areas have already been targeted” for greenway projects (Hellmund and Smith 2006, P228). Besides, we need to realize that greenways can be constructed in various forms for different conservation purposes. To select the key uses is significant, which can help us to develop “project-specific guidelines (Hellmund and Smith 2006, P221)”. “The more specific the guidelines the better”. Key uses in the region should be representative, critical and “give a complete picture of greenway needs (Hellmund and Smith 2006, P221)”.

(2) Defining a broad region to study

In this stage, we aim to develop more concrete project goals and assess the studying areas. At first, we should know what are requirements of the key uses in the region. Normally, “carefully selected key uses may have specific, documented requirements that can guide goal setting and decision making (Hellmund and Smith 2006, P228)”. On the basis of it, we can build our design methods, which is focus on the greenway’s key uses and more meaningful. In second, assessment of the region is necessary. The assessment includes pattern of ecosystem or land uses, strategic points in the landscape which should be developed on the basis of key uses’ requirements.

*(3) Selecting nodes and swaths.*

Now, we should turn to research on the swaths, which means “some areas are elevated for consideration and further study and other areas are eliminated from consideration (Hellmund and Smith 2006, P241)”. In this way, more than one swath may be selected and create a green network together.

*(4) Selecting alternative alignments and setting widths.*

After selection of nodes and swaths, it is necessary to “make effective connections for each key uses” and determine the widths of greenways. For alignments, the most frequent frames are green networks along infrastructures, especially roads. Then, alignments for different alignments should be combining into a complex green network. “



Figure 7.9 A greenways in the same location that has a flexible width can be widened at appropriate locations

Source: Hellmund and Smith 2006

The widths of greenways should be set in local scale, which could meet the requirements of key uses better and on the basis of local conditions. In general, widths of greenways are mostly determined by the existing sites boundaries. It tries to create a greenway with the least occupation of lands. At the same time, setting the widths of greenways should take local ecological conditions into account. As Paul states: “Greenway function is better protected when width

responds to the specific characteristics of adjacent uses (Hellmund and Smith 2006, P245)”.

(5) Implementing and managing

Finally, it is implementation and management of the designed greenways. It cannot be developed in one model due to different site-specific natural conditions and political environment.

7.3 A meaningful landscape

7.3.1 Aesthetics in ecological design

As Louise A. Mozingo describes in the article of “The Aesthetics of Ecological Design: Seeing Science as Culture”: Ecological spaces, especially those in close proximity to urbanized areas where most people live, should be appealing aesthetic experiences (Mozingo 1997). It can enhance the promotion and acceptance of ecological design. Hence, what we should do as landscape architectures are to combine ecological design of the landscape with the social nature of our landscape perception. Nassauer said that “If we probe the social language of landscape form and learn these conventions of landscape appearance, we can use these conventions to label ecological function. (Nassauer 1992)”

However, what are the appealing aesthetic experiences? In Aesthetics and the Good Life Marcia Muelder Eaton states aesthetic experiences as experiences “relies both on our ability to “conceive” of it within a broader cultural context” and “perceive” the sensory qualities of something (Eaton 1989).

(1) Conceive in cultural context: a sense of place

The sense of place comes from our response to features which are already there—either a beautiful natural setting or well-designed architecture (Jackson 1994, P151). With identity as a function of place, we should create a meaningful landscape to wake up local people’s memories and form an attractive landscape for outsiders.

- Working with natural elements and local traditions is important.

Sense of place will provide people feelings of belonging and at home, which can be present in the form of natural elements. Rock, water and trees, as natural elements, form a microcosm that is typical for the most primitive places and have an intrinsic story to tell (Norberg-Schulz 1980, P27). The combination of elements creates meaningful places to identify with. At the same time, building styles, ways to construct pavements or planting regimes, as local materials and traditions can be critical put into use to connect places to the past time and wake up people’s memories.

- Respecting a vernacular sense of order

Respecting a vernacular sense of order – of “neatness” and “cues to care”- ecologically responsible landscapes can become publicly accepted (Mozingo 1997). It means a combination of constant orderly frame and dynamic messy ecosystem. “The desire for constancy and the necessity of dynamism evolve into the more subtle sense of continuity- that some parts of the landscape will be the same year after year and are places appropriate for overt aesthetic statement, and that these introduce and present the fluctuating part of the landscape (Mozingo 1997)”.

(2) Perceive the sensory qualities: everyday aesthetic qualities

Beside to work on local identity and sense of place, there are some qualities, what have been embedded into our everyday life, be ignored. Saito calls them “everyday aesthetics” and plead for more discussion of them in the aesthetics. From her description, everyday aesthetic originated from our ordinarily life and “in some ways they are very complex, because they are often context-dependent”. In addition, it is familiar to all people and should get all our concerns and response. Therefore here are two points are focus on to construct everyday aesthetic qualities. One is relationship between order and disorder. The other is the appearing of aging, which emphasize on the changing of landscape with time.

- Order& disorder

A landscape absolutely controlled by people is better or landscape developed naturally and in the form of disorder and irregularity is more beautiful. For Satio, it is neither a total control over natural processes nor a wholesale submission to them is appreciable (Saito 2007, P173). She believes that we need to find “appropriate balance between them”.

Order: The orderly design can not only form a special landscape which will use spaces effectively, but also expresses human control over natural (Saito 2007, P164). As Thomas states that “sometimes it is a nice way to impose human order on the otherwise disorderly natural world”(Saito 2007, P164).

Disorder: Saito believes that “The appearance of disorder and irregularity can stimulate to the imagination than the opposite qualities” (Saito 2007, P167). This kind of landscape can provide various imaginations, which don’t have confinement in sights. “And the sight is fed with an infinite variety of images without any certain stint or number” (Saito 2007, P167). People preferred this landscape due to different reasons. As Kant said that disorder and irregularity nature “with which imagination can play in an unstudied and purposive manner is always new to us, and one does not get tired of looking at it” (Kant in Saito 2007, P168).

How to combine order and disorder into a system is a lasting discussion. In Joan Nassauer’s *Messy Ecosystems, Orderly Frames*, she mentions that indigenous plants, wildflowers and other garden materials can provide well ecological benefits, at the same time, they may develop into a mess, unkempt landscape appearance what are not attractive and accessible for us. Based on it, Nassauer proposes to put natural space, which needs to be protected and nurtured, into an orderly package: “It requires placing unfamiliar and frequently undesirable forms inside familiar, attractive packages. It requires designing orderly frames for messy ecosystems”

- Appearance of aging

As disorder and irregular appearances of landscape is appreciable for someone and is context-depend, people have different ideas about the appearance of aging objects. As Saito states that “when human think about what features of the pure sensuous surface of aging materials are aesthetically appreciable and what are not, various opinions will be formed due to the appearance of aging will have different forms” (Saito 2007, P175). By the weathering and long-time use, a surface made by metal, plastic becomes tatty. However, wood or stones will be smoother and simpler. The appearances of aging are complex and diverse. Therefore, human’s reactions to them are various as well. Someone complain about the results of time. The others in favour of this old man: Time. Constable is known for his saying that “time will finish my painting.” (Saito 2007, P176)

Saito divided materials into “age well” and “age bad” materials in her book. She believes that “despite these various ways in which materials and objects age and our diverse reactions to them, we do seem to share some consistent responses concerning which materials “age well” and which do not.” Age-well materials are major natural materials, what as Saito explained, has less processes and “tend to respond rather amicably to changes brought about by nature (Saito 2007, P178)”. And Pauline von Bonsdorff points that “less processed materials, such as stone or wood, show in their very texture, as traces, processes of nature such as growth or sedimentation...Natural materials...react more smoothly to natural processes and are likely to cooperate with these: they are receptive and interactive in relation to the climate (Pauline in Saito 2007, P178)”

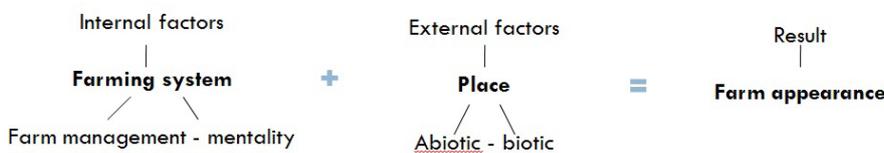
Age- well materials: such as wood, stone, brick, and clay.

Age- bad materials: such as concrete, plastic, and aluminium

People’s reactions on the appearance of aging are diversity and are “not simply a response to its sensuous surface, but heavily invested with various associations (Saito 2007, , P180)”. Some kind of landscape is preferred by humankind due to our activities of imagination and association instead of the qualities of items. These imagination and association are focus on special objects. But where are they from? According to Saito’s statement, they are caused by our experiences and “the locus of our experience is the object’s appearance, and the mode of association is the contrast between the present condition and the earlier condition (Saito 2007. P182)”. We will appreciate the appearance of aging objects which keep their identity and invoke our aesthetic experiences. They are productions of natural processes and our expectations. Pauline von Bonsdorff describes that it is important to accept unplanned nature which is the aging appearance of landscape. It can be influences by repeated use and weather. She argues that “appearance of aging shows the interaction of nature and culture, with humans as mediators, belonging to both sides, erecting and wearing down. (Saito 2007, P183)”. In this case, if we can design for age-well landscape, we can integrate human and nature in a harmony way.

At the same time, imagination and association caused by “our experience of aged objects are historical” as well. These imagination and association may be acceptable or not. It is because their different causations. Aging of appearance caused by “human violence or natural catastrophe” will wake up sorrowful memory and be unpleasant. Here, ruins are special and characteristic objects. Ruins, as the directly “witness” of histories, provoke various associations. Woodward define them as “exemplary frailty”, which are “the most potent and poignant reminder of historical associations”. They can present that time is always equal for everyone; no matter you are rich or poor. In additional, these aging objects can “help us adopt a more positive attitude toward our own process of aging and eventual demise (Saito 2007, P186)”.

Appearance of agricultural landscape



7.3.2 Create a better living environment

In final, on the basis of ecological functions and aesthetic values, a meaningful landscape should be put into use. Here, it means the use of landscape for life, which includes people and also the ecological life of birds, fish and so on. Due to the uses of landscape for ecological life has been considered in the ecological approach, putting landscape into use here major means to attract people and create a better living environment. To assess the quality of living environment, two aspects are important. First, we should pay attention on the physical form of landscape to meet the practical requirements. In second, create a comfortable atmosphere is significant as well, especially in the global context of climate change.

Physical form of landscape

To design a living, dynamic landscape, physical forms of landscape can be used as landscape elements for design. Catherine Dee states that “while landscapes are living, dynamic, bio-cultural systems, they can be thought of as complex, spatial structure (Dee 2001, P1)”.

-Landscape fabric

Landscape fabric refers to the total landscape structure and the context for development. To design for landscape fabric, two major qualities should be considered.

Coherence: which refers to the order of a place, how well it fits together?
Complexity: refers to the diversity and richness of elements within a place.

(Dee 2001)P17

Diversity without coherence leads to chaos. Coherence with only a little diversity leads to fossilisation and boring landscapes for visitors. Diversity becomes meaningful only when it acts in a certain landscape coherence.

(Hendriks, Stobbelaar et al. 2000)

-Five landscape elements

There are five elements determine the morphology of landscape and experiences by people in landscape. They are spaces, paths, edges, foci and thresholds.

Spaces: explore the enclosure and definition of distinct areas of land for human activities.

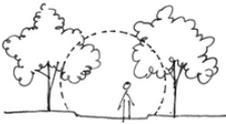
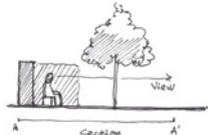
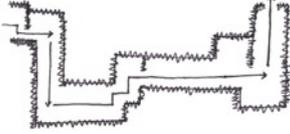
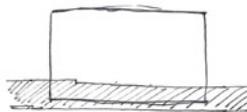
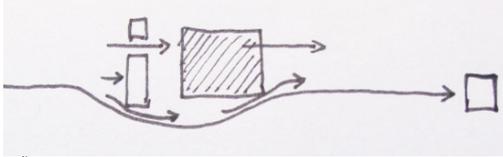
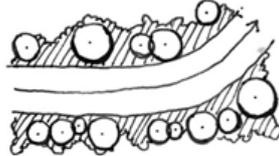
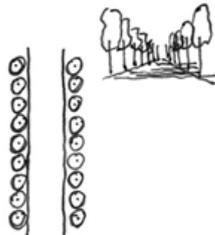
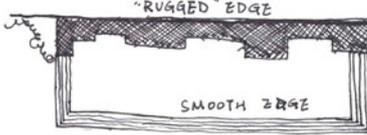
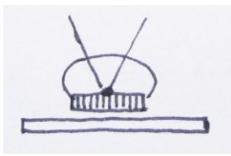
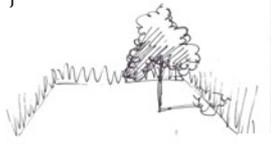
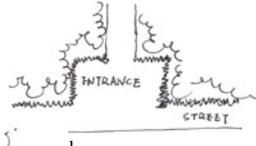
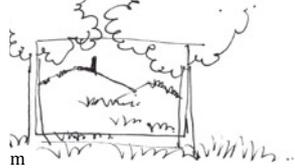
Paths: linear places of movement in the landscape

Edges: means transitional linear places where one space or landscape part becomes another.

Foci: differentiated, contrasting or isolated forms or places in the landscape that possess cultural, social, practical and orientation functions because of their visual distinction.

Thresholds: identified as distinct small spaces or forms in the landscape that have transitional and integrative functions.

Source: Dee 2001, P3

Design Guidelines	
a. Full enclosure on three sides and permeable enclosure with line of trees-allowing views through-walk through	
b. Tall sides of space in proportion to floor width	
c. Enclosure low in proportion to space floor	
d. Different space can be related to each other and form an experience sequence	
e. Paths often designed around edge of open spaces to avoid across the spaces.	
f. Walking distances and pedestrian routes: careful design of pedestrian routes where distant destination is not in view, but where the primary direction toward the destination.	
g. Street plantings form a strong sense of direction	
h. Paths as axis has associations with order, power and control	
i. Edges can be rugged or smooth: rugged edges provide strong interlock between one place and another, and smooth edges can be physical and perceptual barriers.	
j. Edge effect: The edges of the forest, beaches, groups of trees, or clearing were the preferred zones for staying.	
k. In relatively open spaces, single or grouped trees become focal forms as they provide a vertical counterpoint to the relatively horizontal ground plane.	
l. Extension of street to form threshold space, which is the transition between two spaces and attract people.	
m. Vegetation can be arranged to frame views of more distant landscapes	

Source: principles f.g.i from Jan Gehl, 1987; others from Robinson 2004

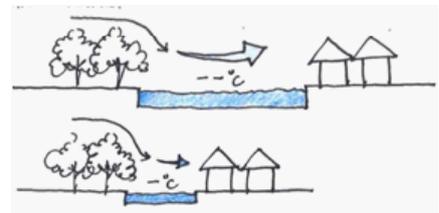
A comfortable atmosphere

As Sanda states in her PhD thesis: Thermal comfort forms an important factor for the usability and attractiveness of outdoor places (Lenzhölzer 2010, P69). A comfortable atmosphere for living environment can increase human activities in the certain spaces and extend the time they play. The prerequisite to create a comfortable microclimate is to learn peoples' need on it. Different outdoor activities will have various requirements. However, "in most of the time, people outdoors require direct sunshine and protection from the wind to be comfortable(Bosselmann and University of California Environmental Simulation Laboratory. 1984)". To create a comfortable atmosphere, three aspects are important. They are urban morphology, green structure and water bodies. Here, for landscape architecture, green structure and water bodies are the most useful tools.

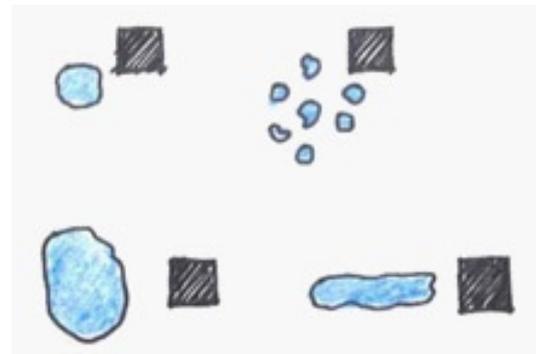
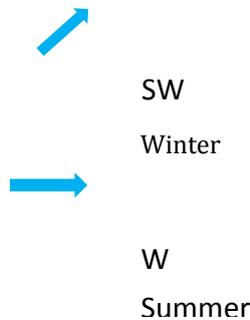
Design with water bodies



Water bodies as cooling elements

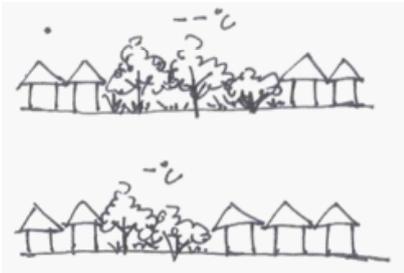


Larger size, more wind and better cooling effects

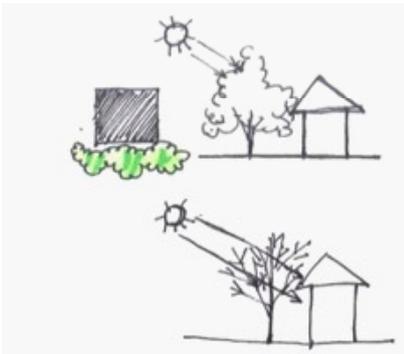


It is better to avoid water on the SW side of the buildings and open spaces, or put small water-surfaces that will not help the wind to gain speed. Hot wind from W in the summer can be cooled down with big water surfaces and get more speed.

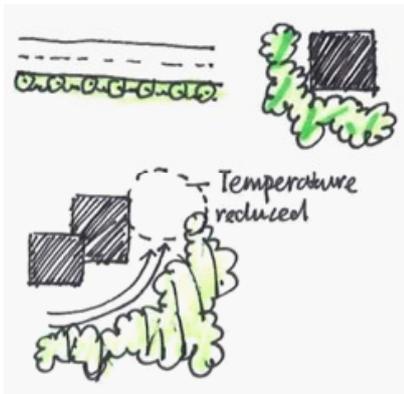
Design with green structures



The larger the individual green areas the greater the range of temperature moderation them.



Plant deciduous trees on the south side of houses, open spaces or pedestrian paths to prevent solar radiation in summer and allow winter sun.



Use vegetation to block the wind and reduce the wind speed in winter
Use buildings and vegetation to direct the wind to required areas

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Chapter 7 Literature study and design principles

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Chapter 8

Strategy development & ecological plan

8.1 Problem statement and design strategy

8.2 Water purification system

8.3 Greenways network

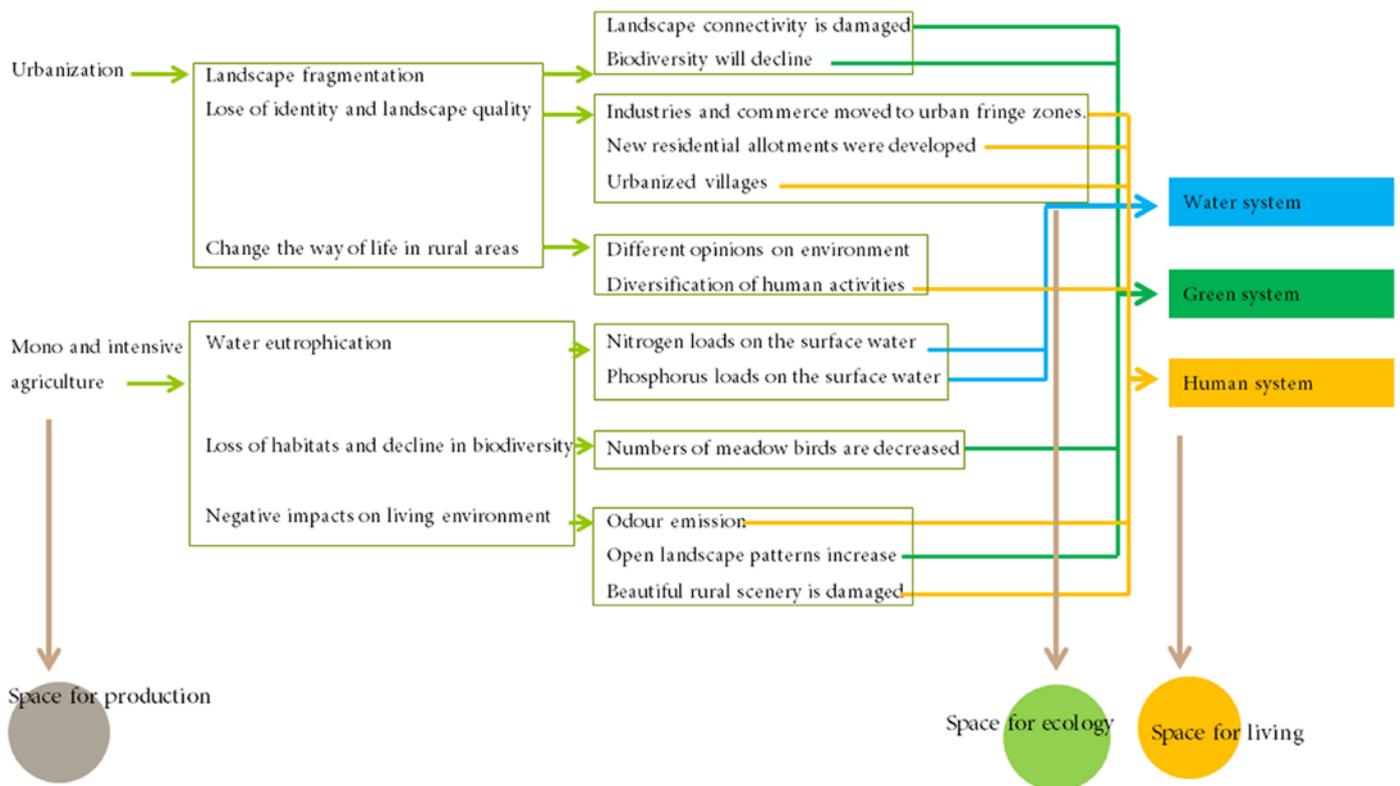


Figure 8.1 Strategy development

8.1 Problem statement and design strategy

To conclude, urbanization and intensive agriculture caused these problems and so many final results. If we classify them, it will form three groups: problems in water system, green system and human system. And combine with major land use in the region, they require space for production, space for ecology, and space for living.

Started from these three aspects, I developed my design strategies and principles. First is developing space for ecology. It explores the possibility to solve ecological problems existed in the region with water purification system and greenways. They aim to improve eco-benefits and biodiversity in the region. Secondly, design for living will take conceives in cultural context and perceive the sensory qualities into account. They will strengthen local identity, develop attractive rural landscape and create better microclimate. For “space for production”, it aims to minimize impacts of ecological and aesthetic plan on production that increase the acceptance of local residents- whose major economical incomes are from agriculture. They work together will get the result of eco-friendly and attractive rural landscape.

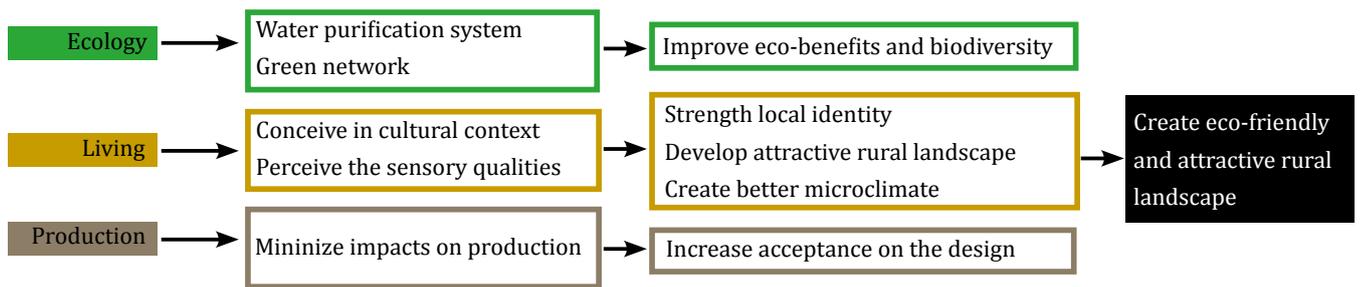
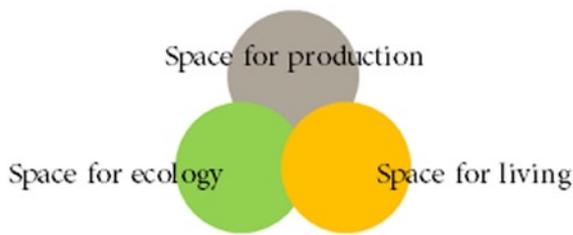


Figure 8.2 Design strategies

Evaluation

Because these strategies will finally determine if my design objective can be reached, they will be developed as my criteria. The degree of my plan and design may reach every items can be used to expect final results of my research.

	Criteria
Ecology	-provide habitats for meadow birds -improve landscape connectivity -purify water from livestock and arable lands
Living	-provide better living environment -increase local identity and feels of belonging -improve amenity of areas
Production	-occupation in numbers of arable lands and livestock lands -least negative effects from ecological strategies

8.2 Water purification system

8.2.1 Locations for constructed wetlands

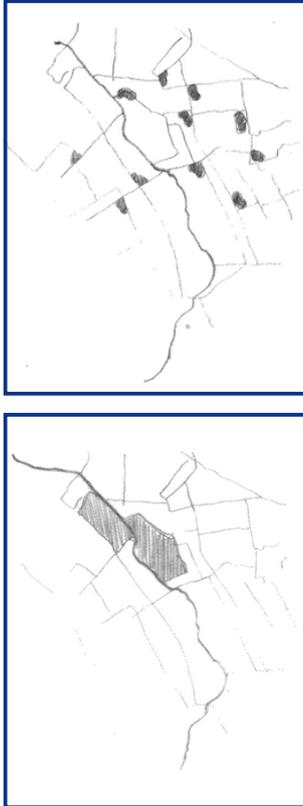


Figure 8.3 Upstream wetlands & downstream wetlands

Based on my research on the wetlands construction, there are two kinds of location for them: upstream wetlands and downstream wetlands. For upstream wetlands, they can control pollution from sources and decrease runoff pollution might occur in the whole watershed. In addition, they can be used as leisure spaces for local residents. The following table is evaluation of upstream and downstream wetlands based on criteria developed before. It is clear that upstream wetlands can produce larger ecological benefits and will be selected here.

Location	Ecology	Living	Production	Others
Upstream	<ul style="list-style-type: none"> -It will control pollution from sources - It can decrease runoff pollution and erosion might occur in the whole watershed 	<ul style="list-style-type: none"> -It can be used as dispersed recreational spaces on sites 	<ul style="list-style-type: none"> -Several small lands need to be occupied from different landowners 	<ul style="list-style-type: none"> - Low cost for individual wetlands - Individual wetlands would be much smaller and possibly easier to establish
Downstream	<ul style="list-style-type: none"> -It will control runoff pollution when it flows away the catchment -Polluted runoff will flow through the whole region 	<ul style="list-style-type: none"> -It will provide large recreational space in the whole region 	<ul style="list-style-type: none"> -It will occupy a large area from few landowners 	<ul style="list-style-type: none"> -High cost for individual wetlands - Only one wetland need be established

Table 8.1 Evaluation for upstream and downstream wetlands

If we locate wetlands in the stream lands, there are large numbers of non-point pollution formed in the term of runoff in the pasture and arable lands in the region. There are two major methods can be used to solve it: nutrient/sediment control system and buffer zones.

Types	Ecology	Living	Production	Others
Nutrient/sediment control system	<ul style="list-style-type: none"> -Treatment efficiencies are good and measurable 	<ul style="list-style-type: none"> -Less ancillary benefits 	<ul style="list-style-type: none"> -Use several regular areas in pastures 	<ul style="list-style-type: none"> -Involve fewer lands and landowners
Buffer zones	<ul style="list-style-type: none"> -Enhance landscape connectivity -Protect aquatic ecosystem -Treatment efficiencies are good but not easy to measure 	<ul style="list-style-type: none"> - Ancillary benefits as recreational space. 	<ul style="list-style-type: none"> -Occupy linear space along waterways 	<ul style="list-style-type: none"> -More landowners are involved

Table 8.2 Evaluation for nutrient/sediment control system and buffer zones

According to the above evaluation, we can see that both of them can treat wastewater efficiencies but buffer zones have additional benefits in the terms of enhancing landscape connectivity and protecting aquatic ecosystem. At the same time, they may be used for recreational activities as well. Both of them have some impacts on production. Therefore, buffer zones will be used to treat dispersed pollution in the region.

8.2.2 Purification system

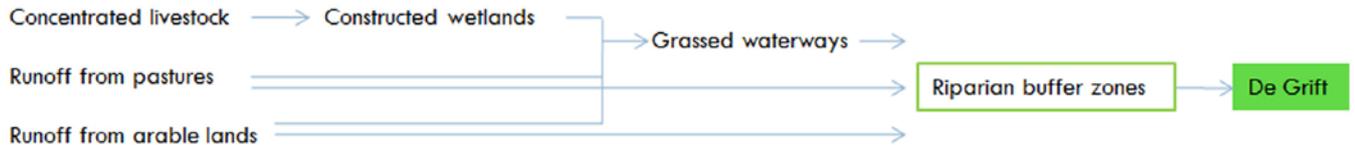


Figure 8.4 Procedure of water purification

To conclude, water purification system will be constructed in two orders. First, constructed wetlands at the source designed and operated specifically for treating wastewater emanating from concentrated livestock. Secondly buffer zones provide treatment from a variety sources. They are represented by buffer strips of riparian wetlands along permanent streams. It provides treatment with less concentrated, aggregate wastewater from a variety sources, and also produce ancillary benefits.

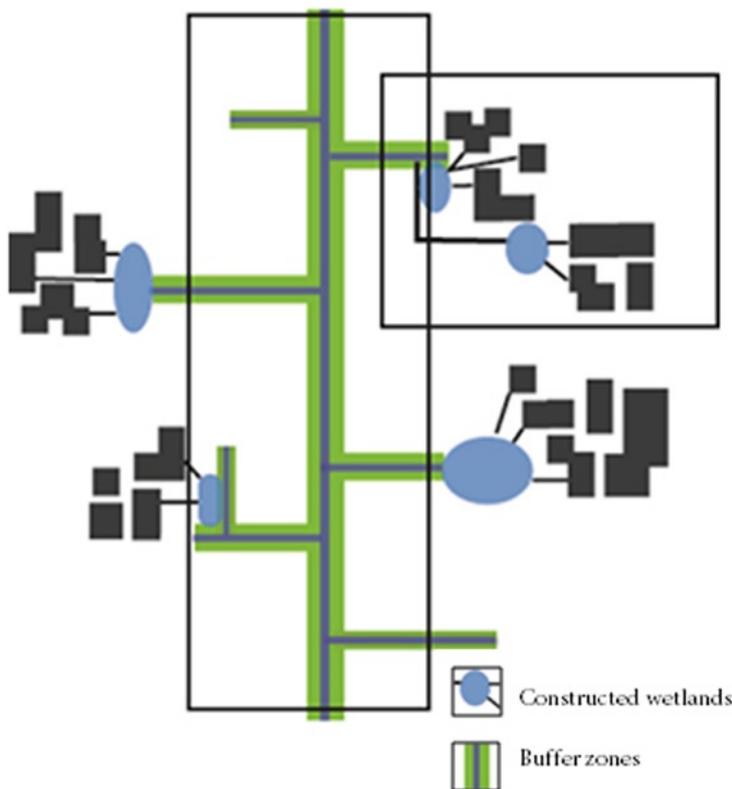


Figure 8.5 Model of water purification system

8.2.3 Suitability analysis for constructed wetlands

Suitable locations are analysed through division of upstream and downstream lands, current land use, water flow according to topography and water pollution.

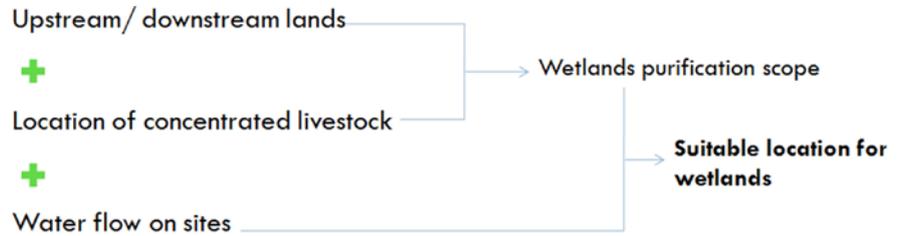
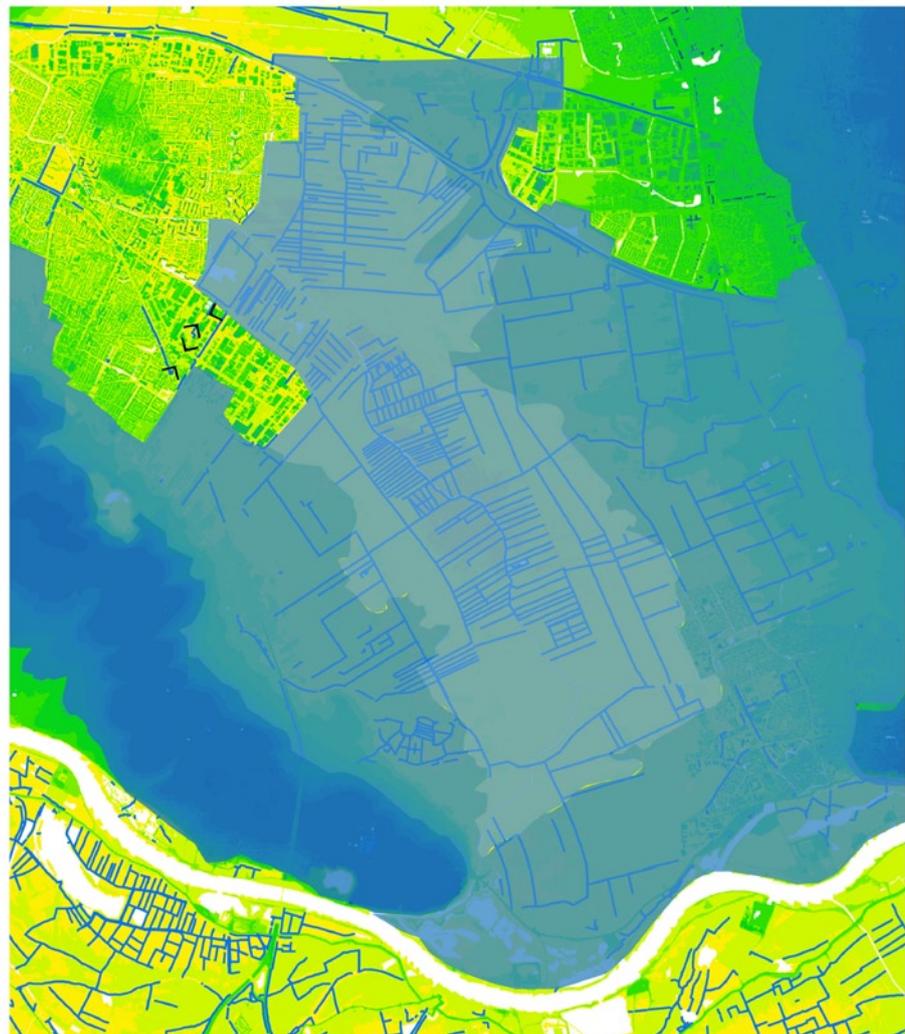


Figure 8.6 Procedure of suitability analysis

Step 1: Division of upstream and downstream lands

Due to different locations for constructed wetlands and buffer zones, first step of suitability analysis is dividing upstream and downstream lands in the region. This division is based on the surface water flow and groundwater flow in the region.

Figure 8.7 Division of upstream and downstream lands



Step2: Location of concentrated livestock

As I explained constructed wetlands will be built at the source and operate specifically for treating wastewater emanating from concentrated livestock. Hence, identifying locations of concentrated livestock is significant. It can be analyzed on the basis of current land use map. As what we can see from figure 8.8, green ones show the location of concentrated livestock and they are major located in the upstream lands.

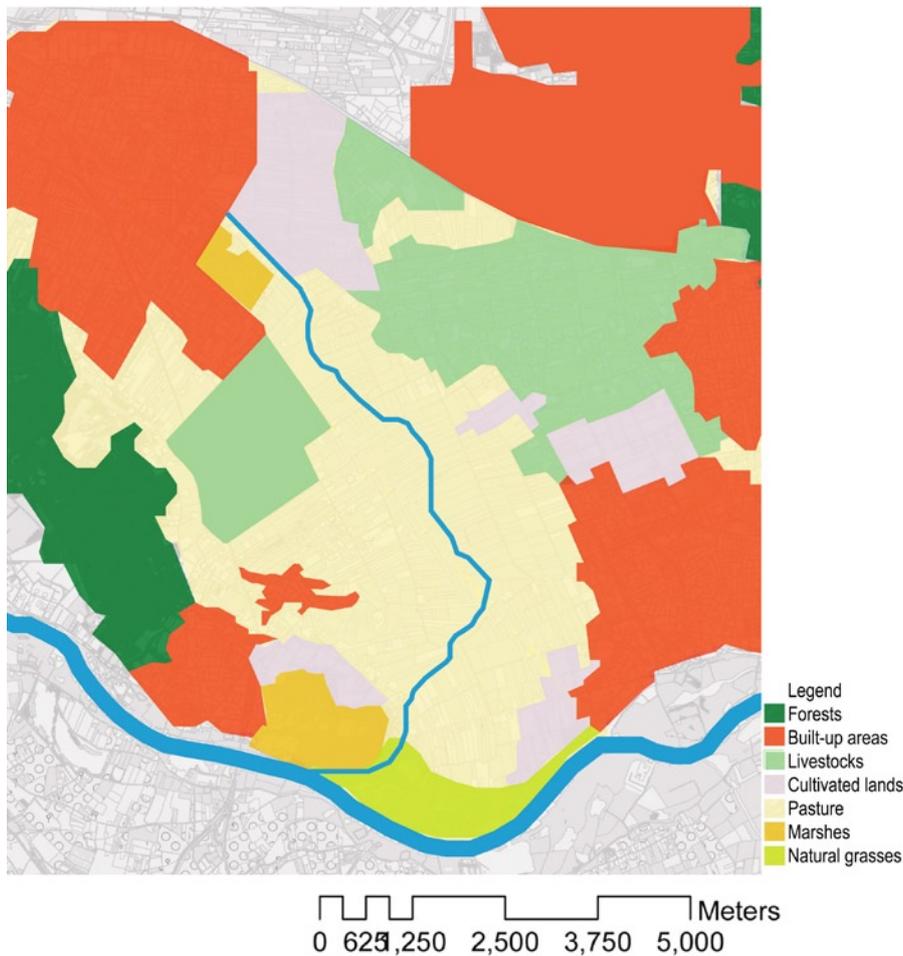


Figure 8.8 Land use map

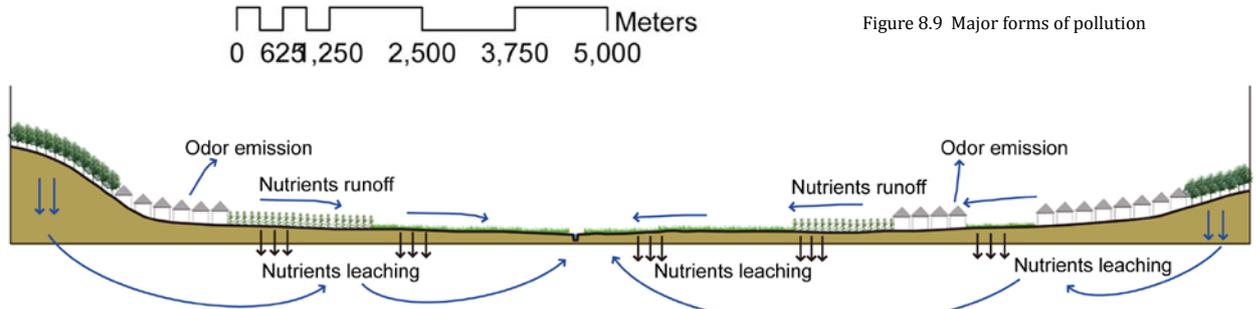


Figure 8.9 Major forms of pollution

Geomorphology	Hills Moderately slope Saturated zone with fresh water	Upstream lands Gently slope, light seepage	Downstream lands The lowest zone, strong seepage	Upstream lands Gently slope, light seepage	Hills Moderately slope Saturated zone with fresh water
Land use	Forests	Villages, roads Concentrated livestock Crop fields	Grazing lands	Villages, roads Concentrated livestock Crop fields	Forests
Pollutants		Animals feed, fertilizer Manure	Manures	Animals feed, fertilizer Manure	
Nutrients		Nitrogen, Phosphorus Ammonia	Nitrogen, Phosphorus	Nitrogen, Phosphorus Ammonia	

Step 3: Water flow on sites

Areas in the lower sites, which can provide gravity flow of wastewater to the system, are preferred. The flow is not only for flow from farmsteads to the system, but also between system components. It can reduce costs and maintenance of pumping wastewaters.

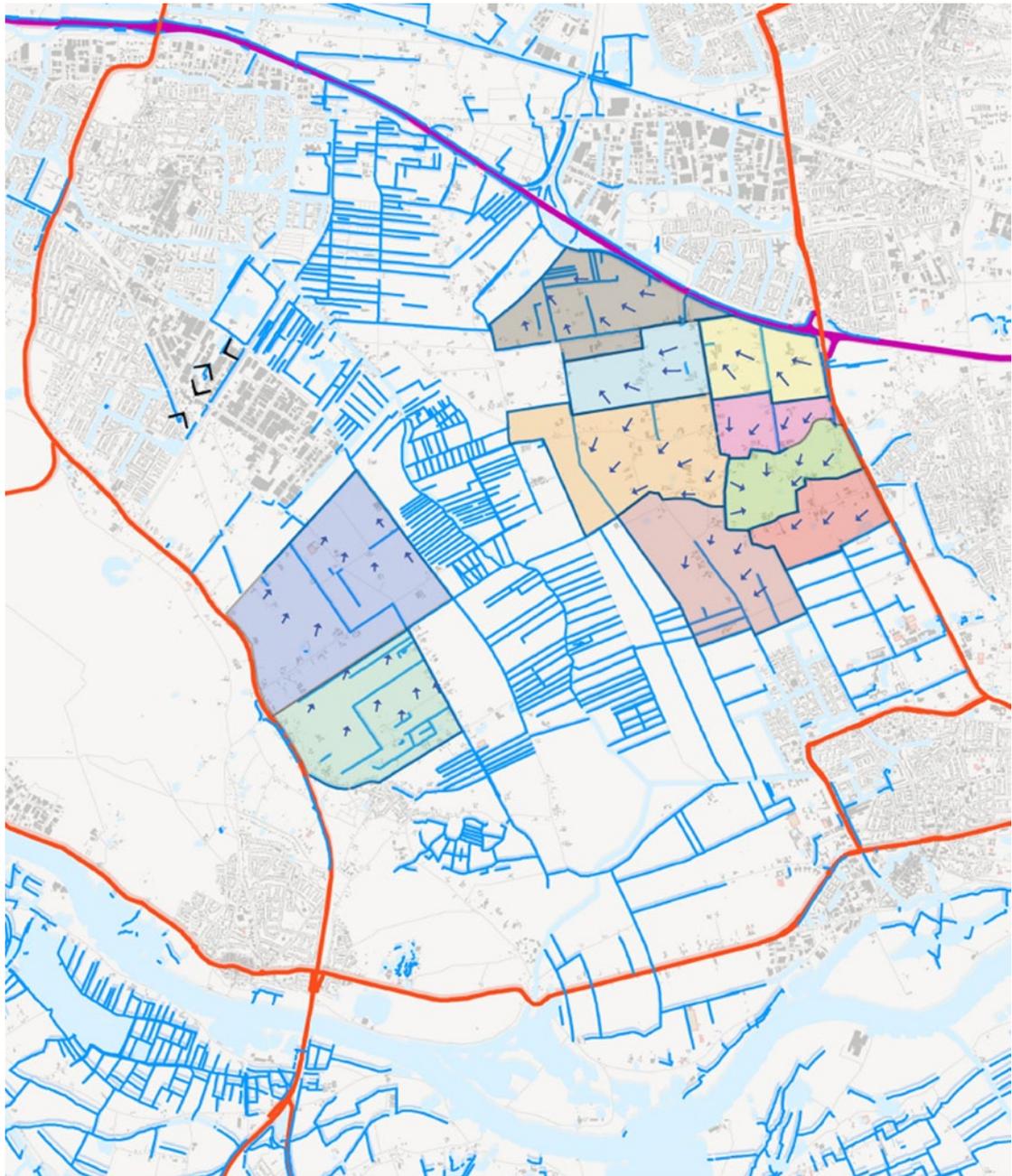
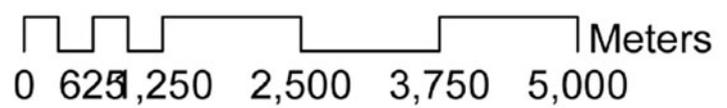


Figure 8.10 Water flows



Step 4: Suitable locations for constructed wetlands

After suitability analysis on the previous three steps, we can confirm the suitable locations for constructed wetlands to purify wastewater. As we can see from the following figure, the dark blue ones are locations for them.

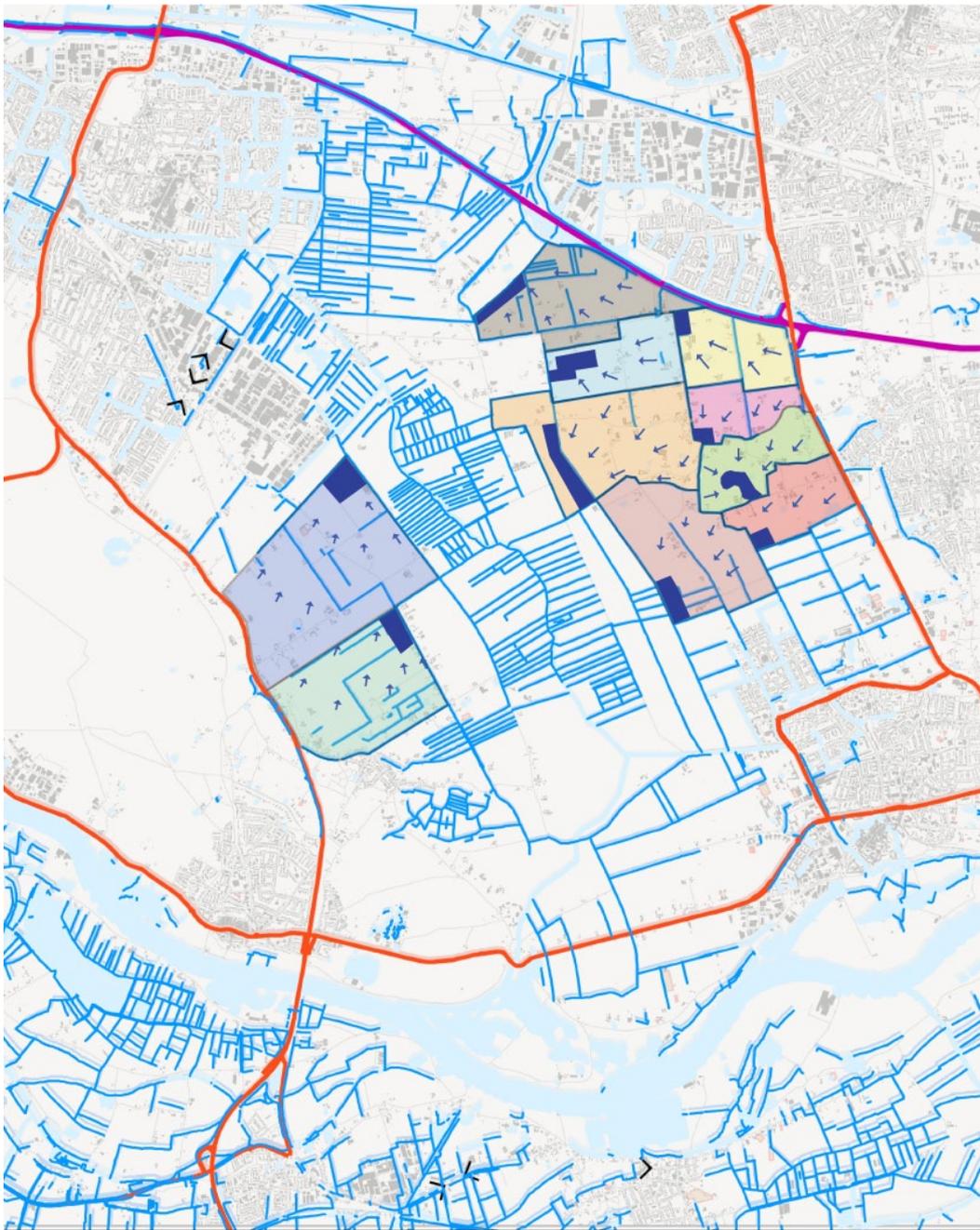
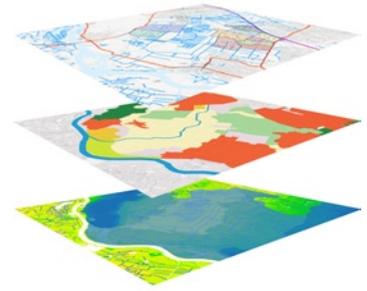
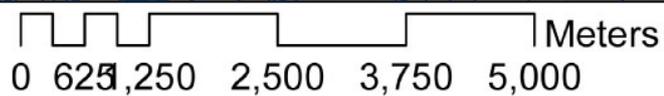


Figure 8.11 Suitable locations for wetlands



8.2.4 Suitability analysis for buffer zones

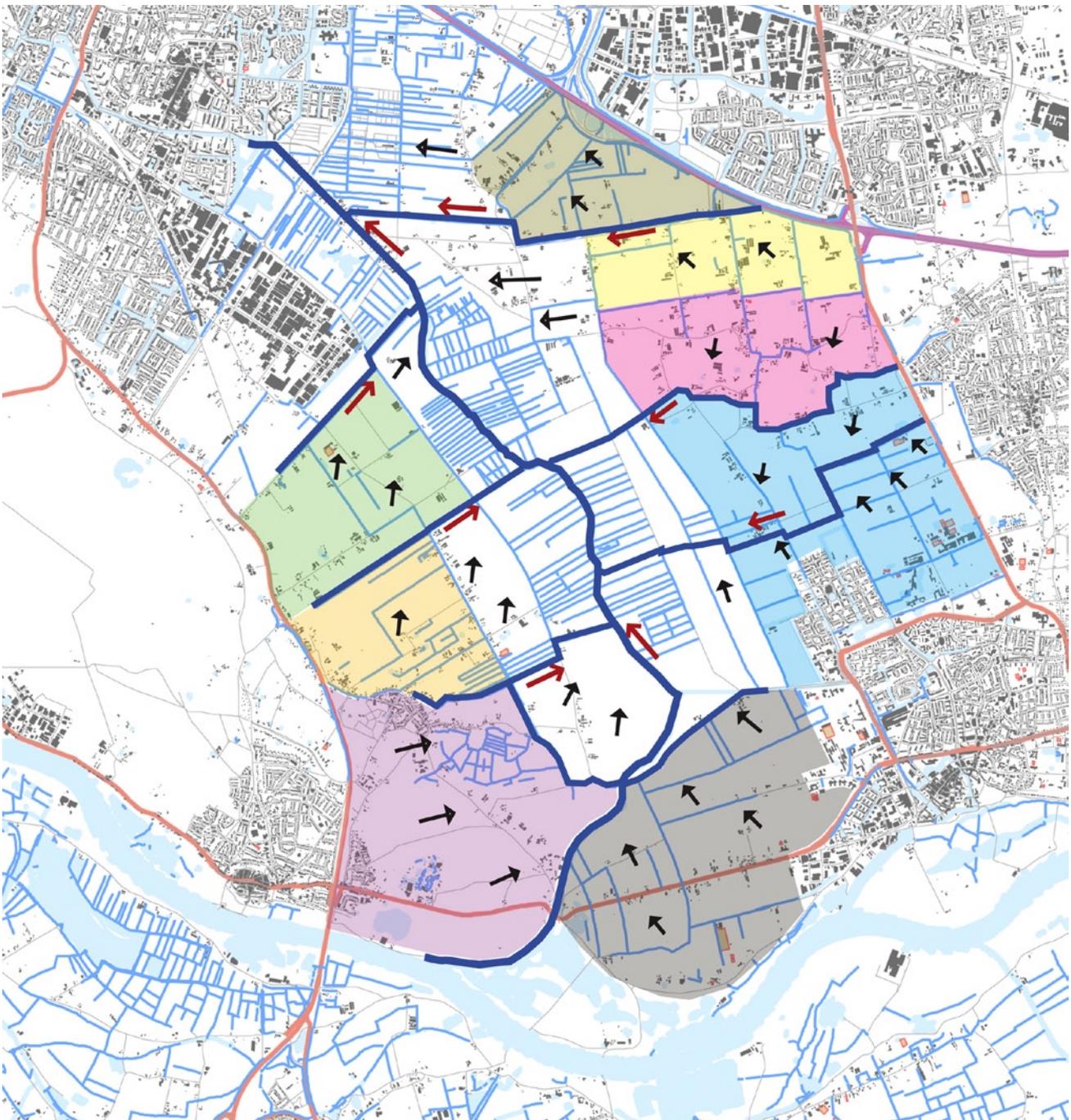
To analysis suitable locations of buffer zones, we need to learn about water flow from upstream to downstream areas at first.

Step1: Water flow

Water flow from upstream lands to downstream ones are major through ditches in the region, and some of ditches are main transportation pathways here. I divided the upstream areas into several sub-watershed according to suitability analysis for constructed wetlands. It is clear that dark blue ones are mainly used for “water traffic” between two zones and should be grassed to decrease pollution.



Figure 8.12 Water flow from upstream to downstream lands



Step2: Types of pollution

As we learned from the previous chapter, structure of buffer zones will be changed for different types of pollutants. Here, I combine my analysis for nitrogen and phosphorus loads in the surface water in the problem analysis part, and produce the map to illustrate major pollutants types along the stream.

Grassed buffer zones :
removal of phosphorus in shallow groundwater.

Forested riparian buffer zones:
deal with shallow concentrations of nitrates and dissolved pollutants

A reasonable structure of riparian buffer zone which will integrate forested and grassed ones will produce a more acceptable result in areas suffering from nitrogen and phosphorus pollution.

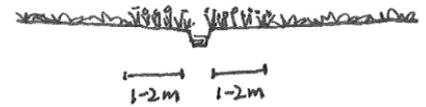


Figure 8.14 Grassed waterways

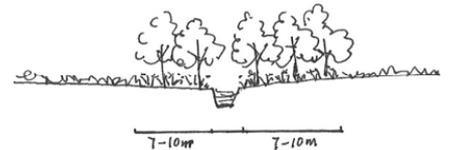
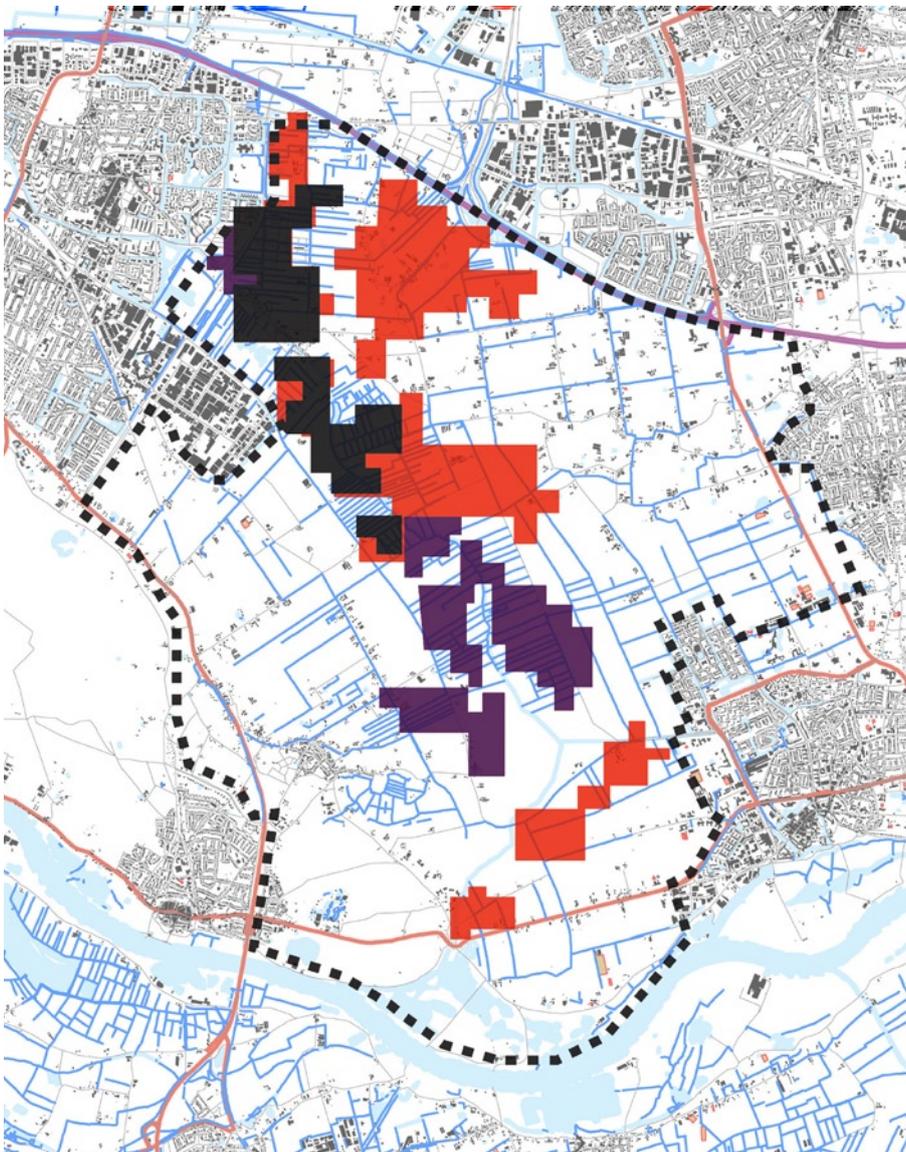


Figure 8.15 Forested riparian buffer zones



Based on the problem analysis in the chapter 6, I did research on the distribution of different pollution types. Black ones mean seriously pollution of nitrogen and phosphorus. Orange ones is the location of nitrogen pollution. The most serious areas for phosphorus pollution are marked by the purple ones.

Figure 8.13 Pollution distribution

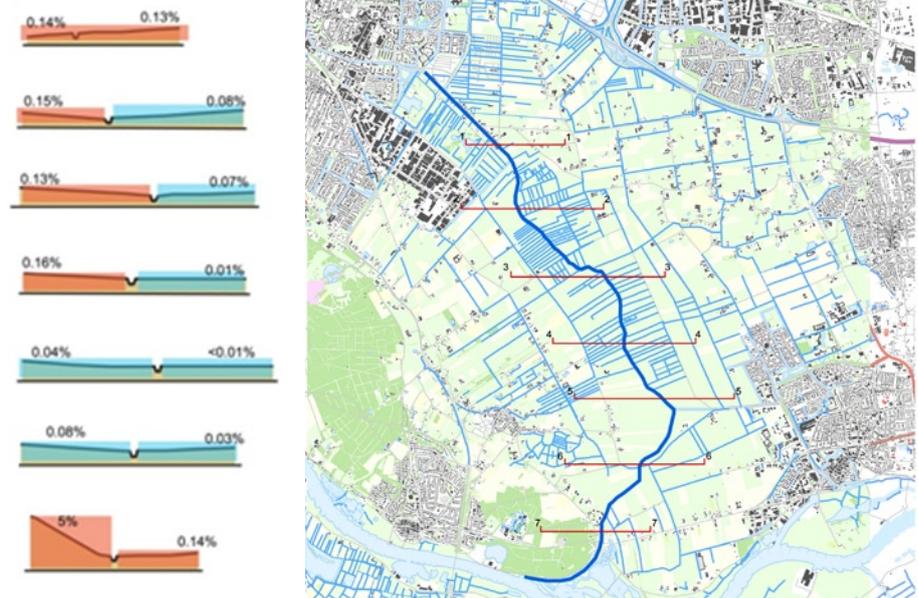


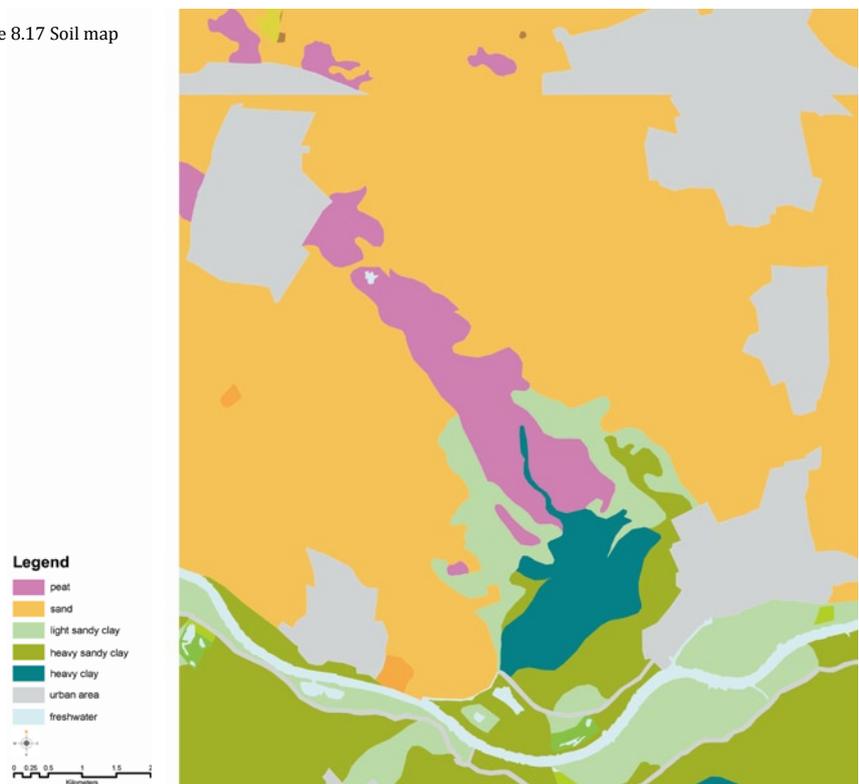
Figure 8.16 Upland slope along the stream

Step3: Slope and soil analysis

Finally, slope and soil conditions in the region should be taken into account. In theory, slopes < 5% can enhance pollutant removal effectiveness of buffers. Otherwise, wider buffers are required.

In the lower parts, soils, with low permeability, occupy the largest percentage. They are difficult to infiltrate water in the forms of surface runoff so that wider buffer strips will be required.

Figure 8.17 Soil map



Step 4: Suitable locations for buffer zones

Based on the suitability analysis, I get the following illustration which shows suitable locations for buffer zones. From this illustration, light green ones are possible locations for grassed waterways which will decrease water flow velocity and increase infiltration of pollutants by vegetation. On the basis of different sub-watershed, their locations are confirmed. Then, dark green strip is the riparian buffer strip which can protect aquatic ecosystem, form green corridor and treat wastewater from dispersed and variety sources.

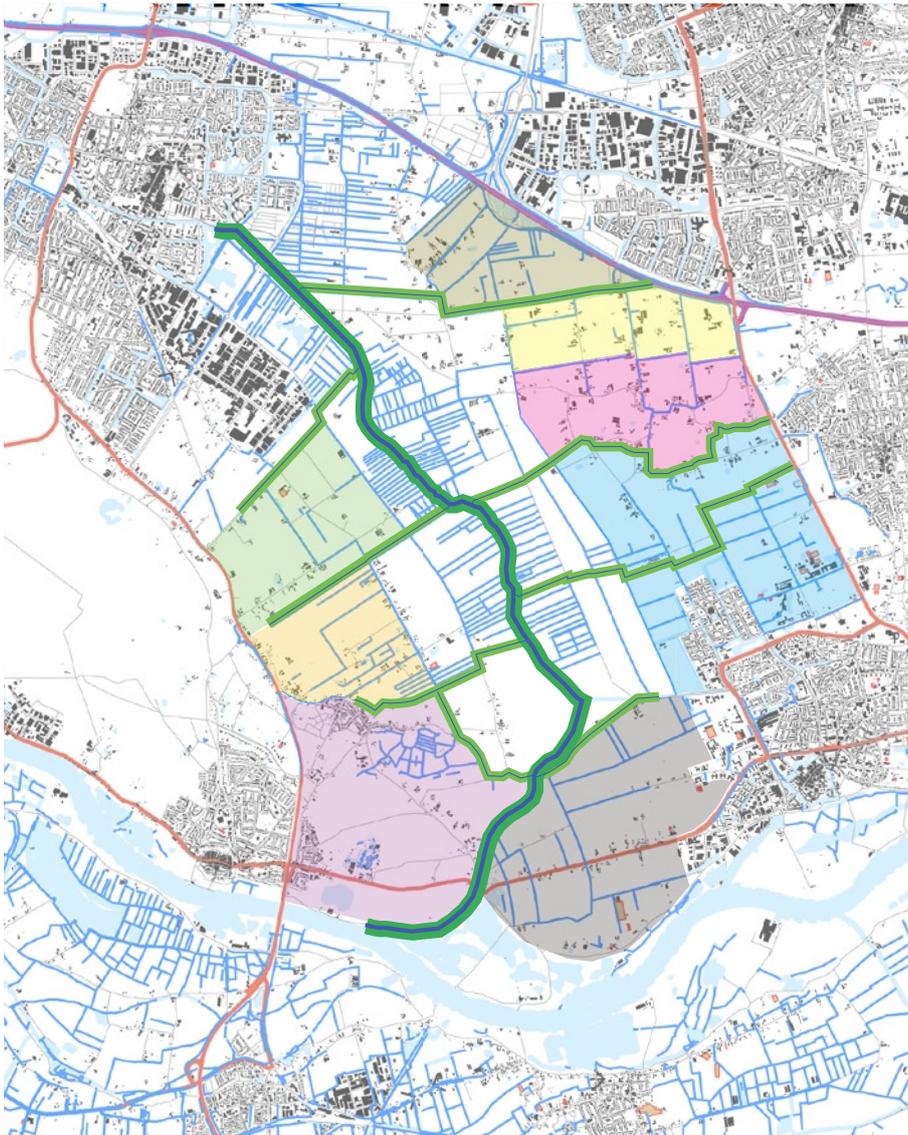
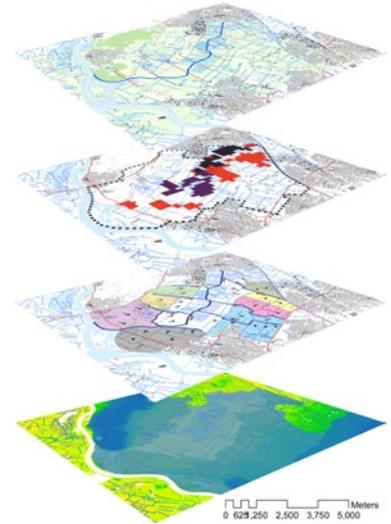
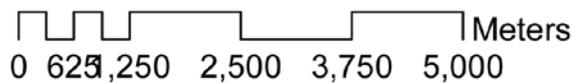


Figure 8.18 Locations of buffer zones



8.2.5 Ecological plan for water purification system

On the basis of suitability analysis for constructed wetlands and buffer zones, water purification system will be consisted by:

Constructed wetlands: constructed close to pollution sources, deal with concentrated pollutants from livestock.

Grassed waterways: main ditches and waterways will be grassed to slow water velocity, remove sediments and nutrients of runoff from grazing lands and arable lands in the upstream lands.

Riparian buffer zones: be developed along the stream and aim to purify runoff from both upstream and downstream lands. Plants can uptake nutrients from groundwater as well.

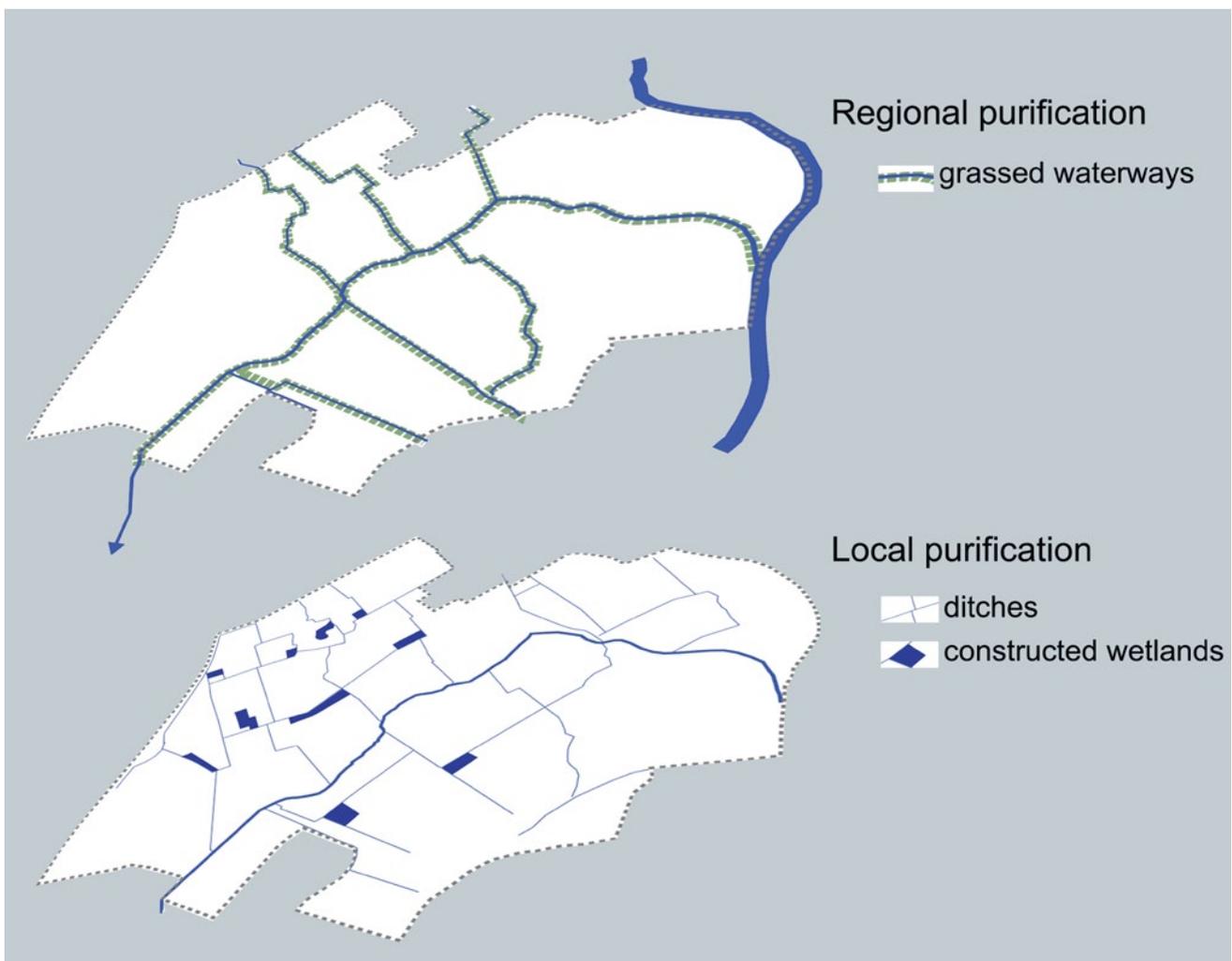


Figure 8.19 Water purification system

8.3 Greenways network

In strategic framework to design greenways, five steps are proposed. They are:

- a. Identifying potential issues, stakeholders, and preliminary goals.
- b. Defining a broad region to study.
- c. Selecting nodes and swaths.
- d. Selecting alternative alignments and setting widths.
- e. Implementing and managing

In the parts for landscape analysis and problem statement of my studying area, the first two steps have been identified. Greenways will be used as solution for biodiversity decline. Local climatic, physiographic, biological, economic, social, and cultural characteristics have been analysed. Areas have been conserved and planned to be conserved have been identified. The key uses would be habitats for meadow birds. On the basis of these analysis and design requirements for step c and d, design process will be developed in five steps.

8.3.1 Strategic framework for greenways development

Step1: What are key and indicating species in the field?

Greenways are major planned to protect meadow birds. Here, two species of meadow birds are used as indicating species.

- *Lapwing.*

The lapwing is the most numerous waders, but both nationally and regionally declining species. It is scattered throughout the Binnenveld and especially in the maize land. There are other meadow birds in the Binnenveld require similar living conditions as lapwing so measures of the lapwing also benefit them.

- *Godwit*

Godwit as major critical kind occurs mostly in the north and within the central part of the field (Meent Bennekom, Bennekom Meadows, De hooilanden). Suitable habitats for them include both nature and surrounding agricultural land. Godwit is included into the Dutch red list of threatened bird species. Of the godwit measures also benefit the rare species of critical such as redshank and curlew.

Step 2: What do habitat requirements of these species?

In recent decades, almost all meadow bird species in the Netherlands are declining and some are placed in the Dutch red list of threatened bird species. (van Beusekom et al. 2005 in Van der Vliet, Van Dijk et al. 2010). There are several factors lead to this result and they include collecting eggs, hunting and alterations of habitat (van der Vliet, van Dijk et al. 2010). However, intensification of agriculture in the rural areas has been considered as the most important cause, which impacts on the “reproductive success” in the terms of more farming activities, increasing numbers of livestock and lowering

groundwater tables. In addition, “opportunities for safe breeding by meadow birds are hampered by an increase of elements that obstruct visibility in the otherwise open habitat (van der Vliet 2008)”.

Lapwing and godwit prefer open landscape as habitats, especially in breeding period. It is because open landscape has less view obstructions. For vegetation structure, lapwing likes to live in grassland, marshes, shrubs and godwit prefer grassland, marshes, shrubs and maize lands. Both of them require a high groundwater level which is lowest groundwater level 80cm below ground. It will have rich soil fauna and provide sufficient food. And also a high groundwater level can delay agricultural activities.

Landscape elements which will affect breeding distribution of meadow birds are disturbances. "The distance where the population density is depressed due to the presence of a disturbing source is called the disturbance distance (van der Vliet, van Dijk et al. 2010)". There are two types of disturbances:

-View-obstructing elements: elements that hamper visibility

-Flat elements: cause disturbance by the presence of potential predators without impairing visibility.

The following table illustrates maximum disturbance distance (m) from landscape elements for two species of meadow birds in the Netherlands during the breeding season.

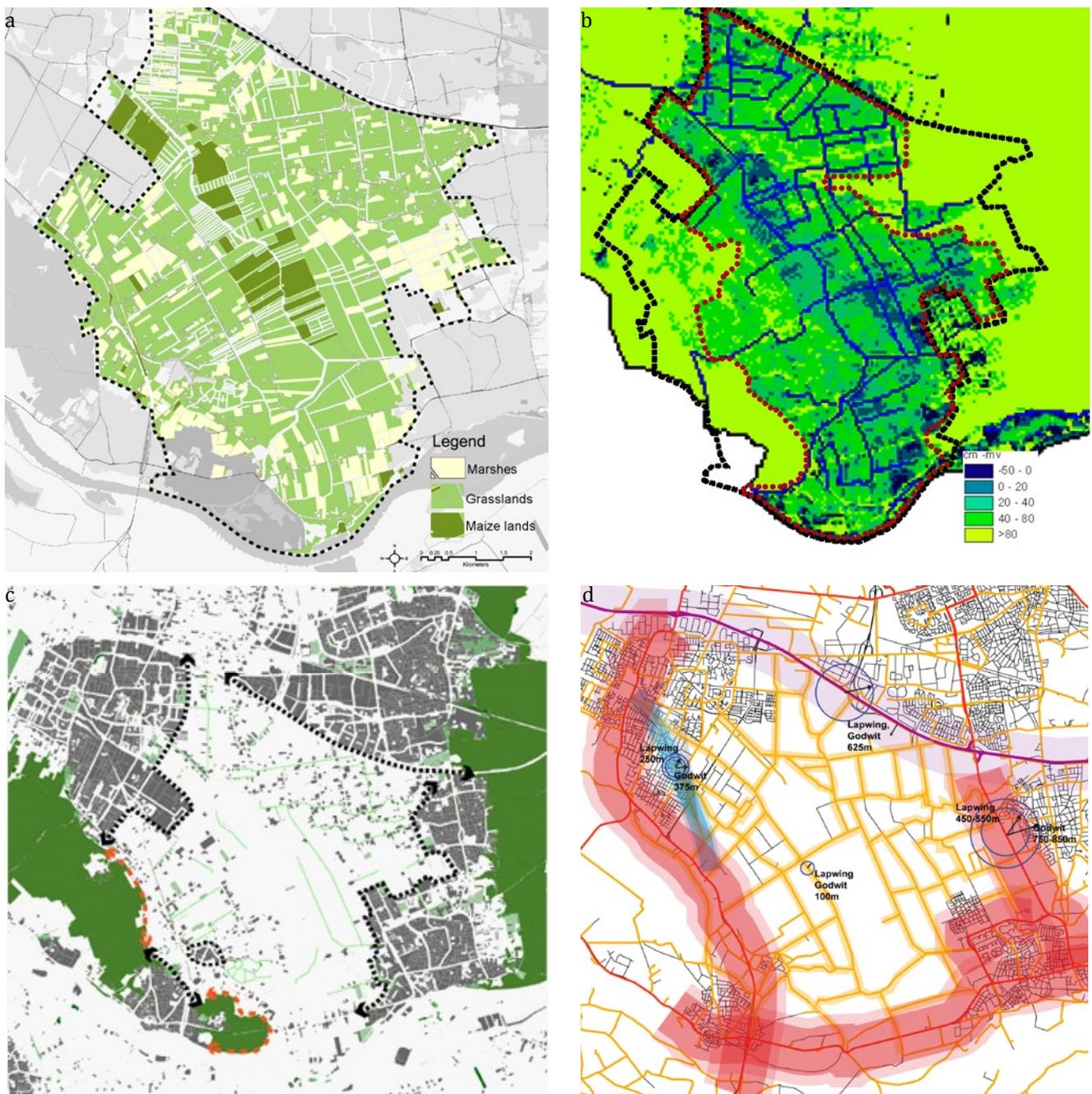
Landscape element	Distances for species	
	Lapwing	Godwit
View-obstructing elements:		
Forest edge	100	100
Group of trees	250-350	250-350
Tree line, hedge	50	50
Edge village/city	>500	>500
Single Farm house	250-350	350-450
Flat elements		
Railways	250	375
Highways	625	625
Main roads	450-550	750-850
Minor roads	100	100

Table 8.3 Maximum disturbance distances for lapwing and godwit

Step3: What are habitats characteristics of the region?

Based on habitats requirement of meadow birds, I did analysis on my studying area to find out suitable habitats for lapwing and godwit. From figure 8.20a, we can see that most of the region is occupied by marshes, grasslands and maize lands. And for lapwing and godwit, lowest groundwater level 80cm below ground is non-constraining. Deeper drainage is considered as constraining. Hence, central part surrounded by red lines in figure 8.20b will be suitable. Considering about view-obstructing elements, they are major in the terms of forest edges, city and village edges and single farm house. Most of them are distributed in the higher parts of the region. Disturbances from flat elements are showed in the figure 8.20d. They are major surrounding four cities. And also some disturbances from minor roads.

Figure 8.20 Habitats characteristics analysis: vegetation pattern; groundwater; view-obstructing elements and flat elements



Step4: Where are suitable habitats for these species?

In step 2 and step 3, we have learned about requirements of lapwing and godwit, and also have done analysis in the Binnenveld according to these requirements. In this step, based on the former analysis, I identify suitable habitats for lapwing and godwit. Figure 8.21 shows places where suitable for meadow birds in breeding period in Binnenveld. It is the central part of the valley, where is major occupied by grassland and maize lands, has fewer disturbances from human activities and transportation network, and relatively high groundwater level from 0-40 cm.



Figure 8.21 Suitable habitats

However, disturbances still exist in the edges of this area due to highly density agriculture and fast urbanization. Negative impacts from them should be decreased by better vegetation structure in the region.

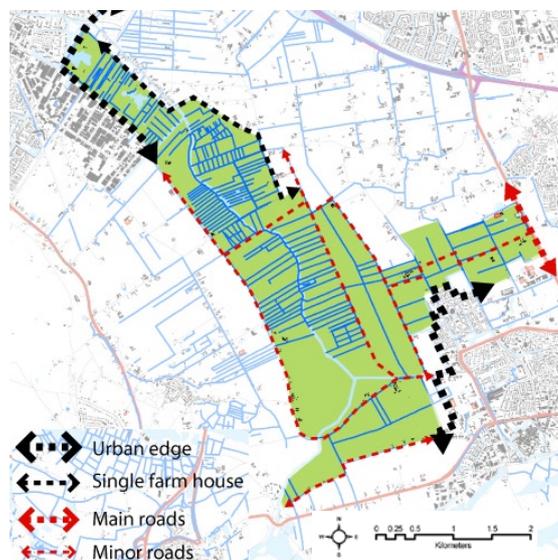


Figure 8.22 Disturbances surrounding the habitats

Step5: How to conserve and develop these habitats?

To conserve habitats for meadow birds, there are two important aspects. First, how suitable habitats be conserved. Second, how to connect them into the regional green structure. In figure 8.23, potentials for connections in the regional scale are illustrated. It uses the existing fragmented green structures in the region and forms corridors from conserved habitats to forests in western and eastern sides.

Then, on account of how to conserve suitable habitats and develop potential green corridors, three alternatives are proposed.

(1) The whole suitable habitats will be conserved, and green corridors are developed to connect them to hilly landscape. At the same time, negative impacts of habitats edges will be diminished by planting trees. It will produce high ecological benefits, but conserved areas will not be available for human use any more and it will occupy large size of pastures and arable lands.

(2) In second alternative, several valuable parts are identified from the suitable habitats. They are not only suitable for breeding of meadow birds, but also have rich vegetation resources. The values of them will be explained later. This alternative aims to decrease occupation of agricultural lands. It can form some habitats for meadow birds and conserve several valuable resources, but they are in fragmentation.

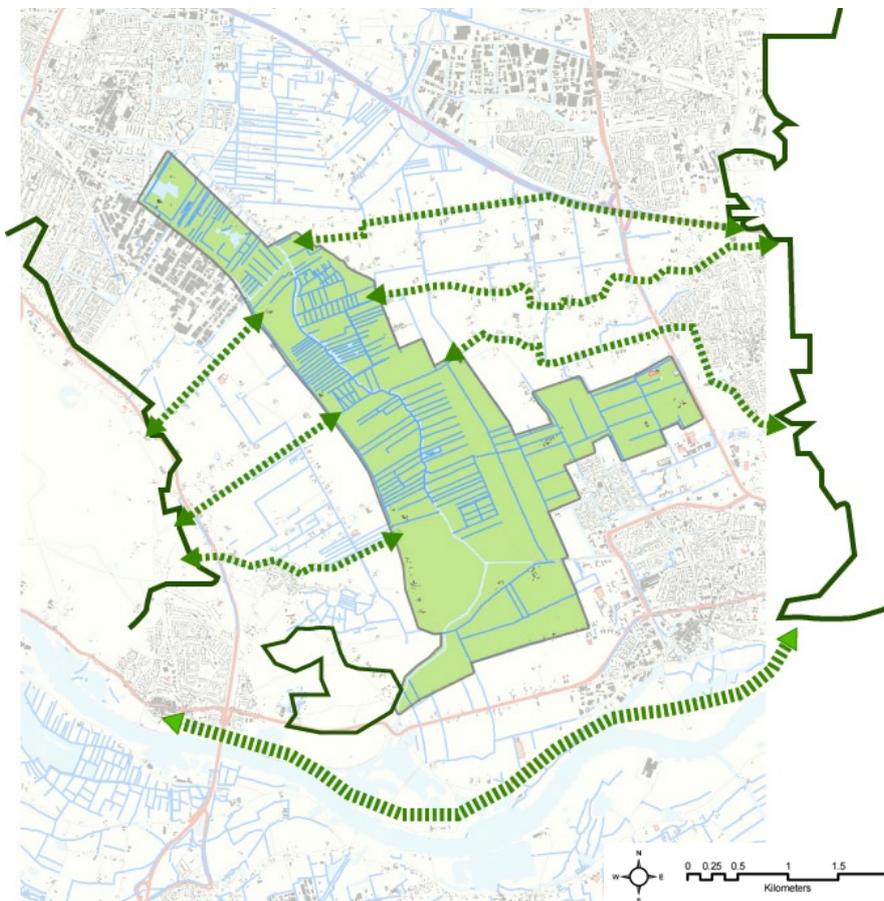


Figure 8.23 Strategy to connect the habitats to the surrounding environment

	Effects	Range
Ecology	-Provide most habitats -Build best landscape connectivity -Diminish negative influences from disturbances	High
Living	-Limitation of human use in conserved areas	Low
Production	-Occupy a large number of grazing and arable lands	Low

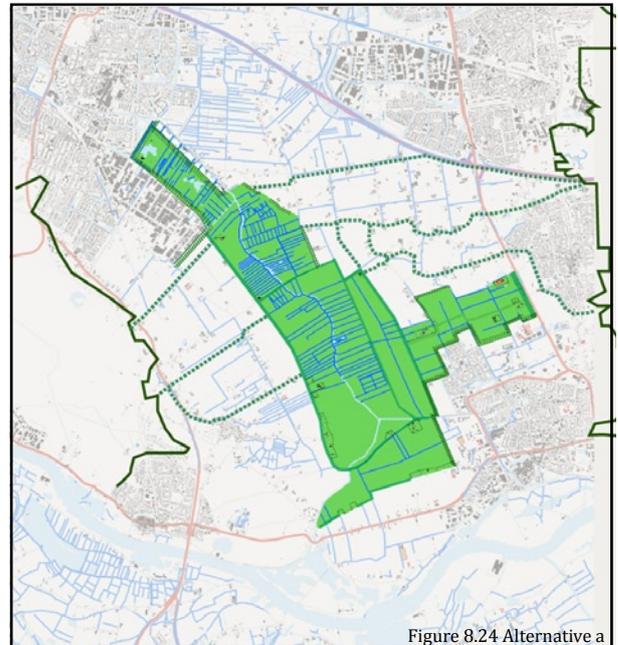


Figure 8.24 Alternative a

	Effects	Range
Ecology	-Conserve most valuable areas -Develop green corridors -Diminish negative influents from disturbances	Low
Living	-Limitation of human use in conserved areas	Medium
Production	-Occupy several grazing and arable lands	Medium

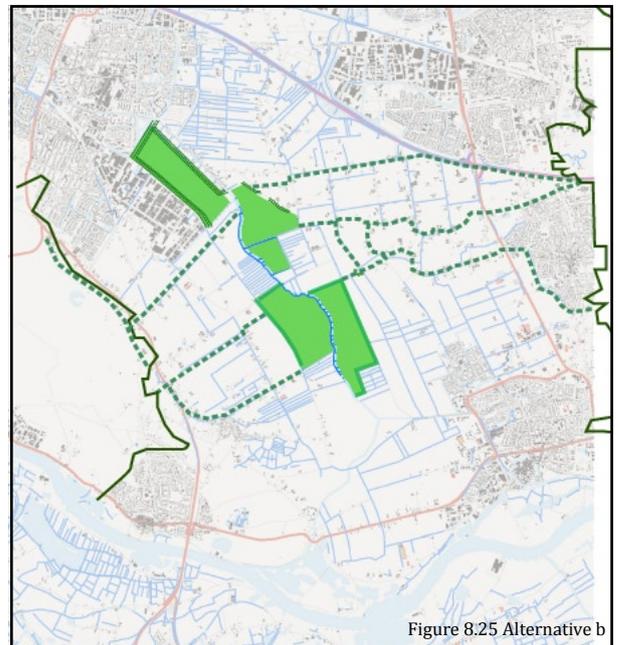


Figure 8.25 Alternative b

	Effects	Range
Ecology	-Conserve most valuable areas -Connect conserved areas -Develop green corridors -Diminish negative influents from disturbances	Medium
Living	-Limitation of human use in conserved areas	Medium
Production	-Occupy several grazing and arable lands	Medium

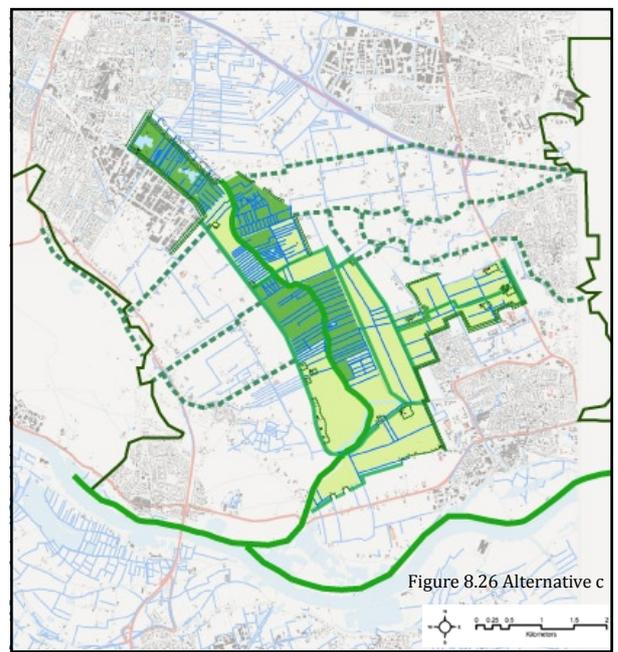


Figure 8.26 Alternative c

(3) Finally, to decrease occupation of agricultural lands in alternative one and increase ecological benefits in alternative two, alternative three is proposed. In this alternative, habitats proposed to be conserved in two terms. Dark green ones, where are most vulnerable areas, will stop agricultural activities completely and be used for meadow birds' habitats. Light green ones will be conserved in the period for birds' breeding (from May to July usually). Then, to connect them together, a riparian green corridor is designed. In additional, green corridors which will connect conserved habitats to forests in the hills are designed.

8.3.2 Ecological plan for greenways

In summary, ecological plan for greenways include four major parts:

(1) Conserved areas: which are suitable for breeding of lapwing and godwit. In addition, there are valuable plant species should be conserved. Take The Benne Meent Kommer for example, it is home for blue grass. Blue grass used to be a vegetation type used to be rich in Gelderland Valley. However they are replacing by rush and encroaching vegetation gradually. Hence, these areas urgently require conservation. The list for valuable plant species will be attached in the appendix.

(2) Periodly conserved areas: where are suitable for breeding of meadow birds. To decrease the impacts and occupation on agriculture, they will be conserved in the breeding periods.

(3) Buffers. These buffers aim to diminish negative influences from disturbances (i.e. roads system, single farming house and villages) to conserved habitats. They are native species planted in the edges of conserved parts .

(4) Corridors. Corridors are formed to connect between conserved areas and periodically conserved areas. At the same time, they will connect all the conserved parts to surrounding forests,

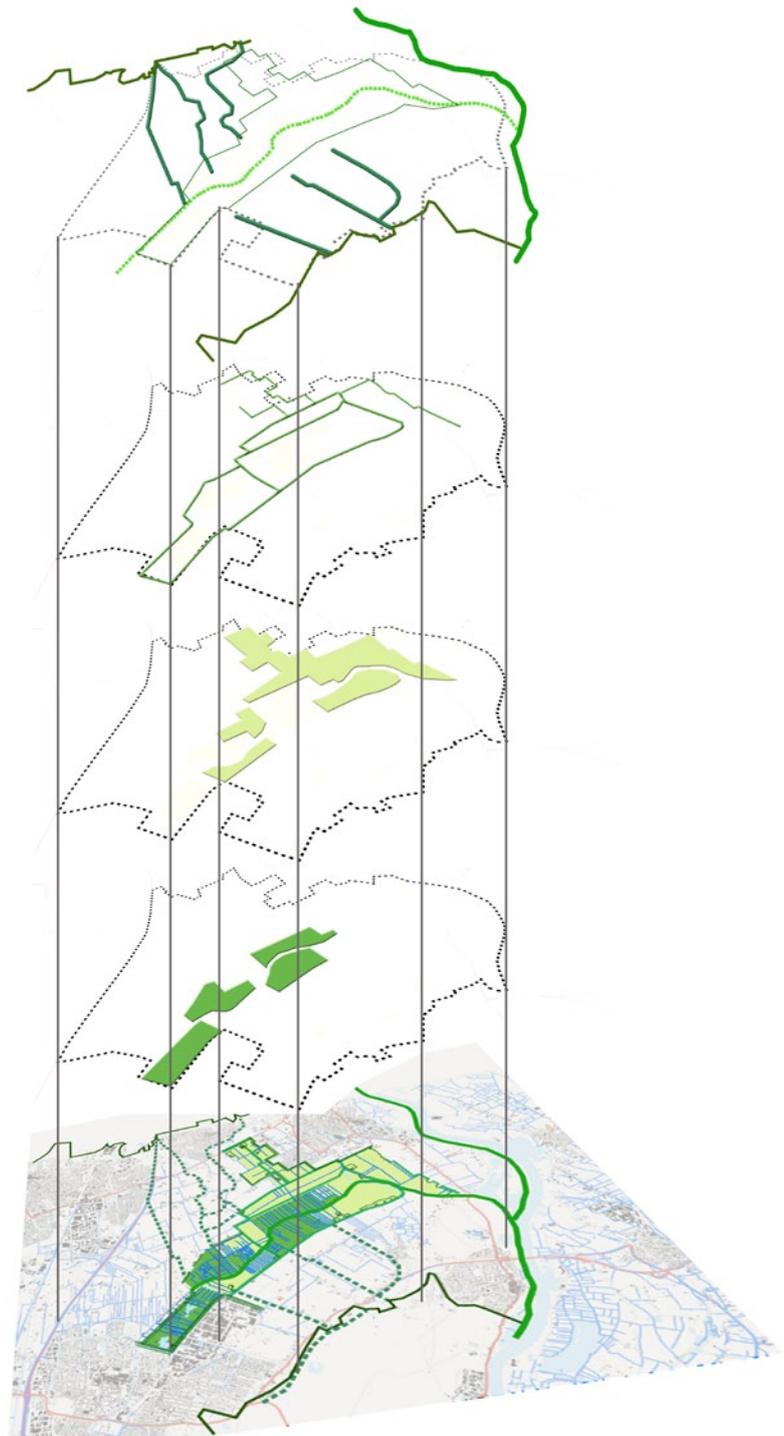


Figure 8.27 Greenways network

References:

Van der Vliet, R. E., Schuller E., Wassen M.J (2008). "Avian predators in a meadow landscape: consequences of their occurrence for breeding open-area birds." J. Avian Biol 39: 523-529.

Van der Vliet, R. E., J. van Dijk, et al. (2010). "How different landscape elements limit the breeding habitat of meadow bird species." Ardea 98(2): 203-209.

Chapter 9

Detailed design & landscape plan

9.1 Introduction

9.2 De Kraats

9.3 De Meent & De Kampen

9.4 Landscape plan

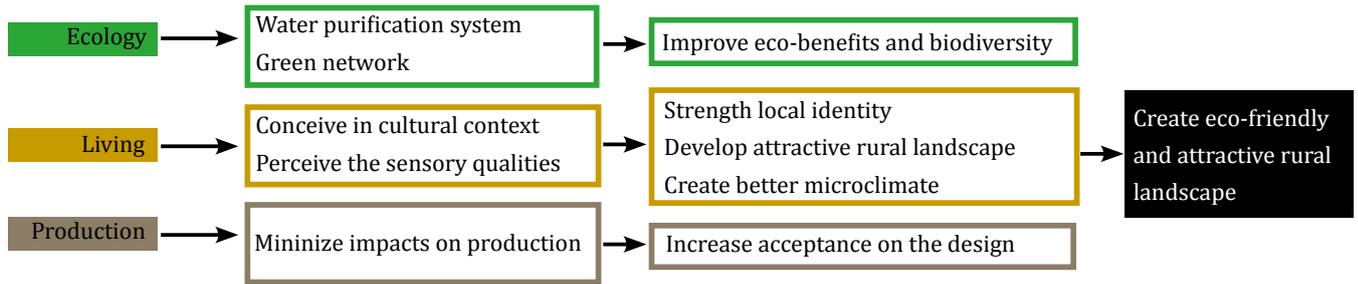


Figure 9.1 Design strategies

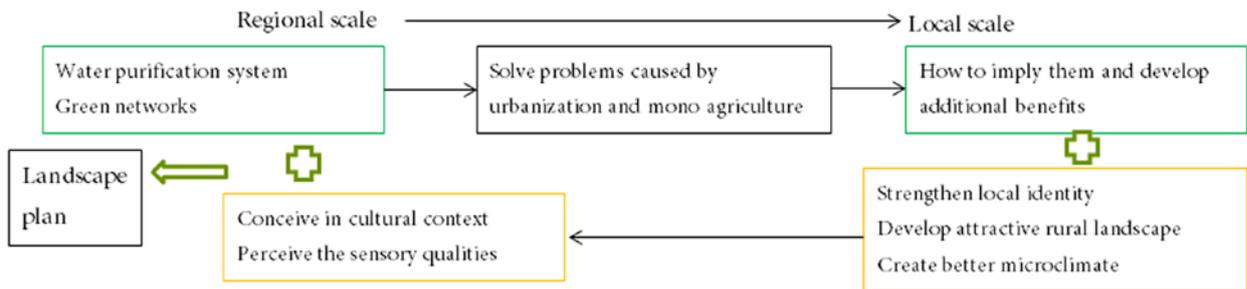


Figure 9.2 Plan and design processes in various scales

9.1 Introduction

Research driven design

In the former chapter, strategies of water purification system and green networks have been researched on. Both of them can create eco-benefits in the region and improve biodiversity. In ecological plan, water purification system and green networks are proposed in the regional scale. They contain strategies development, suitability analysis, and ecological plan for them. However, the thesis aim to create eco-friendly, attractive rural landscape which require to apply and test design strategies and design principles in the concrete design and embed design into local context. Hence, how does these sustainable and innovative design principles and methods can be applied? Do they work? Or how well does it work? We should to verify them.

In addition, to create attractive rural landscape, we need to take human needs into account. According to literature studying in the chapter 7, space for living requires conceive in cultural context and perceive the sensory qualities. Design with aesthetics may improve acceptances of ecological design. But do design strategies and principles for living work? Or how well do they work? They need to be applied and tested in local scale.

Besides it, every design will produce influences on the surrounding environment. The detailed designs will change the landscape design in the regional scale as well. Hence, the design strategies and principles sum up from detailed design, which include ecological and landscape quality ones, should be

integrated into the total landscape plan in the region.

To conclude, major purposes of this chapter are to transform ecological plan into the concrete design in the local scale and build the landscape plan in the regional scale. For concrete design, it includes four steps: site selection; site analysis; design and evaluation. Then the most suitable design strategies and principles for "space for living" will be abstracted and applied into landscape plan.

Sites selection

In this part, detailed design will be used as a showcase to verify aforementioned principles and methods. Two different areas are selected as representative areas for ecological plan in the region and also used for research on landscape plan. For ecological plan, land use pattern, soil types and groundwater table are major factors that affect the application of ecological plan into the concrete design in local scale. For landscape plan, six landscape units are identified to show different cultural landscapes. These two areas are chose on the basis of intensive agricultural land use, diverse groundwater levels, distinctive soil types and different landscape units.

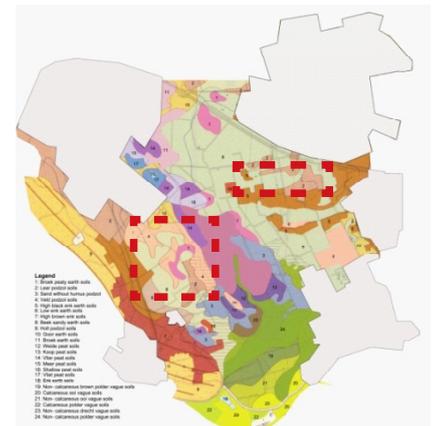


Figure 9.3 site selection according to soil structure

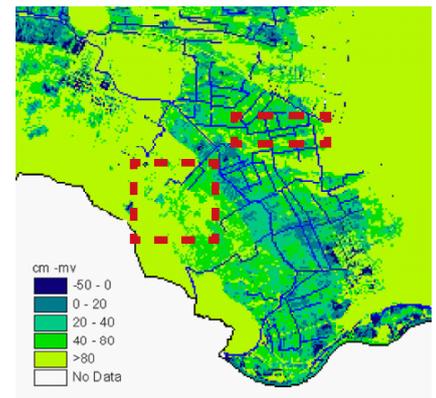


Figure 9.4 site selection according to groundwater level

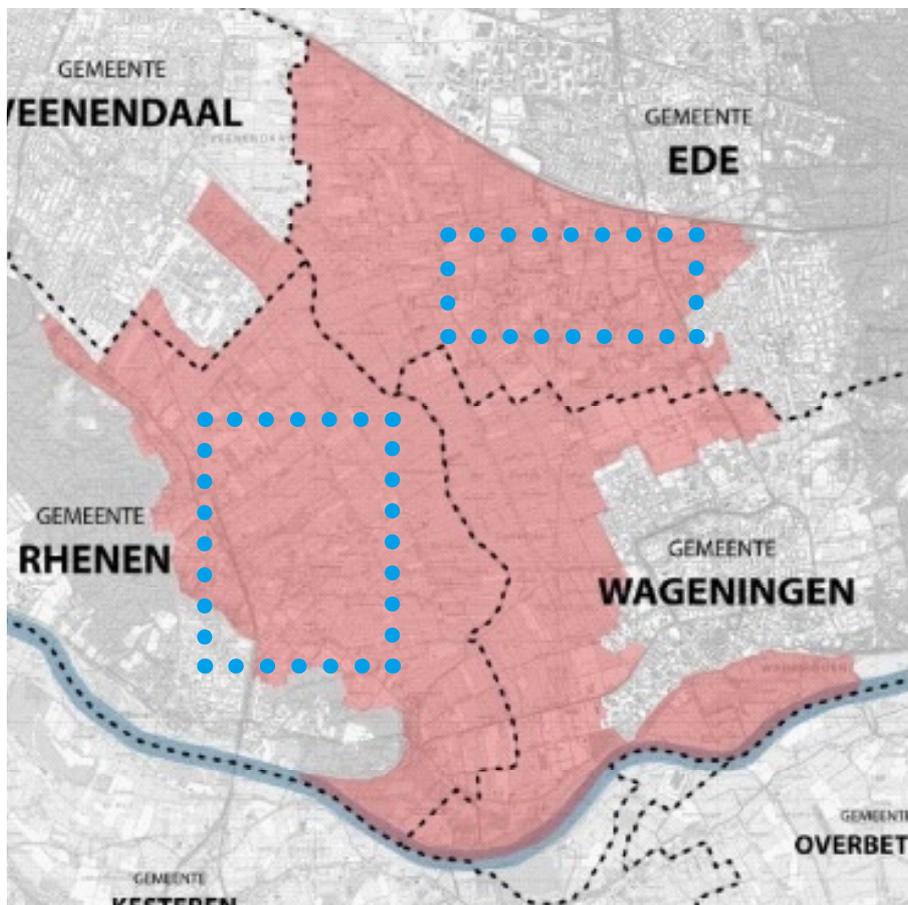


Figure 9.7 The two design locations

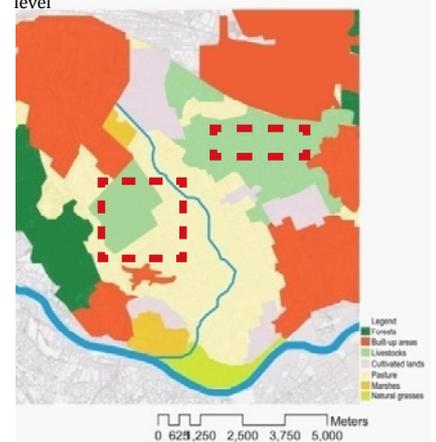


Figure 9.5 site selection according to land use

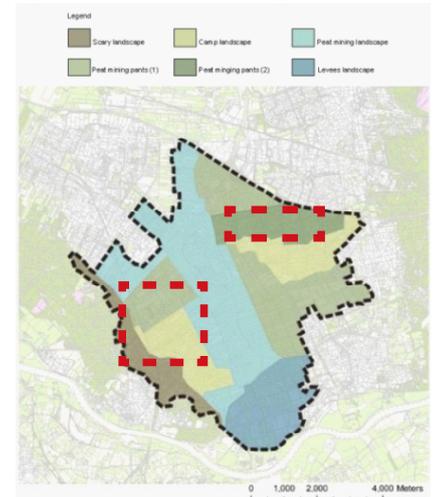


Figure 9.6 Site selection according to landscape units

9.2 De Kraats

9.2.1 Landscape analysis

The Kraats is a hamlet between Bennekom, Ede and Veenendaal. It is appealing to farmers and citizens. The name 'De Kraats' is more connected to poor and arid grasslands. The Kraats itself is in fact originally a barren pasture and some pieces have been explored recently. After the last ice age (about 12,000 years ago), a kind of hard west wind created sand dunes (dekzandruggen) that formed the basis for the current settlements. Agriculture then took place especially in the somewhat higher ground, and livestock concentrated on the pastures of the lower lands.

Soils and groundwater level analysis

Wetlands prefer to be constructed in the sites of non-porous, low permeable soils. If it will be constructed in the porous soils, an impermeable layer should be considered to construct which can keep water level in the pool. In this area, as we can see from the following map, sandy earth soils should be avoided to construct wetlands as much as possible. Constructed wetlands for agricultural

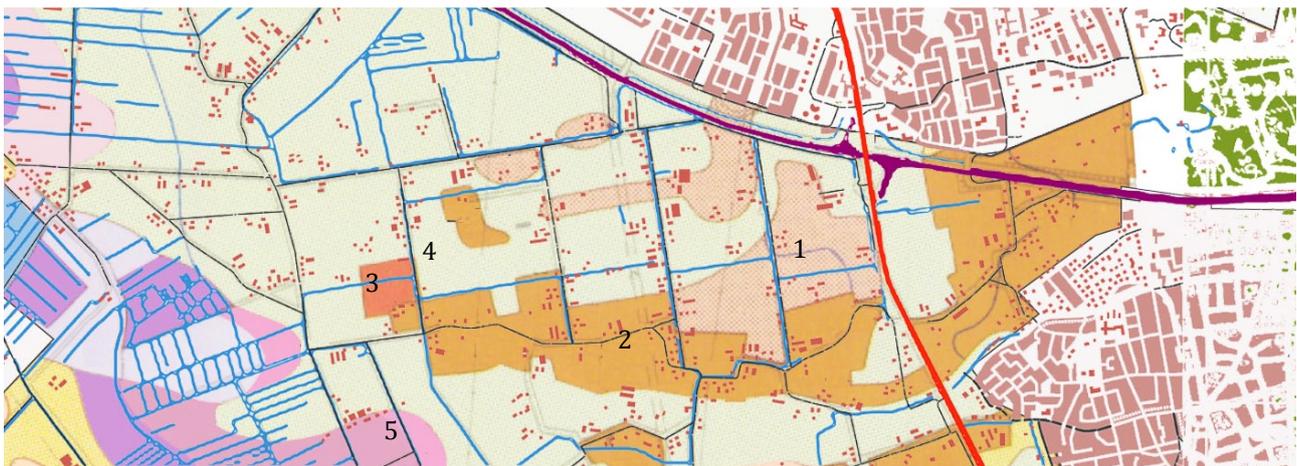


Figure 9.8 Soils structure in de Kraats
Source: According to GIS

1. Humus podzol soils 2. High black enk earth soils 3. Enk earth soils 4. Beek sandy earth soils 5. Koop peat soils



Figure 9.9 Groundwater table in the Kraats
Source: according to GIS

wastewater are usually lined to avoid-possible contamination of groundwater. If the wetland is properly sealed, infiltration can be considered negligible. Hence, parts with lower groundwater table will be preferred.

Landscape characters analysis

- Topography

This area is located in the transition from high, dry soils to low, wet soils.

- Appearance of landscape

The major landscape pattern is small scale openness landscape, which is formed by roads, ditches and plants. But nowadays small scale openness landscape are turning to open landscape. Traditional landscape pattern is disappearing and local identity is losing.

- Allotment pattern

The village is occupied by strip allotment, which is mainly developed along the north-south mining roads. There are a lot of new houses are developed due to urbanization but they barely to fit into the existing landscape. Intensive agriculture led to an increasing number of horse peddocks, warehouses and fermentation equipment, which affect the amenity of the area.

- Planting pattern

The part is typical for east-west structure of cultivated plots and accompanying plantings. These plantings create nice landscape framework and many linear vegetation elements, such as windbreak and hedgerows. However, vegetation is suffering from decline and landscape is occupied by buildings gradually.



More openness landscape due to the increasing pastures



Fermentation equipments destroy the beautiful landscape



Pasture along the roads

Figure 9.10 Images of the Kraats
Source: by the author



Figure 9.11 Landscape analysis for the Kraats: roads system, water, vegetation and building pattern.
Source: GIS database

9.2.2 Design assignments and conceptual scheme

Design assignments

Design assignments

Based on the ecological plan and landscape analysis for this site, design assignments for this area are:

- Purify wastewater from intensive livestock
- Protect vegetation structure and sources in the area
- Conserve traditional landscape pattern and local identity
- Create attractive and comfortable rural living environment

Conceptual scheme

Conceptual scheme in different scales

To achieve these assignments, I consider this site in two scales: regional scale and local scale. In regional scale, we should consider about relations between this site and surrounding environment. Due to special location of the site, as transition between high and low areas, it should link from hilly landscape to stream landscape. Hence, eastern and western sides should be kept as open views and connected. There is a sand ridge existed in the southern side. Combined with the special topography, green corridors will be developed and form an enclosure landscape.

In local scale, design is proposed in three layers:

(1) Conserve traditional landscape structure

The traditional landscape structures in the site includes north-south peat mining roads, buildings developed along roads, east-west structure of cultivated plots and accompanying windbreak trees, and also ditches along cultivated plots.

(2) Planting design

Firstly, I propose to form green connection to the downstream landscape and hilly landscape which will be corridors for meadow birds and also continued

Figure 9.12 Scheme in the regional scale



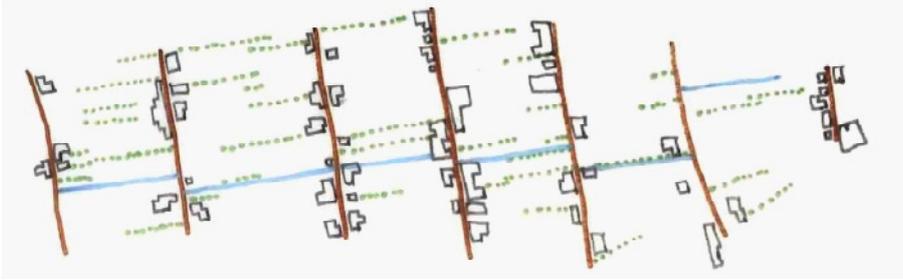


Figure 9.13 Conserve traditional structure



Figure 9.14 Scheme for planting design

landscape experiences for people. Secondly, an extension and strengthening of the network of roads by planting. It can enhance traditional landscape pattern, reduce the negative noisy and air pollutions, hide agricultural and livestock equipments and form beautiful rural landscape. Finally, on the basis of consideration in regional scale, in the northern and western sides, open views of the villages from the main access will be retained. And in the southern side, the street blend slightly, accompanying with planting, creating a more enclosed feeling to the area.

(3) Water system design

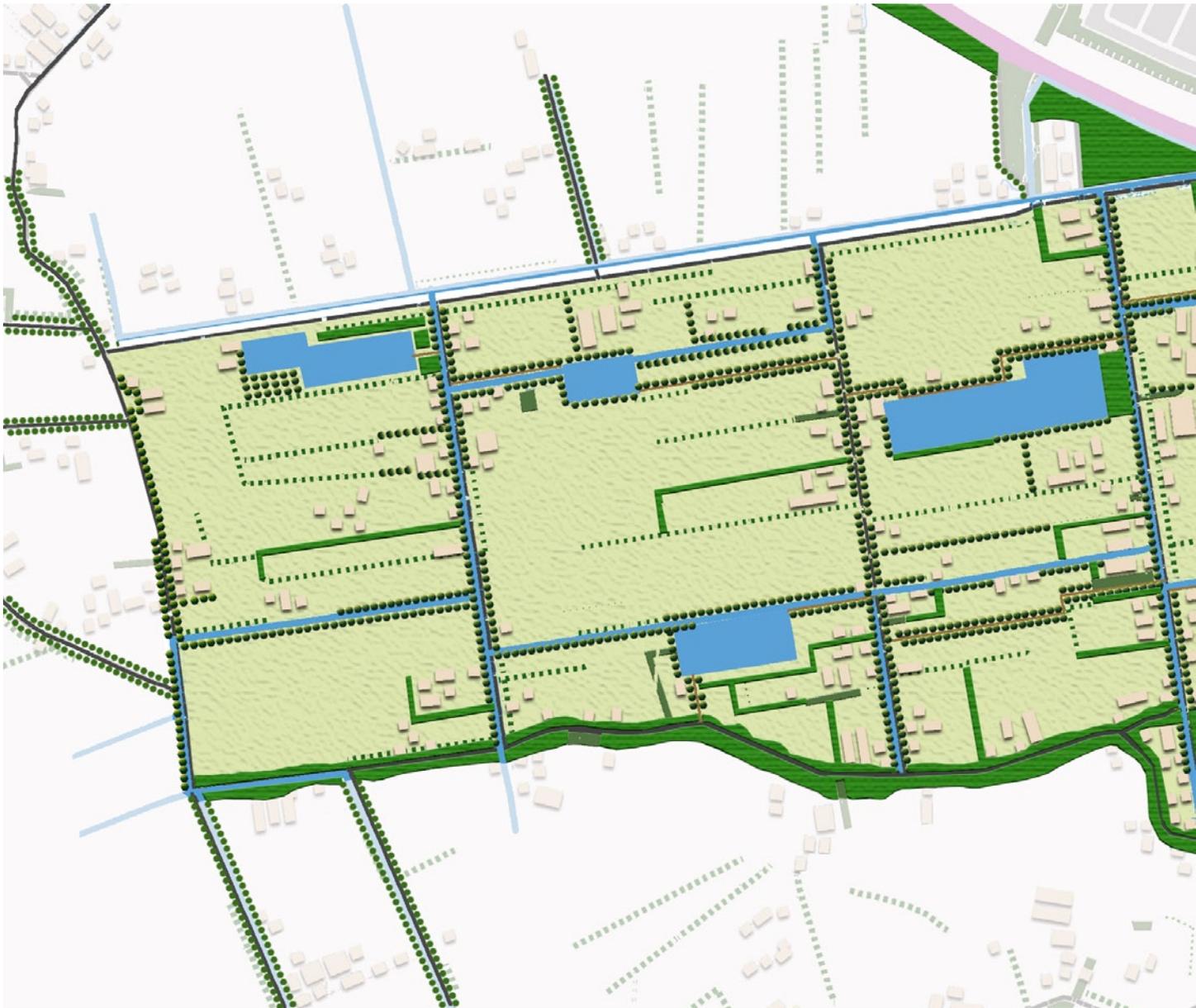
To design for water system, firstly wetlands should be located in the frames formed by roads. It can decrease the possible impacts on traditional landscape structure. Their forms should be embedded into local context. Hence, block patterns are selected. At the same time, they should combine with ditches to lend identity. In second, to purify wastewater from intensive livestock, structures of wetlands should be considered carefully. How to construct it can purify most wastewater? What size does it require? And How well does it work? These questions will be explained in the water system of design. Then, water as a basis landscape element can produce additional benefits. They will be used to create better microclimate and provide space for leisure activities.



Figure 9.15 Scheme for water system

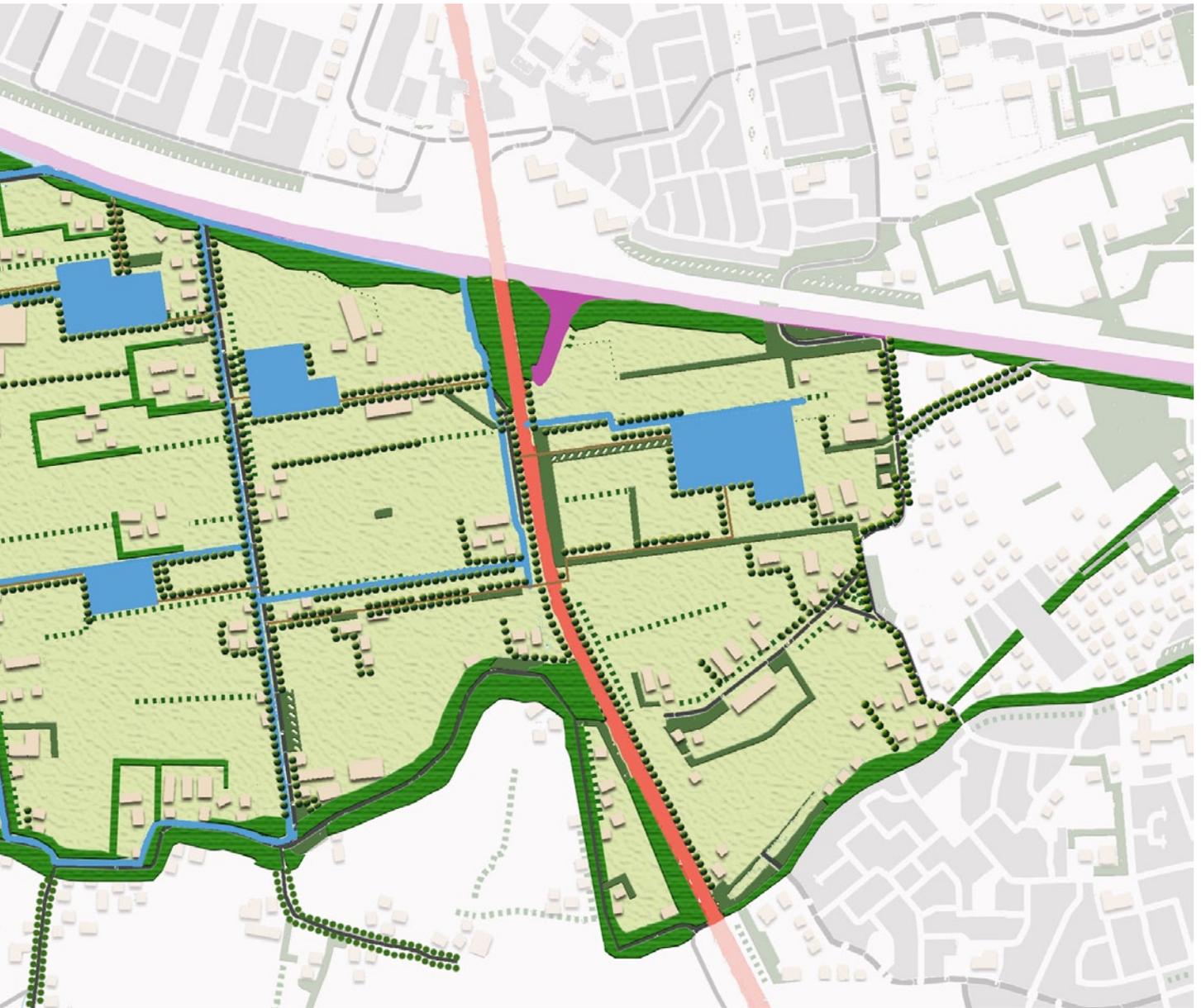
9.2.3 Proposed design

On the basis of conceptual scheme in different scales, design for "De Kraats" is proposed as following map. It contains water purification system, green network and space for people. In water purification system, wetlands are constructed in each frame formed by ditches and roads. Combine with existing water structures in the site, ecological system to purify wastewater is designed. For green network, trees lines and groups of trees are designed to connect existing fragmented vegetation. In total, they will create a livable and attractive

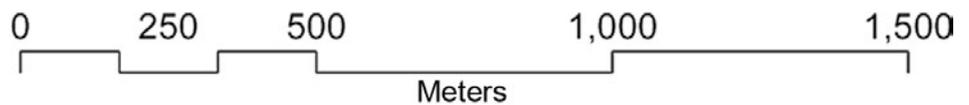
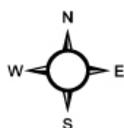


rural landscape. For human, spaces for leisure activities (i.e. walking, seating, jogging) are provided in the water and green systems. Continued experiences from stream landscape to agricultural landscape to hilly landscape are created. Local identity and feeling of belonging is conserved.

Figure 9.16 Proposed design for the Kraats



 ditches



Proposed trees lines

Along the roads system, a lot of native trees will be planted to form anthomy streets. Oaks, beech, poplarstand and pine trees are proposed. They can improve the landscape connectivity, hide the horse peddocks, warehouses and fermentation equipment in the agriculture. What's more, they can protect wind in the winter and provide shadow in summer.



Figure 9.17 Current situation

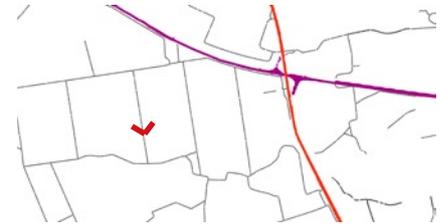


Figure 9.18 Images for the future



Design for green corridor

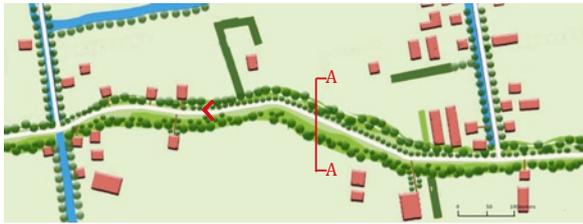
Green corridor in the southern side of the Kraat play a important role in the local landscape. In the ecological aspect, it can connect conserved habitats along the stream to forests in the eastern sides. It will be one of the corridors in the Binnenveld for birds' movement in the east-west direction. In the aesthetic aspect, combine with the topography, it will form an nearly enclosure landscape in the southern side of the Kraats. The traditional landscape element- sand ridges will be strengthened by planting trees. Traditional landscape pattern will be recovered and conserved. Landscape experiences from stream landscape to hilly landscape will be linked. At the same time, it can protect cold wind in the west-southern side in winter for the Kraats and form a better microclimate. Trees planting and paths cross it will create a natural environment and spaces for communication. More social activities will happen in the site.



Figure 9.19 Bird view of current situation



Figure 9.20 design for green corridor



Green corridor require a diverse vegetation structure. It will be consisted by trees, shrubs and grasses that various species can find their favorite areas. This diverse structure, which will combine various species will be more stable.





Figure 9.22 Images for the future



Figure 9.21 Current situation



Figure 9.23 Cross-section A-A

9.2.4 Water purification system

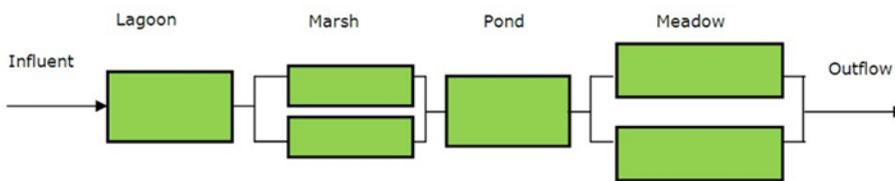
In the water purification system, wetlands constructed in upstream lands will require deliberate management manipulation to maintain optimal treatment performance, but riparian buffer zones would provide substantial water purification without active management and would support additional wetlands functions. Here, wetlands aim to treat runoff from intensive livestock.

(1) Site selection

Locations for constructed wetlands depend on site conditions: soils, groundwater level and topography. As I explained in the soil and groundwater analysis, wetlands should be designed in the sites of non-porous, low permeable soils and parts with lower groundwater table. In addition, areas in the lower sites, which can provide gravity flow of wastewater to the system, are preferred.

(2) Structure of wetlands

To treat wastewater in the first order, marsh- pond- meadow wetlands are chose. The marsh-pond-meadow system comprises four steps: (1) initial screening of the incoming waste-water followed by lagoon; (2) a surface flow marsh planted with plants, such as cattails in a sand medium; (3) a pond with aquatic plants and fish; (4) a meadow planted with reed canary grass or sedges. Lagoon is used to remove solids and phosphate. Shallow basin can remove phosphate, organic loads and solid in ammonification. Pond functions as aerobic lagoon and in the removal of organic load and nitrogen in nitrification and denitrification. Finally, meadow, in the oxidized environment, will functions in the further reduction of ammonia and nitrogen. In theory, this system can remove 77 per cent of nitrogen in the form of ammonia and 82 per cent of total phosphorus. (Stauffer and International Institute for Environment and Development. 2009, P113)



	Lagoon	Marsh	Pond	Meadow
Form		Shallow basin with 10-20 cm of water	Constructed pond with 0.5-1m water depth	Continuous flows with 1-5 cm water
Vegetation		Cattail, bulrush, reed, rushes	Duchweed, algae	Reed canary grass, sedges
Removal	Solids, grit ,debris, phosphate	Phosphate, organic loads and solids	Organic load, nitrogen	Ammonia, nitrogen

Table 9.1 Structure of constructed wetlands



Figure 9.24 Possible aquatic plants for constructed wetlands

(3) Computation for waste loading and required sizes of constructed wetlands

Waste loading computations

After selection of sites, we have to count size of wetlands we need to achieve desired discharge standards. The size it required depends on: (1) the quantity of organic wastes to be treated per day; and (2) the capacity for a given area of wetlands to transform a fixed quantity per day.

Table 9.2 Livestock waste and nutrient production per animal

	Production (g) per animal per day		
	BOD5	N	P
Dairy cows	875	183	57.5
Swine	75	86.3	40
Poultry	8	2.02	1.07

Source: CBS

Table 9.3 Average number of animals per farm in Binnenveld

	Dairy cows	Swine	Poultry
Binnenveld-west	17	327	6324
Binnenveld-oost	19	327	5443

Source: CBS

1) Computations for organic load generated per farm per day in Binnenveld-oost:

-Organic load generated by cows per day

BOD5 produced by cows per day:

$$875 \text{ g BOD5 cow-1 day-1} \times 19 = 16625 \text{ g BOD5/day}$$

Nitrogen produced by cows per day:

$$183 \text{ g N cow-1 day-1} \times 19 = 3477 \text{ g N/day}$$

Phosphorus produced by cows per day:

$$57.5 \text{ g P cow-1 day-1} \times 19 = 1092.5 \text{ g P/day}$$

-Organic load generated by swine per day

BOD5 produced by swine per day:

$$75 \text{ g BOD5 swine-1 day-1} \times 327 = 24525 \text{ g BOD5/day}$$

Nitrogen produced by cows per day:

$$86.3 \text{ g N swine -1 day-1} \times 327 = 28220.1 \text{ g N/day}$$

Phosphorus produced by cows per day:

$$40 \text{ g P swine-1 day-1} \times 327 = 13080 \text{ g P/day}$$

-Organic load generated by poultry per day

BOD5 produced by poultry per day:

$$8 \text{ g BOD5 poultry} \cdot 1 \text{ day}^{-1} \times 5443 = 43544 \text{ g BOD5/day}$$

Nitrogen produced by cows per day:

$$2.02 \text{ g N poultry} \cdot 1 \text{ day}^{-1} \times 5443 = 10994.86 \text{ g N/day}$$

Phosphorus produced by cows per day:

$$1.07 \text{ g P poultry} \cdot 1 \text{ day}^{-1} \times 5443 = 5824.01 \text{ g P/day}$$

-Organic load generated in total per day

BOD5 produced in total per day:

$$16625 \text{ g BOD5/day} + 24525 \text{ g BOD5/day} + 43544 \text{ g BOD5/day} \\ = 84694 \text{ g BOD5/day}$$

Nitrogen produced in total per day:

$$3477 \text{ g N/day} + 28220.1 \text{ g N/day} + 10994.86 \text{ g N/day} = 42691.96 \text{ g N/day} \approx 42692 \text{ g N/day}$$

Phosphorus produced in total per day:

$$1092.5 \text{ g P/day} + 13080 \text{ g P/day} + 5824.01 \text{ g P/day} = 19996.51 \text{ g P/day} \\ \approx 19997 \text{ g P/day}$$

2) Computation for required areas of constructed wetlands

-Anaerobic lagoon

Application rate: 200kg BOD5 ha⁻¹/day

Treatment area: $84694 \times 0.001 / 200 = 0.42397 \text{ ha} \approx 0.43 \text{ ha}$

Removal efficiency= 50% of BOD5, 20% of Nitrogen, 30% of Phosphorus

Effluents: BOD5= $84694 \times 0.5 = 42397 \text{ g BOD5/day}$

Nitrogen= $42692 \times 0.8 = 34153.6 \text{ g N/day}$

Phosphorus= $19997 \times 0.7 = 13997.9 \text{ g P/day}$

-Marshes

Application rate: 100kg BOD5 ha⁻¹/day

Treatment area: $42397 \times 0.001 / 100 = 0.42397 \text{ ha} \approx 0.43 \text{ ha}$

Removal efficiency: 30% of N, 30% of P

Effluents: N= $34153.6 \times 0.7 = 23907.5 \text{ g N/day}$

P= $13998 \times 0.7 = 9799 \text{ g P/day}$

-Pond

Application rate: 40kg N ha⁻¹/day

Required area: $23908 \times 0.001 / 40 = 0.5977 \text{ ha} \approx 0.60 \text{ ha}$

Removal efficiency: 60% of N

Effluents: N= $23908 \times 0.4 = 9563.2 \text{ g N/day}$

-Meadow

Application rate: 20kg N ha⁻¹/day

Required area: $9563.2 \times 0.001 / 20 = 0.47815 \text{ ha} \approx 0.48 \text{ ha}$

Removal efficiency: 90% of N

Effluents: N= $9563.2 \times 0.1 = 956.3 \text{ g N/day}$

-Total wetlands system area

Lagoon: 0.43ha; Marshes: 0.42ha; Pond: 0.60ha; Meadow: 0.48ha;

Total: 1.93ha (1ha=10000m²)

3) Computations for each sub-catchment areas

Zone1: with 8 farms

Required area: $8 \times 1.93 = 15.44\text{ha} = 154400\text{m}^2$

Zone2: with 4 farms

Required area: $4 \times 1.93 = 7.72\text{ha} = 77200\text{m}^2$

Zone3: with 2 farms

Required area: $2 \times 1.93 = 3.86\text{ha} = 38600\text{m}^2$

Zone4: with 6 farms

Required area: $6 \times 1.93 = 11.58\text{ha} = 115800\text{m}^2$

Zone5: with 4 farms

Required area: $4 \times 1.93 = 7.72\text{ha} = 77200\text{m}^2$

Zone6: with 3 farms

Required area: $3 \times 1.93 = 5.79\text{ha} = 57900\text{m}^2$

Zone7: with 5 farms

Required area: $5 \times 1.93 = 9.65\text{ha} = 96500\text{m}^2$

Zone8: with 5 farms

Required area: $5 \times 1.93 = 9.65\text{ha} = 96500\text{m}^2$

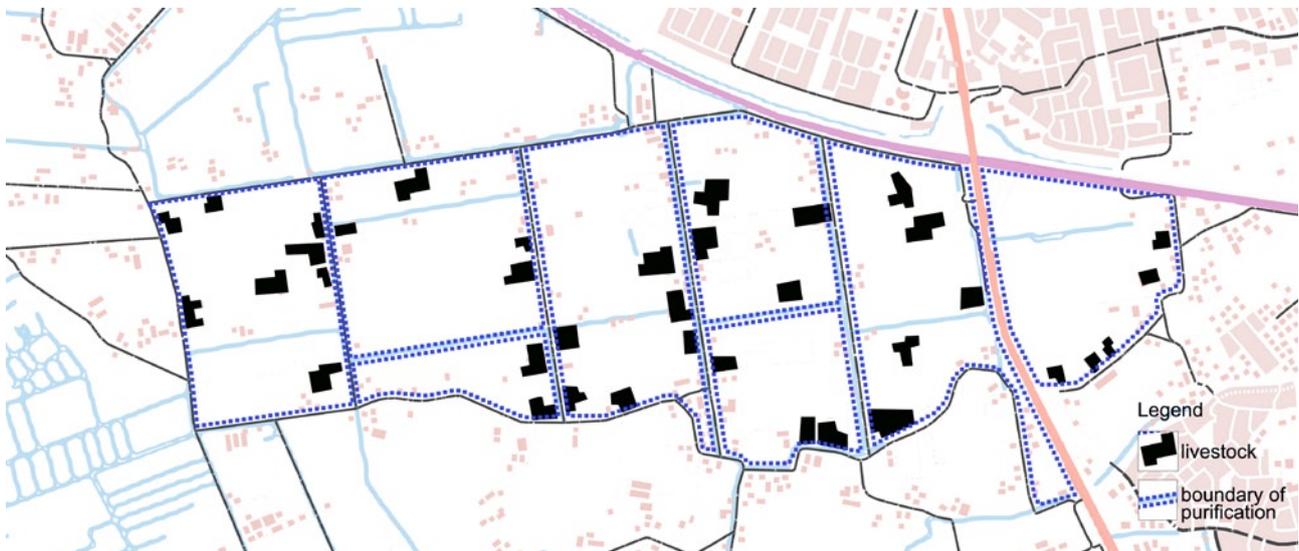


Figure 9.25 Locations of livestock

In total:

Required area: 714100m²

(4) Computation for removal efficiency

Effluents of waste:

Nitrogen: 956.3g N/day Phosphorus: 9799g P/day

Removal efficiency:

Nitrogen: $(42692g \text{ N/day} - 956.3g \text{ N/day}) \div 42692g \text{ N/day} = 97.76\%$

Phosphorus: $(19997g \text{ P/day} - 9799g \text{ P/day}) \div 19997g \text{ P/day} = 51\%$

Therefore, the system can remove 97.76% of nitrogen and 51% of phosphorus.

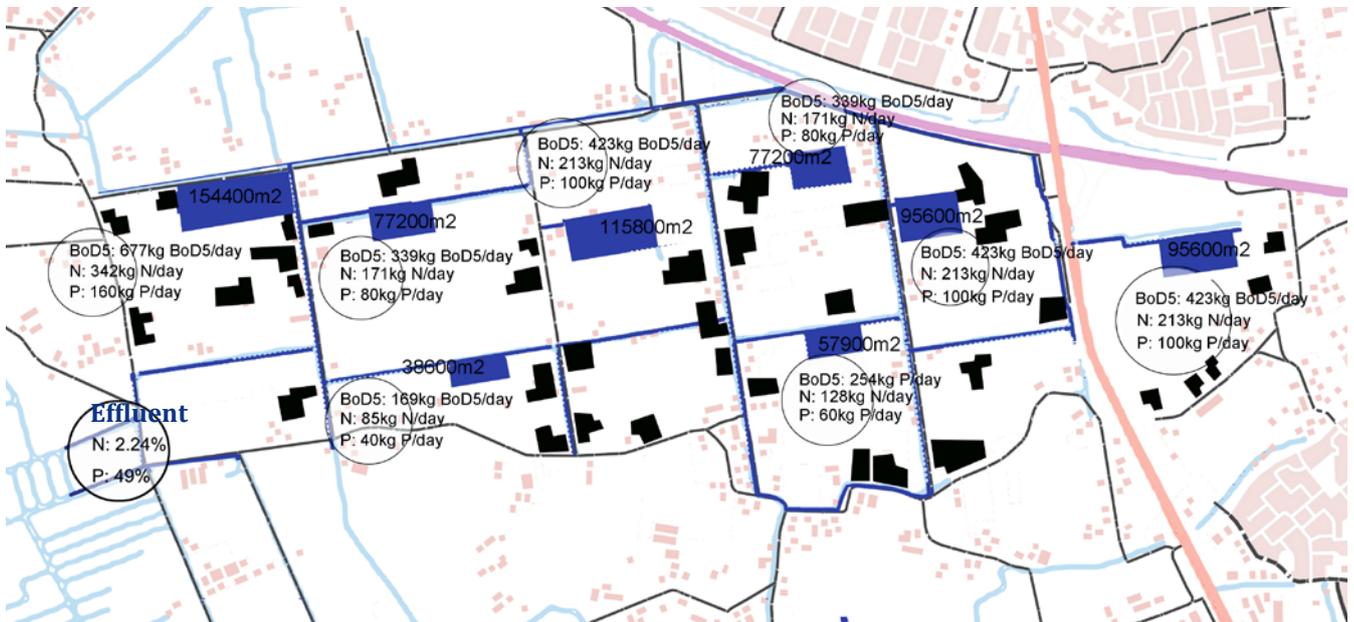


Figure 9.26 Required sizes for wetlands



Figure 9.27 Design for one wetland

(5) Example for wetlands design

Take one of the constructed wetlands for example, water in this system will flow from lagoon, marsh, pond to meadow. Lagoon will be constructed in the relatively higher ground, so that water will flow on gravity. When wastewater flow into pond and meadow, it will be much clearer. So these areas can be used as leisure spaces and people will be accessible to water bodies. Local materials can be used to construct wood bridges, seatings and so on. Native and pioneer species are proposed, what can suit the environment faster and easier. They will improve the environment quickly and don't require much management.

Structure and function of wetlands can change in the timeline. In 2015, it can be used for water purification and with little human activities. With the improving in the quality of water, there is an increasing number of wildlife living here. Take

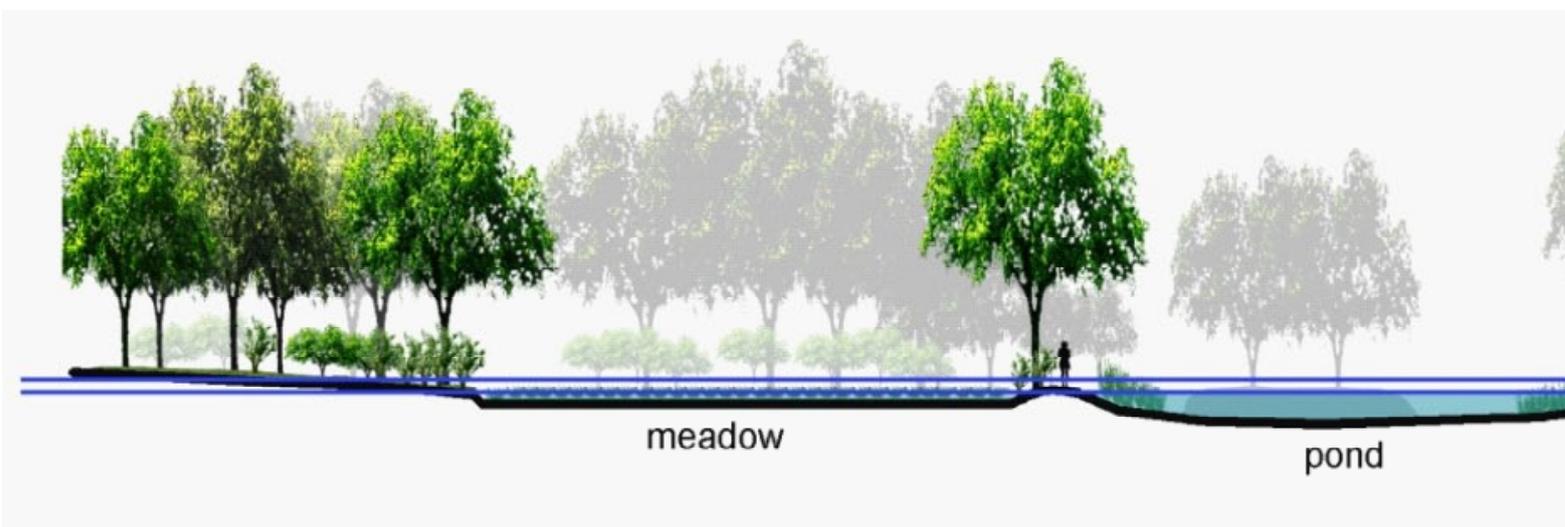




Figure 9.28 Images for 2015

meadow for example, it is not necessary to have so much plants in 2030. More open water spaces can be used for human and aquatic plant will be more diversity. To 2050, it will have a climax vegetation structure. Constructed wetlands will be transformed into natural ones.

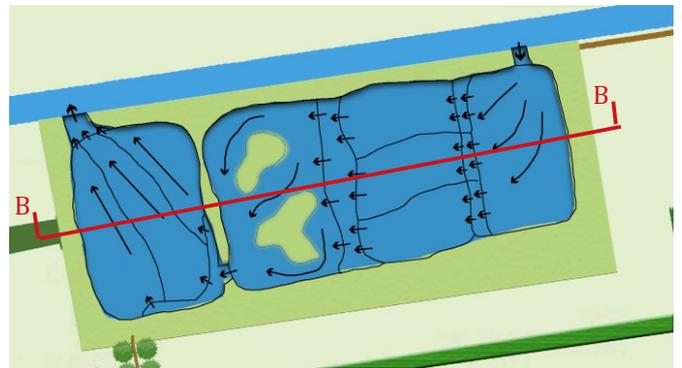


Figure 9.29 Water flow in the wetland

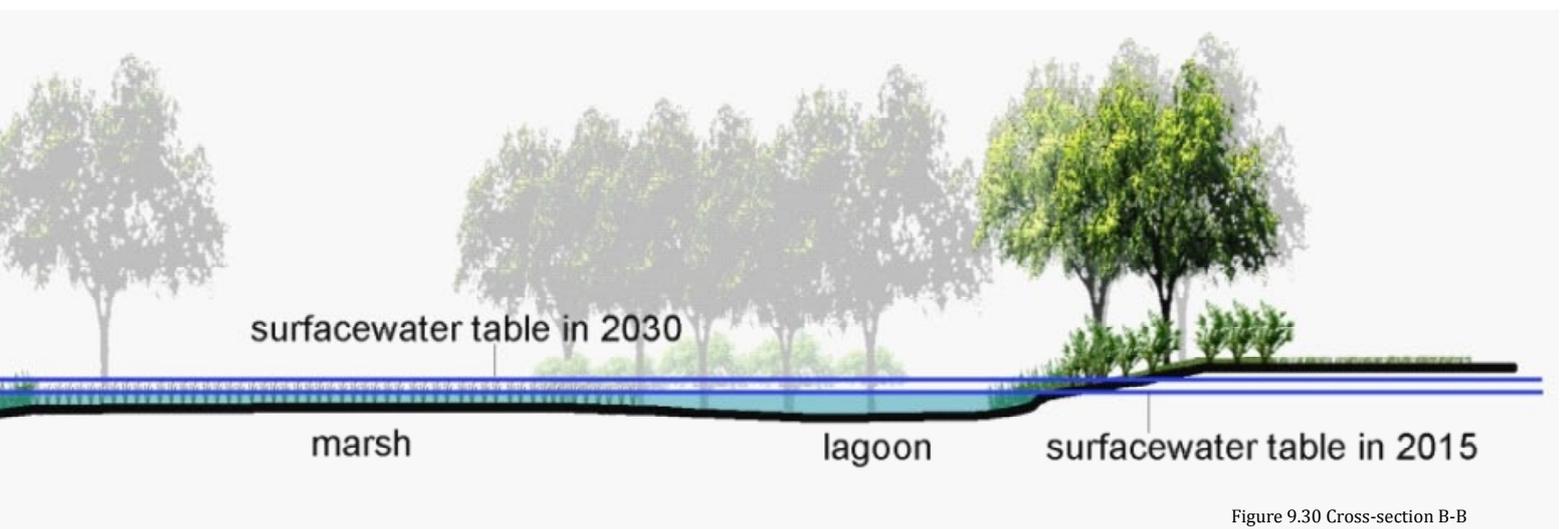


Figure 9.30 Cross-section B-B



Figure 9.31 Images for the 2030

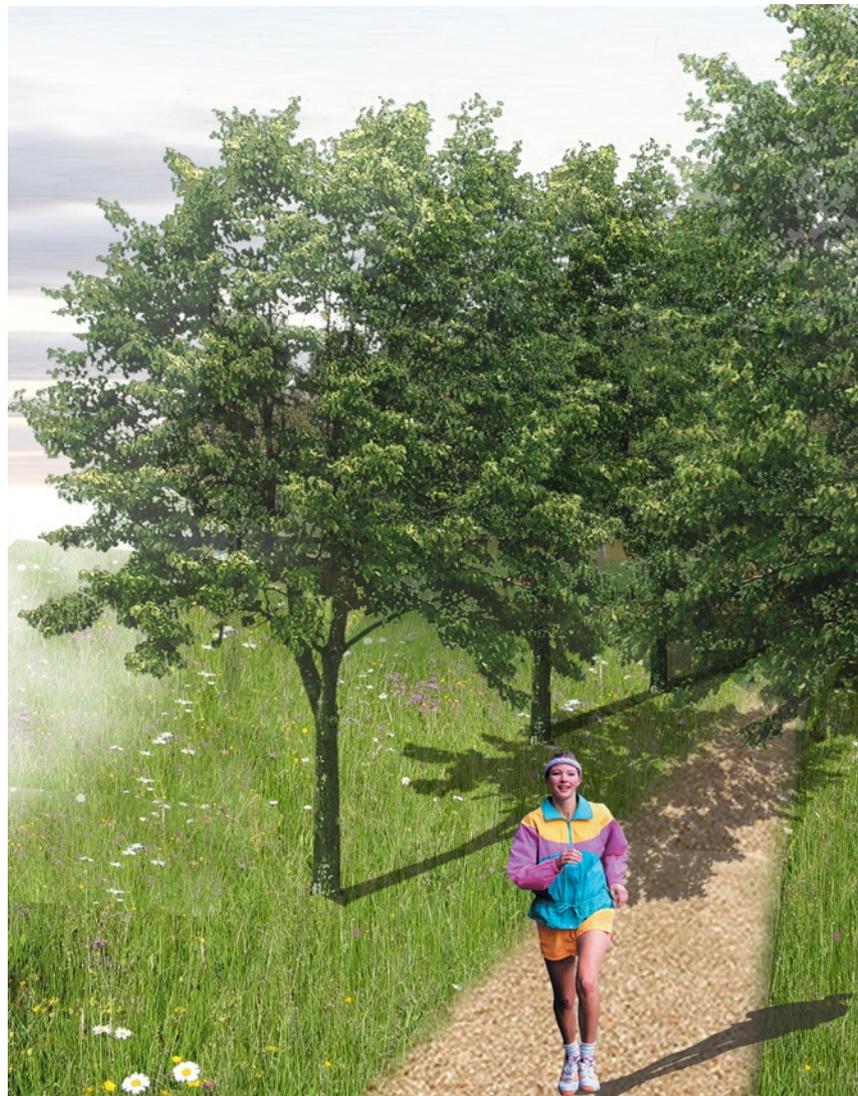


Figure 9.32 Images for the 2050



9.2.5 Evaluation

The criteria used to evaluate designs has been built in the beginning of last chapter. It is based on my design purpose and strategies and includes three aspects: ecology, living and production.

Criteria	
Ecology	-provide habitats for meadow birds -improve landscape connectivity -purify water from livestock and arable lands
Living	-provide better living environment -increase local identity and feels of belonging -improve amenity of areas
Production	-occupation in numbers of arable lands and livestock lands -least negative effects from ecological strategies

✖ Bad ★ Normal ★★ Good ★★★ Best

To evaluate them, there are two methods: quantitative and qualitative. Criteria as provide habitats, improve landscape connectivity and purify water can be quantitative research. But for local identity and amenity, I did evaluation in qualitative research. Then to range them, three stars are leveled as most positive effects.

Evaluation in ecology

- Provide habitats for meadow birds

In this design, suitable habitats for meadow birds are limited. Constructed wetlands can be used as habitats, but it requires a period for the improvement of water quality at first. After about ten years, wetlands will finish preliminary wastewater treatment and there are not so much wastewater let out. They can be used as habitats for meadow birds. Due to limitation in size and time, the design will get one star for habitats available.

Criteria	Range
Ecology	★



Figure 9.33 Possible habitats for meadow birds

- Improve landscape connectivity

To improve landscape connectivity, trees will be planted along roads system, linear plantings are developed along cultivated plots and corridors are designed to connect this site to regional green structure. In the local scale, green networks are mainly designed in terms of linear planting. They can be used as stepping stones for meadow birds' movement. In the regional scale, green corridors aim to connect conserved habitats in the downstream areas to forests in the hills. It will function as a major corridor in the regional ecological plan. In total, green structure in the site is connected but in a relatively simple and single way.

	Criteria	Range
Ecology	Improve landscape connectivity	☆☆



Figure 9.34 Landscape connectivity in the site

-Purify water from livestock and arable lands

According to computation in chapter 9.2.4-water purification system, constructed wetlands plan to remove 97.76% of nitrogen and 51% of phosphorus in wastewater. Compare to normal standard of wetlands purify capacity- nitrogen removal:70% and phosphorus removal: 45% (Schierup et al., 1990; Meuleman, 1994), purify capacity for wastewater from livestock and arable lands has achieved a great result.

	Criteria	Range
Ecology	Purify water from livestock and arable lands	☆☆☆

Evaluation in living

-Provide better living environment

To provide better living environment, this design take two aspects into account. First, more community places and diverse activities should be provided. There are two kinds of community places. In general, leisure activities in public green areas will last for long time (more than one hour). Diverse leisure activities could happen there, such as sitting, walking with dogs, jogging and playing games with friends. Then, streets, as part of urban morphology, can increase opportunities for people to meet each other. In the most time, this kind of activities will be finished in short time.

As we can see from the following analysis, diverse communication could happen in the places. Wetlands are located in each frame of villages so that they can be used as community places for residents. People could have diverse long-time leisure activities. And walking paths are designed to link all constructed wetlands and connect from downstream landscape to hilly landscape. Diverse landscape experiences and space structures will be experienced. Main street in the southern side will be developed into green corridors that nice walking and bicycling environment can be enjoyed.

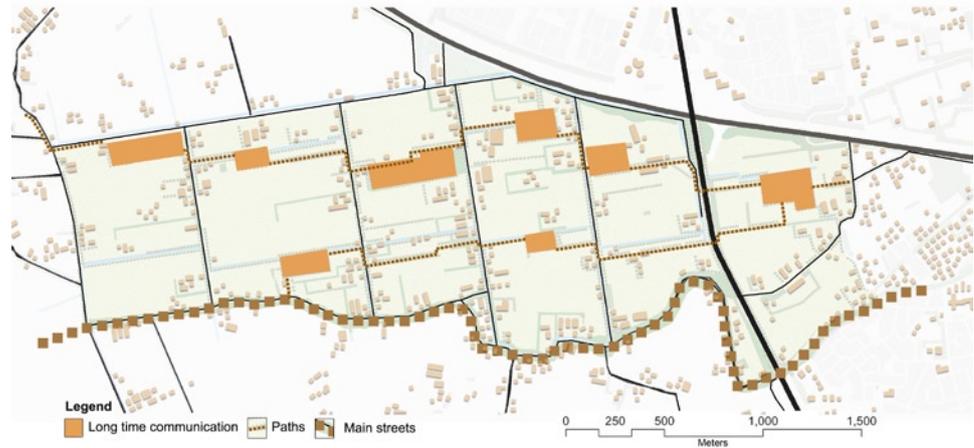


Figure 9.35 Possible leisure spaces

Secondly, better microclimate will be created in the site. Through scientific analysis and design in vegetation and water elements, I aim to create a comfortable atmosphere for residents. As I described in the chapter of "Design principles", people prefer to have outdoor activities in the places of direct sunshine and protection from the wind. Green corridor in the west-south side can protect cold wind in winter to go through the site and wetlands will be bordered by trees lines to decrease cold air. In summer, cold wind in the wetlands will be directed to public green areas. In addition, deciduous trees are proposed on the south side of houses to moderate temperature.

	Criteria	Range
Living	Provide better living environment	☆☆☆☆

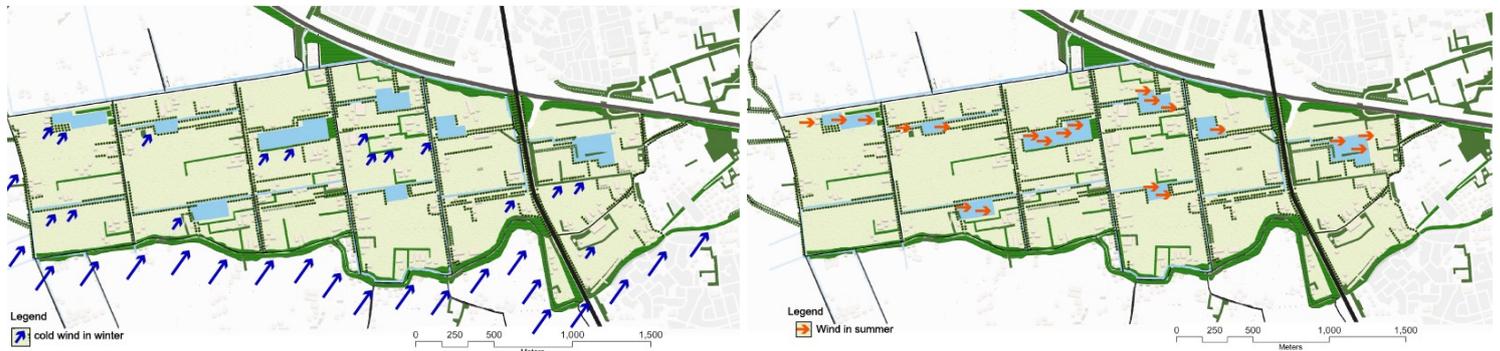


Figure 9.36 Wind flow in the site

	Criteria	Range
Living	Increase local identity and feels of belonging	☆☆

-Increase local identity and feels of belonging

To improve sense of place, local landscape pattern is conserved and native materials and species are proposed to be used. At the same time, new landscape elements will follow traditional landscape forms and integrate into local context.

	Criteria	Range
Living	Improve amenity of areas	☆☆

-Improve amenity of areas

Native vegetation will not only create beautiful rural landscape but also function as sight barriers to diminish negative impacts from livestock. The total green structure will form continued experiences from stream landscape to hilly landscape, Wetlands, combined with ditches, will lend the local water identity and form diverse landscape experiences.

Evaluation in production

-Occupation in numbers of arable lands and livestock lands

One of the most important influences from this design to agriculture is occupation in arable lands and livestock areas. Even I have tried to minimize the possible occupation, there are still numbers of agricultural land use need to be took for wetlands and green corridors.

	Criteria	Range
Production	Occupation in numbers of arable lands and livestock lands	★★★

-Least negative effects from ecological strategies

Besides occupation in agricultural lands, there are another effects from ecological strategies as well. Different landscape and land use will lead to diverse activities of peasants on their lands. Design with ecological care will encourage local people to care their living environment and change their life styles as a consequence. Ecological and recreational activities embedded in the agricultural land use lead to diversification of human activities and economic incomes for local people.

	Criteria	Range
Production	Least negative effects from ecological strategies	★★★

In total, evaluation for this design are made as the follwing table. It is clear that this design will promote site development. It will improve local ecology, create great living environment and produce positive influences on production. Meantime, it will play a active role in the regional development.

	Criteria	Range
Ecology	-provide habitats for meadow birds -improve landscape connectivity -purify water from livestock and arable lands	★ ★★★ ★★★★
Living	-provide better living environment -increase local identity and feels of belonging -improve amenity of areas	★★★ ★★ ★★
Production	-occupation in numbers of arable lands and livestock lands -least negative effects from ecological strategies	★★ ★★

9.3 De Meent & De Kampen

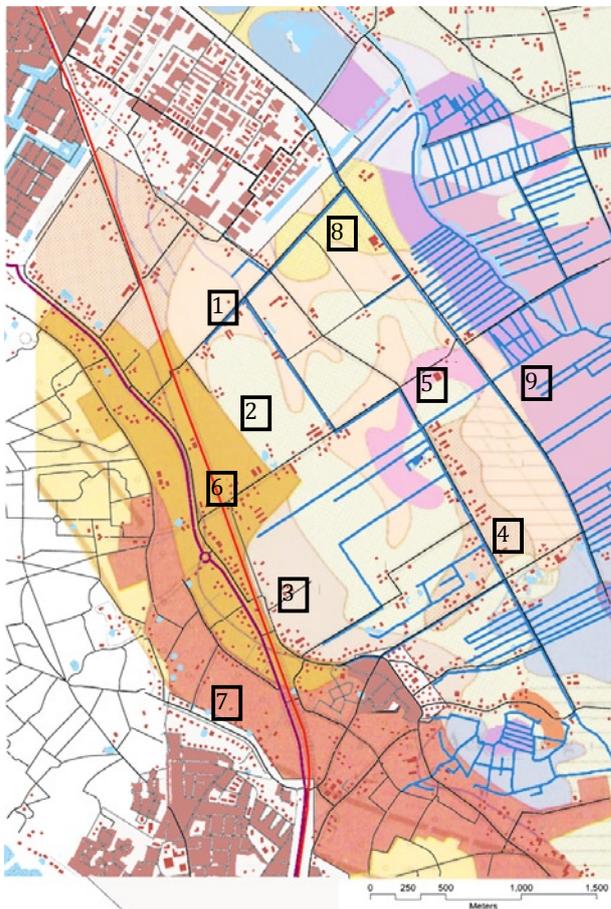
9.3.1 Landscape analysis

In the west parts of Binnenveld, landscape is differ from De Kraats. Here, close to Utrecht Heuvelrug, it is typical for diverse landscape pattern due to variable topography and groundwater conditions. There are diverse cultural landscape in the site. The diverse and beautiful cultural landscape is a reflection of history. Along the Utrecht Heuvelrug, there are the oldest agricultural areas in the Netherlands. Here kampen and engen were constructed. Though there is little left, the peasant communities and ways of land cultivation have left their mark.

Soil and groundwater level analysis

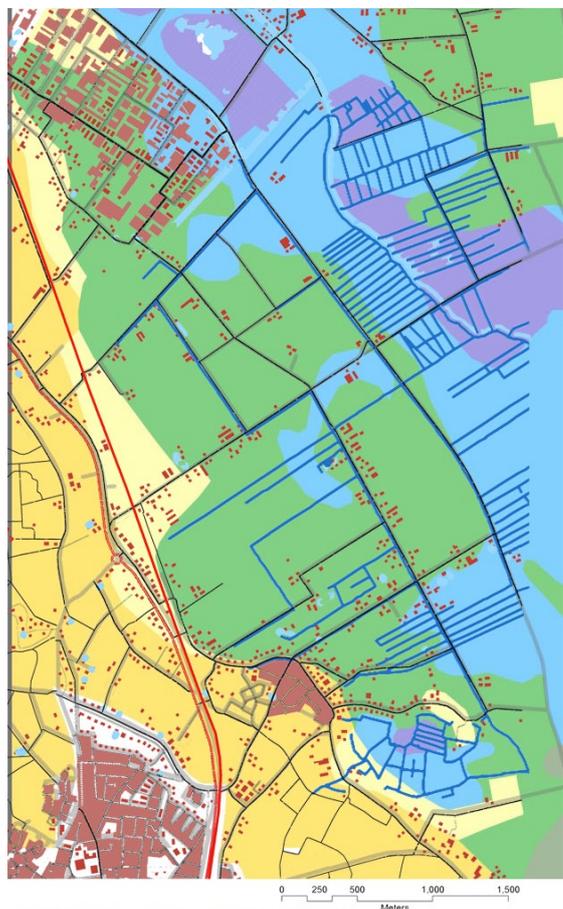
To construct wetlands, non-porous, low permeable soils are preferred. In this area, as we can see from the following map, soils types are more diverse than the first site. It includes different types of sandy, peat and earth soils and sandy earth soils should be avoided to construct wetlands as much as possible. The height of groundwater level in the site is quite low and major below 40. To avoid possible contamination of wastewater to groundwater, areas in lower groundwater table will be better.

Figure 9.37 Soil structure
Source: GIS



1. Veld podzol soils 2. Beek sandy earth soils 3. Low enk earth soils 4. Humus podzol soils
5. Peat earth soils 6. Black enk earth soils 7. Brown earth soils 8. Goor earth soils
9. Koop peat soils

Figure 9.38 Groundwater table
Source: GIS



H<40 H 25-40 H<25 H 40-80 H80-140

Landscape characters analysis

The landscape characters in the site can be divided into two parts. They have similar topography but different appearance of landscape, allotment pattern and planting pattern due to diverse land use in history.

-Topography

The site is closing to Utrecht Heuvelrug and has a position of transition from high, dry soil to low, wet soil.

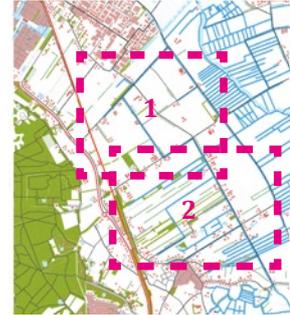


Figure 9.39 Landscape analysis : roads, water system, building distribution, vegetation pattern
Source: according to GIS

-Appearance of landscape

Part 1: This part is typical for open landscape which is intersected by tree-lined avenues

Part2: It is traditional kampen landscape in the netherlands. In this part, small scale openness landscape is a landscape character. Narrow open plots with planting in the strips define the image of strip plots. These small plots are suitable for pastures and main farm business in the region is mixed farms, with crops and livestock.

-Allotment pattern

Part1: This part has a block allotment structure. Buildings get a dominant position in the landscape and their orientation are diverse. But due to diverse orientation and unplanned development of them, they cause a messy landscape.

Part2: In the strip allotment pattern, buildings are major located in the north-south peat mining roads. With the increasing number of houses, they began to occupy an important image in the landscape. However, integration between estates and landscape is losing.

-Planting pattern

Part1: Hedgerows on the boundary of farms and tree-lined avenues increase the seclusion of estates and amenities of the area.

Part2: The cultivated plots have a distinct east-west direction. Plot planting accentuated the strip plots are very characteristic of the landscape. Lines of plantings (windbreak and hedgerows) are more perceptible. However, even the strip structure is still there, planting to strengthen them have been declined.

9.3.2 Design assignments and conceptual scheme

Design assignments

According to above analysis and ecological analysis in the regional scale, I confirmed design assignments in this site.

- Purify wastewater from intensive livestock
- Protect vegetation structure and sources in the area
- Conserve traditional landscape pattern and local identity
- Create attractive and comfortable rural living environment

Because I have developed design strategies and principles for living in the first design, here they will be adapted and modified on the basis of site conditions.

Conceptual scheme in different scales

Consider site development in two scales, I developed my conceptual scheme. First, in regional scale we should consider about relations between this site and surrounding environment. Linkage and accessibility between downstream

lands and hilly landscape should be developed. Then, to divide between urban areas (Veenendaal) and rural areas, buffer zones are proposed. The zones in Veenendaal, which is close to De Meent, are major used as industrial areas. A large number of factories and industries will cause negative effects on rural environment. Thirdly, combine with topography and vegetation distribution, landscape in the site can be closed by hills and woodlands at the foot of hills

After it, there are three layers for site development in local scale.

(1) Local old patterns should be conserved.

Here include landscape frames, allotment and planting patterns. At the same time, the texture of landscape is prososed to be used for new landscape elements. Local materials and species are also suggested because they can recall people's memory of places. All of these approaches will increase local identity and human's feeling of belongingness.

(2) Planting design

Vegetation sources in the site are rich but suffer from declining. To design for vegetation, I propose to connect these fragmented green patches and form green networks as first. Then, green corridors from forests in Utrecht Heuvelrug to meadow habitats should be built. They will function not only as corridors for meadow birds movement but also for completely human experiences in the Binnenveld. Thirdly, aim to diminish negative impacts from infrastructure and increase the amenity of places, plantings along roads network should be strengthened.

(3) Water system design

To purify wastewater from arable lands and livestock, design for water system here is similiar as the first design. It includes several wetlands constructed along ditches and carefully computation for them. The answers for how to construct these wetlands, what size do they require, and how well do they work are based on same model with the first design. Besides them, design with aesthetics will be differ from water systems in De Kraats. Wetlands will be located in the frames of landscape, but they will use local landscape texture and be embedded into local context. In part one, it is mainly block pattern and it means strips in part two.

9.3.3 Proposed design

The image in the following page gives a design for De Meent and De Kampen. The design is structured by constructed wetlands embedded in the local context and a new green network. New paths are designed to link these wetlands and form a continued experiences from stream landscape to hilly landscape. It can improve local living environment and landscape quality as well.

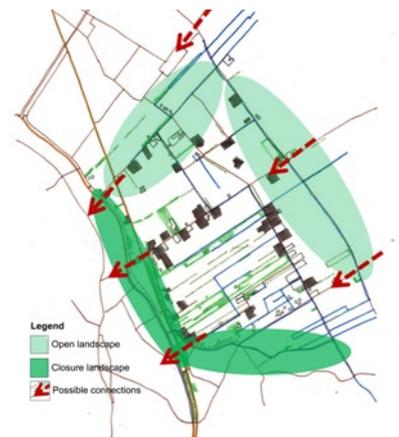


Figure 9.40 Scheme in the regional scale



Figure 9.41 Conserve traditional structure



Figure 9.42 Scheme for vegetation design



Figure 9.43 Scheme for water system

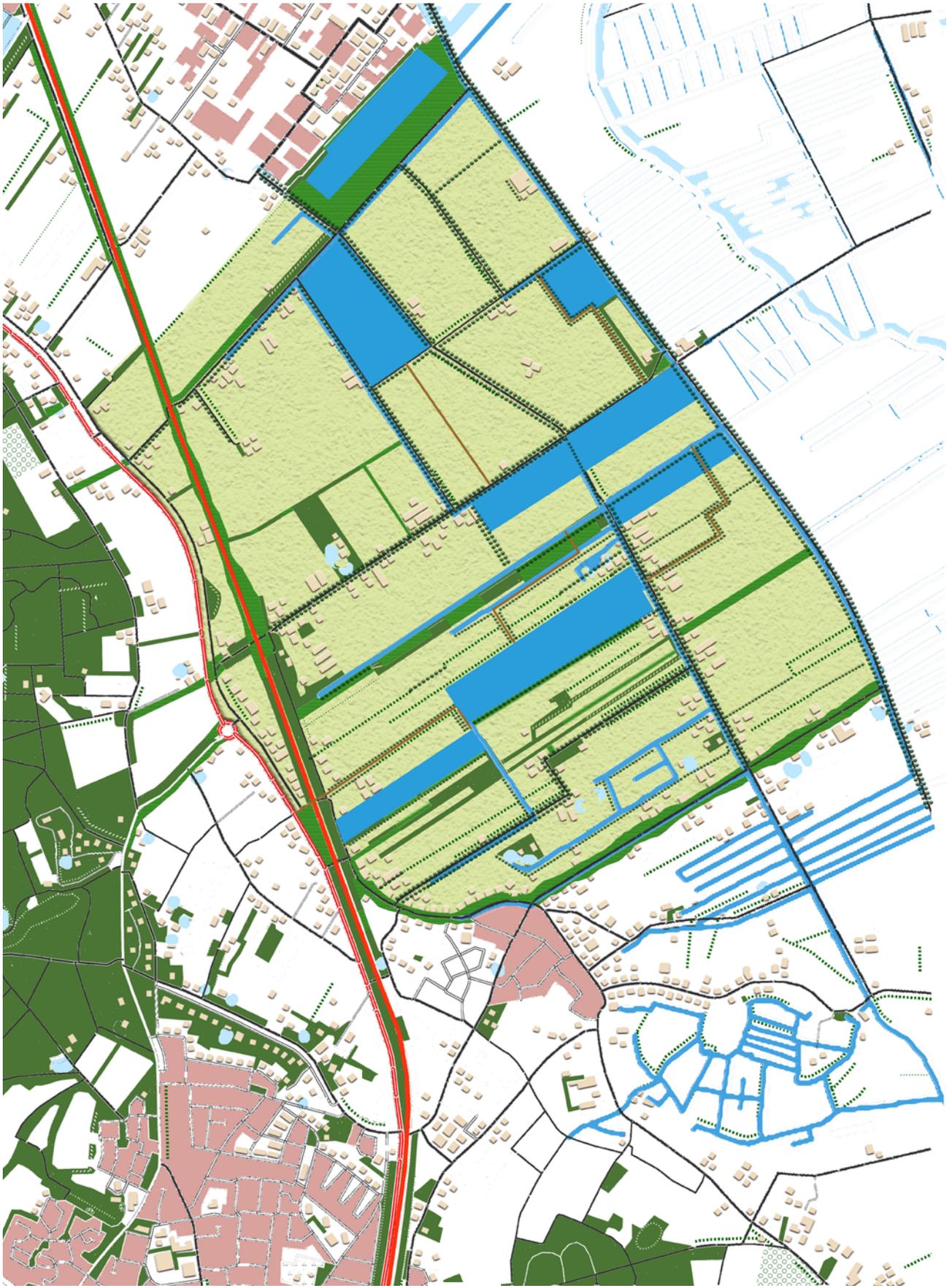
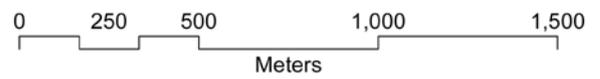
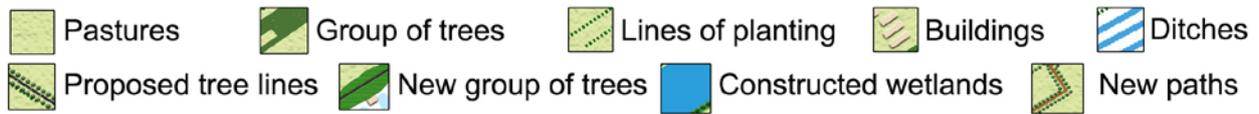


Figure 9.44 Proposed design



Legend



9.3.4 New green network

Compare to the former vegetation structure, new green network is more continuous. This green network is consisted by three parts: trees lines along infrastructure, green corridors connecting fragmented groups of trees, and buffer between urban and rural areas. There are three green corridors for linkage and accessible from stream landscape to hilly landscape. First one is proposed along the buffer, where is a main road from low areas to Utrecht Heuvelrug. Green buffer and this green corridor will cause positive interaction. The second green corridor is designed along one ditch. It is based on the existing vegetation sources. There are several groups of trees there and distribute in seperated way. Final one will cross village Achterberg. Here is one main entrance to Utrecht Heuvelrug. Design of this green corridor can improve local peasants' living environment and increase attraction to outsiders.



Figure 9.45 Current situation of vegetation structure



Figure 9.46 New vegetation structure

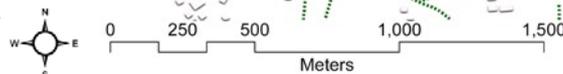




Figure 9.47 Images for the future



Figure 9.48 Current situation

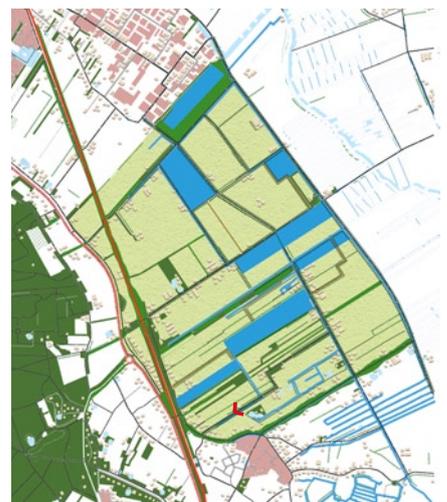
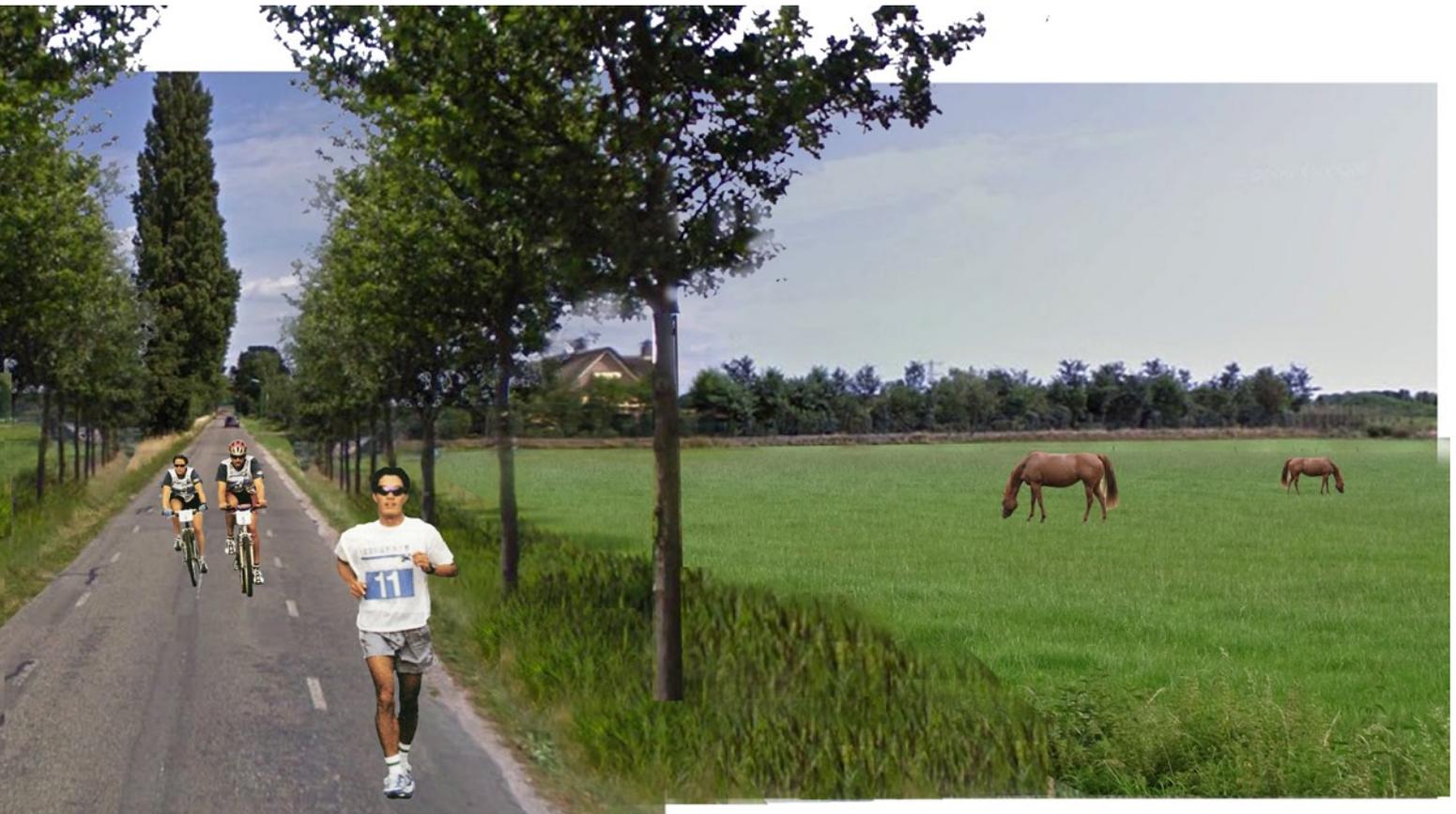


Figure 9.49 Viewpoint



Figure 9.50 Current situation



Trees can be planted on the boundaries of farms to recover the traditional small-scale openness landscape. They can protect views on the agricultural equipments to improve the amenity of places and create better atmosphere.

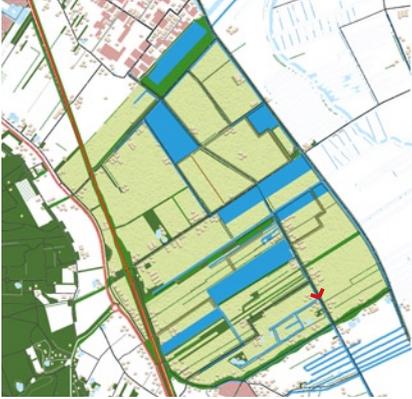


Figure 9.51 Images for the future



Buffer between urban areas and rural areas

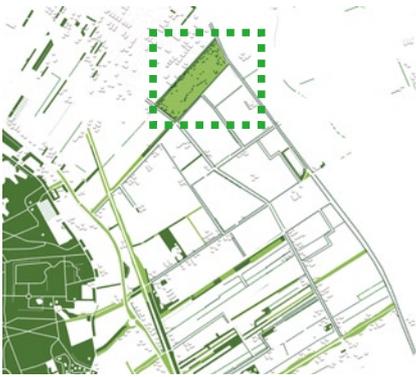


Figure 9.52 Location for buffer

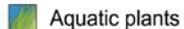
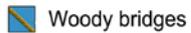


Figure 9.53 Conflicts between the urban and rural areas



In general, there are conflicts between urban and rural areas due to different land use, morphology, and services. Unfortunately it is common in the Binnenveld because it is closed by four cities. Fast urbanization aggravate these conflicts and call for solutions. In this site, rural areas close to urban parts in the northeastern corner. Buffer between urban and rural areas is proposed to solve these conflicts. From the right illustration, we can see that conflicts are major difference between people and natural environment. Hence, a common use of place and intersting will link two parts together. A park which can provide leisure and natural environment is suggested. It can diminish negative effects from industry on rural landscape such as noise, air pollution and sight damage, and also increase communication between people living in different areas. In the park, wetland will be constructed to purify wastewater from rural areas. The structure of wetlands is similiar as first detail design and consist of lagoon, marsh, pond and meadow. Diverse spaces for leisure activities will be provided. Workers can have their lunches on the grasslands in the sunshine. Peasants can walk with their dogs in the curved paths. Even birds and fishes can get their living spces here. Local materials and native species are proposed that feelings of belongingness will be increased.

Legend

-  Grasslands
-  Shrubs
-  Aquatic plants
-  Evergreen trees
-  Deciduous trees
-  Wetlands
-  Paths
-  Woody platform
-  Woody bridges
-  Seats

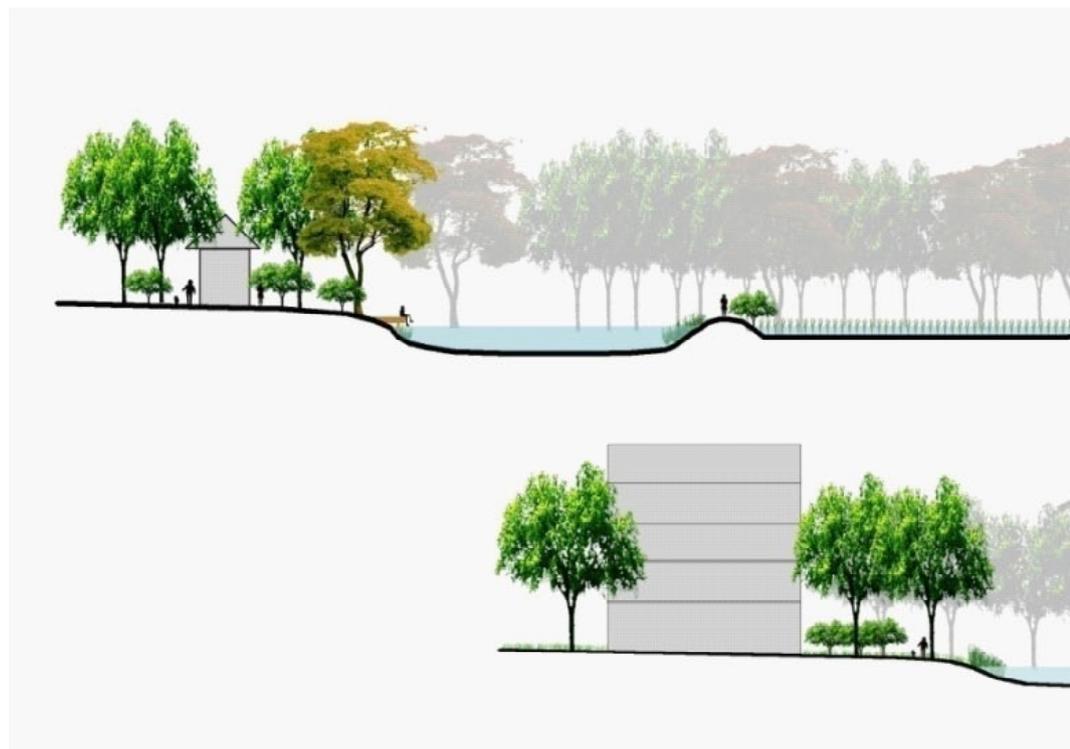




Figure 9.54 Proposed design

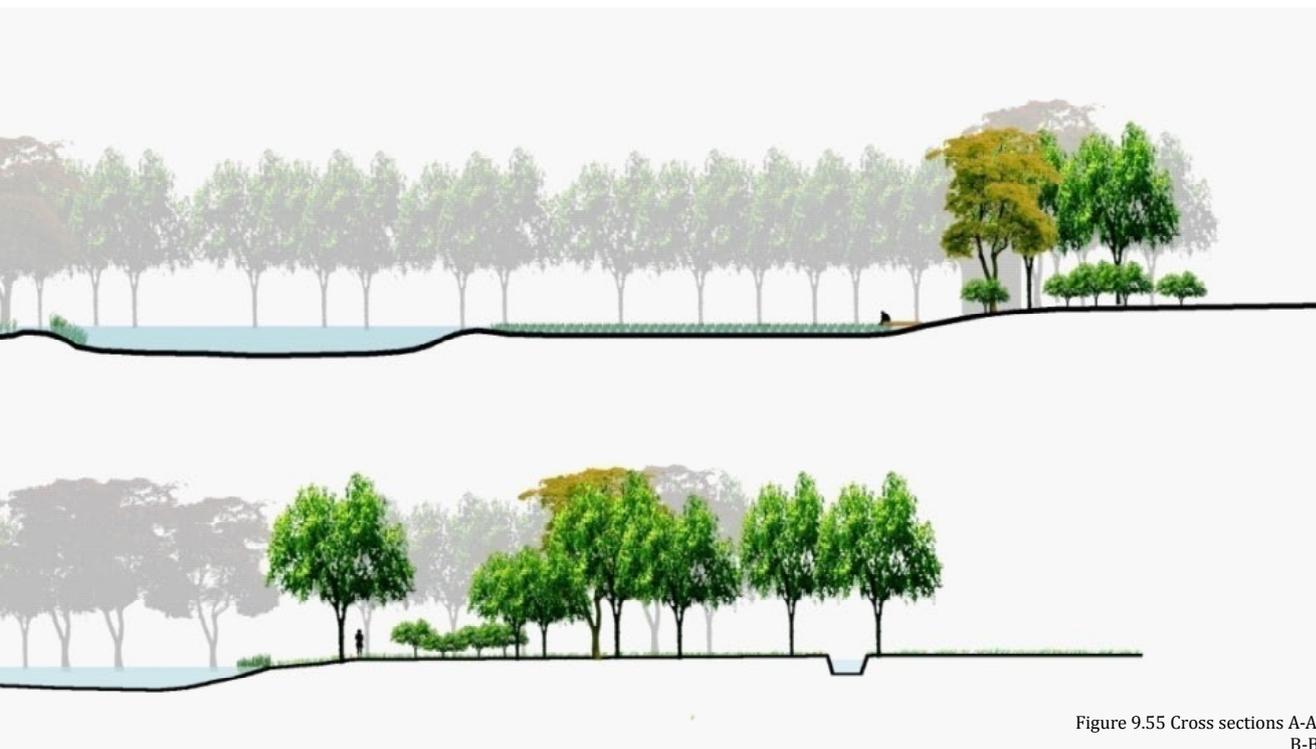


Figure 9.55 Cross sections A-A
B-B



Figure 9.56 Current situation

Figure 9.58 Images for the future



Chapter 9 Detailed design & landscape plan

Except considerations about communication, design takes microclimate into account as well. It aims to create a suitable atmosphere for outdoor activities. Vegetation will provide shadow in summer and protection from wind in winter. Water in the wetlands can function as cooling elements to moderate temperature.



Figure 9.57 View point of image



9.3.5 Water purification system

Structure for wetlands to purify wastewater is similar as the first detailed design. It is consisted by lagoon, marsh, pond and meadow. But due to different numbers of average animals per farms in Binnenveld-oost and Binnenveld-west, required sizes for wetlands are different.

Table 9.4 Livestock waste and nutrient production per animal

	Production (g) per animal per day		
	BOD5	N	P
Dairy cows	875	183	57.5
Swine	75	86.3	40
Poultry	8	2.02	1.07

Table 9.5 Average number of animals per farm in Binnenveld

	Dairy cows	Swine	Poultry
Binnenveld-west	17	327	6324
Binnenveld-oost	19	327	5443

Computation for wetlands

1) Computations for organic load generated per farm:

For Binnenveld- west:

-Organic load generated by cows per day

BOD5 produced by cows per day:

$875 \text{ g BOD5 cow-1 day-1} * 17 = 14875 \text{ g BOD5/day}$

Nitrogen produced by cows per day:

$183 \text{ g N cow-1 day-1} * 17 = 3111 \text{ g N/day}$

Phosphorus produced by cows per day:

$57.5 \text{ g P cow-1 day-1} * 17 = 977.5 \text{ g P/day}$

-Organic load generated by swine per day

BOD5 produced by swine per day:

$75 \text{ g BOD5 swine-1 day-1} * 327 = 24525 \text{ g BOD5/day}$

Nitrogen produced by cows per day:

$86.3 \text{ g N swine -1 day-1} * 327 = 28220.1 \text{ g N/day}$

Phosphorus produced by cows per day:

$40 \text{ g P swine-1 day-1} * 327 = 13080 \text{ g P/day}$

-Organic load generated by poultry per day

BOD5 produced by poultry per day:

8 g BOD5 poultry -1day-1 * 6324 =50592g BOD5/day

Nitrogen produced by cows per day:

2.02 g N poultry -1 day-1 * 6324 =12774.5g N/day

Phosphorus produced by cows per day:

1.07 g P poultry-1 day-1 * 6324 =6766.68g P/day

-Organic load generated in total per day

BOD5 produced in total per day:

14875g BOD5/day + 24525g BOD5/day + 50592g BOD5/day
=89992g BOD5/day

Nitrogen produced in total per day:

3111gN/day + 28220.1g N/day+ 12774.5g N/day =44105.6gN/day

Phosphorus produced in total per day:

977.5g P/day+13080g P/day+ 6766.68g P/day= 20824.18g P/day

2) Computation for required areas of constructed wetlands

-Anaerobic lagoon

Application rate: 200kg BOD5 ha-1/day

Treatment area: $89992 \times 0.001 / 200 = 0.44996 \text{ha} \approx 0.45 \text{ha}$

Removal efficiency= 50% of BOD5, 20% of Nitrogen, 30% of Phosphorus

Effluents: BOD5= $89992 \times 0.5 = 44996 \text{g BOD5/day}$

Nitrogen= $44105.6 \times 0.8 = 35285.5 \text{g N/day}$

Phosphorus= $20824.18 \times 0.7 = 14576.9 \text{g P/day}$

-Marshes

Application rate: 100kg BOD5 ha-1/day

Treatment area: $44996 \times 0.001 / 100 = 0.44996 \text{ha} \approx 0.45 \text{ha}$

Removal efficiency: 30% of N, 30% of P

Effluents: N= $35285.5 \times 0.7 = 24699.85 \text{g N/day}$

P= $14576.9 \times 0.7 = 10203.83 \text{g P/day}$

-Pond

Application rate: 40kg N ha-1/day

Required area: $24699.9 \times 0.001 / 40 = 0.617 \text{ha} \approx 0.62 \text{ha}$

Removal efficiency: 60% of N

Effluents: N= $24699.9 \times 0.4 = 9879.96 \text{g N/day}$

-Meadow

Application rate: 20kg N ha-1/day

Required area: $9879.96 \times 0.001 / 20 = 0.493998 \text{ha} \approx 0.49 \text{ha}$

Removal efficiency: 90% of N

Effluents: N= $9879.96 \times 0.1 = 987.99 \text{g N/day}$

-Total wetlands system area

Lagoon: 0.45ha; Marshes: 0.45ha; Pond: 0.62ha; Meadow: 0.49ha;

Total: 2.01ha (1ha=10000m²)

3) Computations for each sub-catchment areas

Zone1: with 3 farms

Required area: $3 \times 2.01 = 6.03 \text{ha} = 60300 \text{m}^2$

Zone2: with 2 farms

Required area: $2 \times 2.01 = 4.02 \text{ha} = 40200 \text{m}^2$

Zone3: with 8 farms

Required area: $8 \times 2.01 = 16.08 \text{ha} = 160800 \text{m}^2$

Zone4: with 6 farms

Required area: $6 \times 2.01 = 12.06 \text{ha} = 120600 \text{m}^2$

Zone5: with 4 farms

Required area: $4 \times 2.01 = 8.04 \text{ha} = 80400 \text{m}^2$

Zone6: with 7 farms

Required area: $7 \times 2.01 = 14.07 \text{ha} = 140700 \text{m}^2$

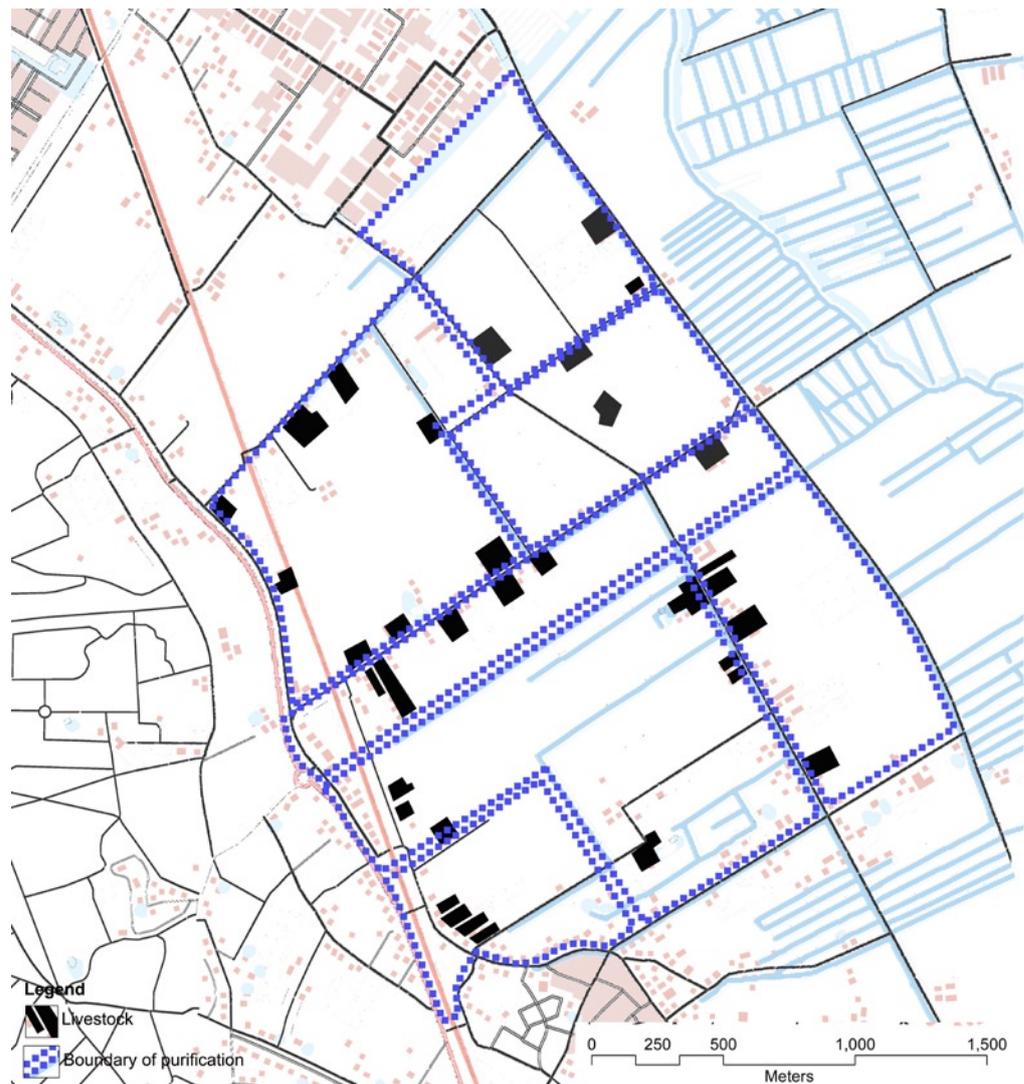
Zone7: with 4 farms

Required area: $4 \times 2.01 = 8.04 \text{ha} = 80400 \text{m}^2$

In total:

Required area: 683400m^2

Figure 9.59 Locations of livestock



(4) Computation for removal efficiency

Effluents of waste:

Nitrogen: 987.99g N/day

Phosphorus: 10203.83g P/day

Removal efficiency:

Nitrogen: $(44105.6\text{g N/day} - 987.99\text{g N/day}) \div 44105.6\text{g N/day} = 97\%$

Phosphorus: $(20824.18\text{g P/day} - 10203.83\text{g P/day}) \div 20824.18\text{g P/day} = 51\%$

Therefore, the system can remove 97% of nitrogen and 51% of phosphorus.

9.3.6 Evaluation

According to the criterias which are developed before, I evaluate design for De Meent and De Kampen in three aspects: ecology, living and production in specific.

Evaluation in ecology

- Provide habitats for meadow birds

In this design, suitable habitats for meadow birds are more than the first one. Except constructed wetlands can be used as habitats, there are numbers of green patches and green corridors available. Even wetlands require a period to improve water quality, they still form several habitats for meadow birds.

- Improve landscape connectivity

Green structures in the site are diverse and connected. New vegetation design connect fragmented green structure in the old days. More trees will be planted along roads to form a network and hide agricultural equipments. Trees will also be used to create natural environment of wetlands, which aim to form better communication places and create nice microclimate. In regional scale, three green corridors are proposed and link from conserved meadow birds' habitats to forests.

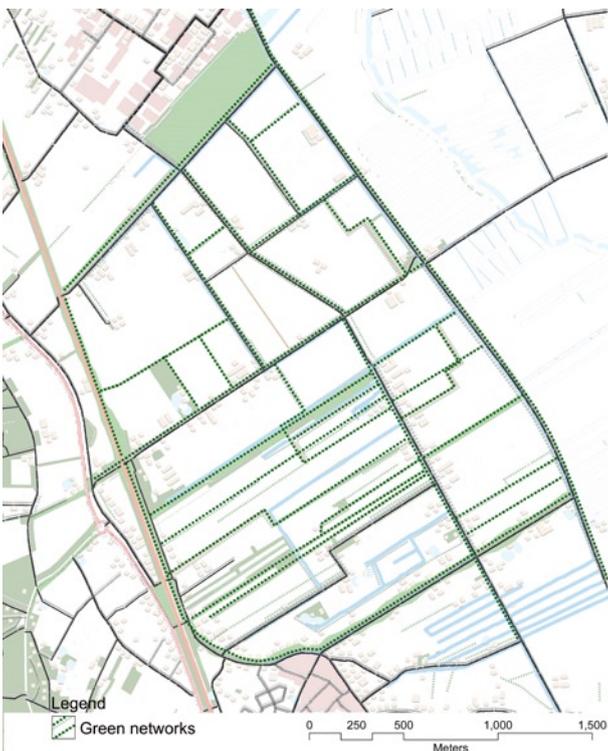


Figure 9.61 Possible habitats for meadow birds

	Criteria	Range
Ecology	Provide habitats for meadow birds	☆☆

	Criteria	Range
Ecology	Improve landscape connectivity	☆☆

Figure 9.62 Green network in the site



-Purify water from livestock and arable lands

Constructed wetlands in the site will remove 97.76% of nitrogen and 51% of phosphorus in wastewater from arable lands and livestock. Compare to 70% of nitrogen and 45% of phosphorus in normal, it has achieved a great result. In water purification system, I design riparian buffer zones as the second order of purification system. In total, they can purify most of polluted water and produce an ecological water system in the region.

	Criteria	Range
Ecology	Purify water from livestock and arable lands	☆☆☆

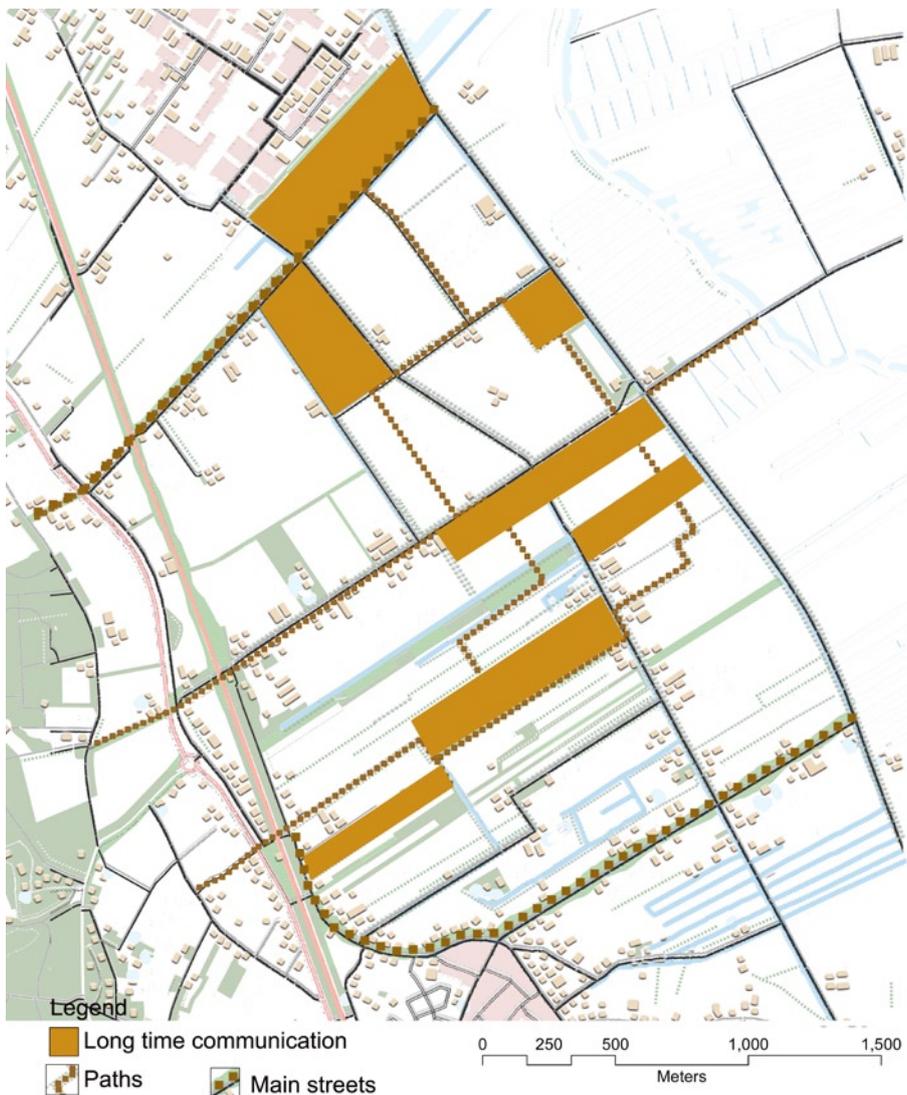
Evaluation in living

-Provide better living environment

This design also takes communication and microclimate as major considerations to create better living environment. First, wetlands, paths and major streets can provide places to people to meet each other and have leisure activities, i.e. walking, jogging.

	Criteria	Range
Living	Provide better living environment	☆☆☆

Figure 9.63 Possible leisure spaces



Second, I aim to create more comfortable atmosphere for residents. In general, places in the sunshine and protection from wind are nice for outdoor activities. Therefore, locations of vegetation and water bodies are important and affect the microclimate. Plants on the south-western sides can prevent wind in winter. And wetlands can be cooling elements to decrease temperature in small scale in summer.

-Increase local identity and feels of belonging

Through keep traditional landscape pattern, use local materials and plant native species, sense of places will be produced. New landscape elements in the design will follow local texture and embed into local context. The small scale of the landscape is preserved and enhanced by planting of linear plantings on property boundary.

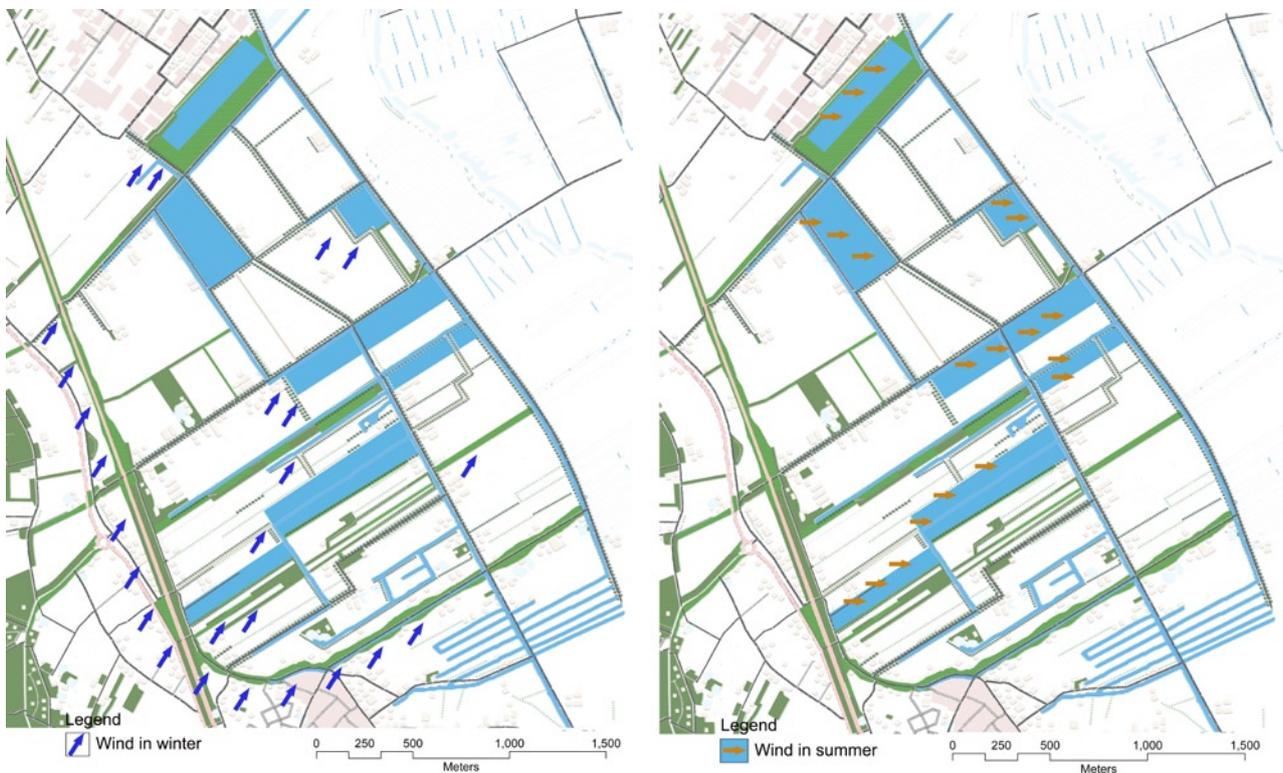
-Improve amenity of areas

In this design, trees are planted along roads to hide agricultural equipments. Natural and native species are planted to create beautiful rural landscape. Diverse planting structures will be applied, such as dense woods, shrubs, wind-break trees, linear plantings. The rural,attractive image of landscape will be recovered.

	Criteria	Range
Living	Increase local identity and feels of belonging	☆☆

	Criteria	Range
Living	Improve amenity of areas	☆☆☆☆

Figure 9.64 Wind flow



Evaluation in production

-Occupation in numbers of arable lands and livestock lands

The design will occupy numbers of arable lands and livestock for wetlands construction and new vegetation structure. Occupation on agriculture has been minimized but land owners will be involved.

	Criteria	Range
Production	Occupation in numbers of arable lands and livestock lands	☆☆

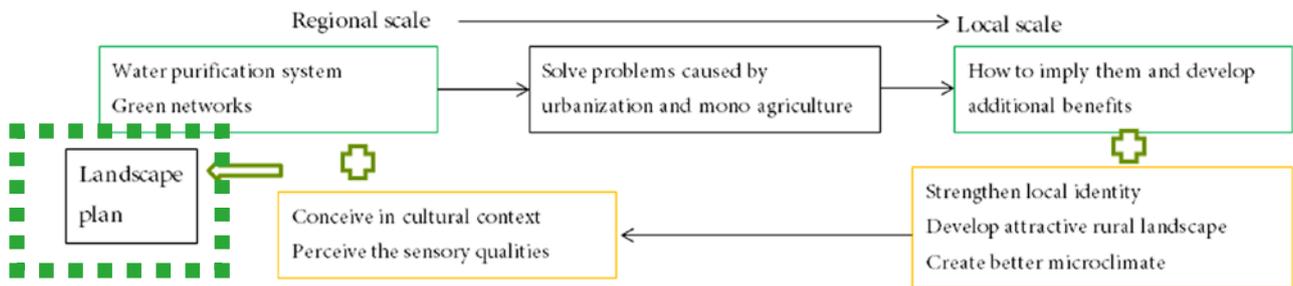
-Least negative effects from ecological strategies

The design with ecological considerations will play a important role in changing people's life styles. It can arouse people's care about their lands and create sustainable landscape as a result. At the same time, changes in the land use and people's ideas about their homes will change local economical model. More diverse economic sources can be developed, such as recreation. Peasants can develop food shop, agricultural experiences in recreation and use natural resources in the eco-friendly way. It will form a cyclic system in good ways.

	Criteria	Range
Production	Least negative effects from ecological strategies	☆☆

To conclude, this design can achieve a great result for ecology, especially for landscape connectivity and water purification. Influences on the living will also better than the first design. It is due to natural environment here having a better condition. In final, it will produce some effects on production. One is in negative aspect, it will occupy large numbers of lands. The other is positive effects, which is the diversification of local people's life styles, their activities and economic incomes.

	Criteria	Range
Ecology	-provide habitats for meadow birds -improve landscape connectivity -purify water from livestock and arable lands	☆☆ ☆☆☆ ☆☆☆
Living	-provide better living environment -increase local identity and feels of belonging -improve amenity of areas	☆☆☆ ☆☆ ☆☆☆
Production	-occupation in numbers of arable lands and livestock lands -least negative effects from ecological strategies	☆☆ ☆☆



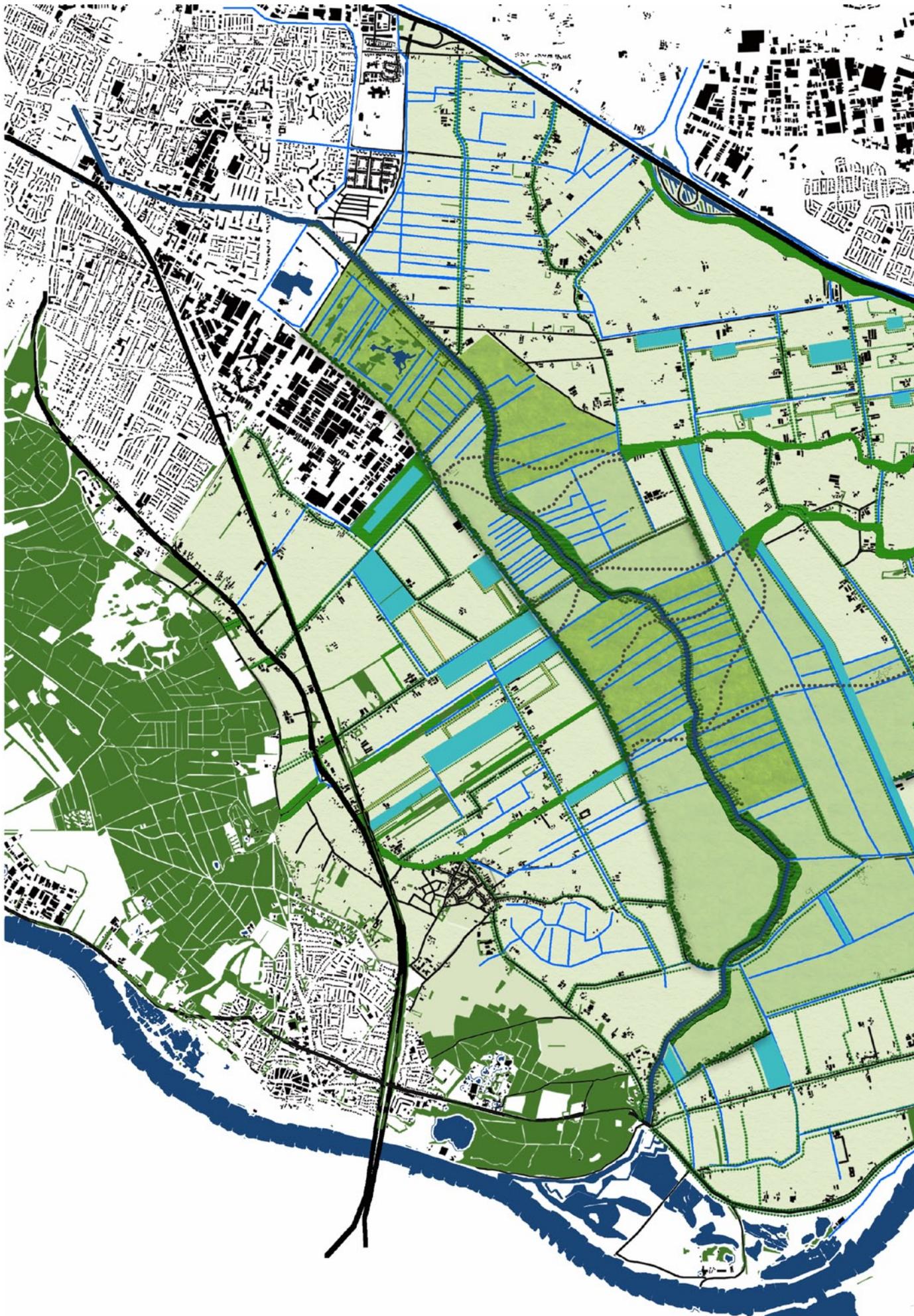
9.4 Landscape plan

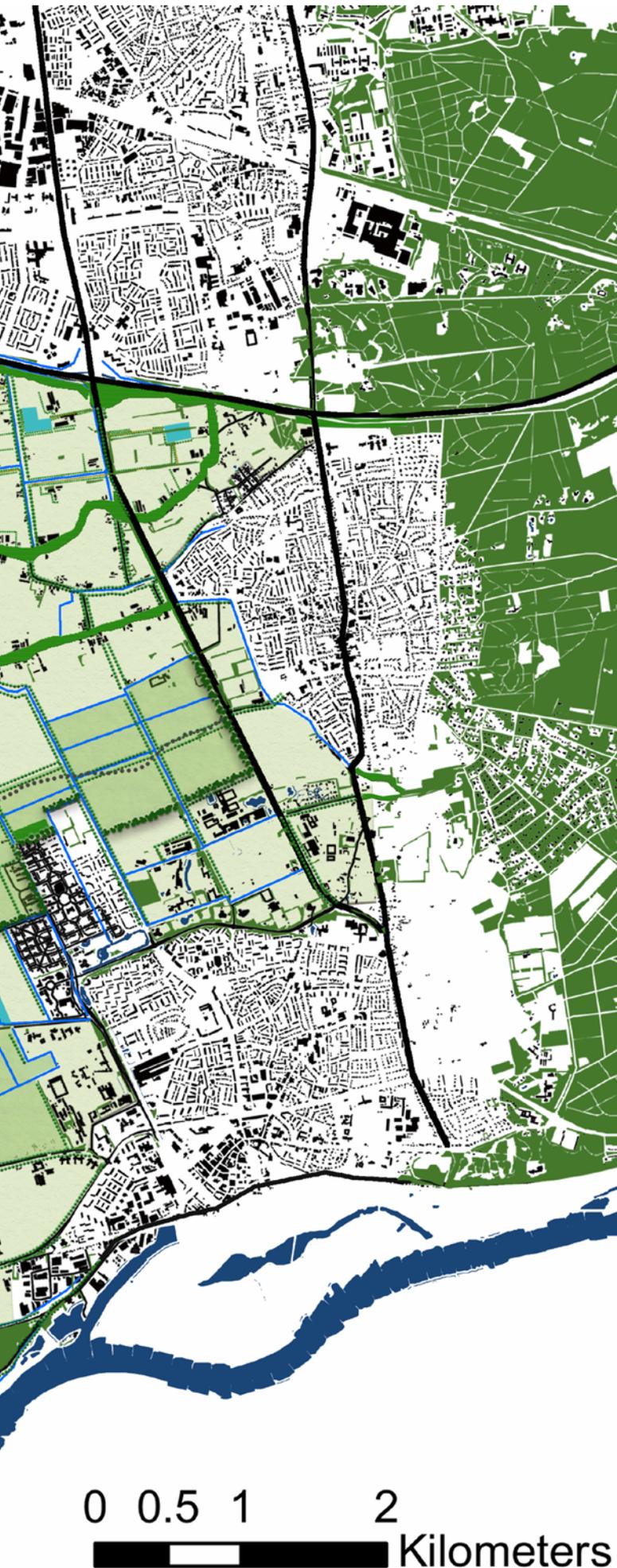
In the ecological plan, I developed water purification system and green network in the Binnenveld to improve the eco-benefits and biodiversity. Two detailed designs not only apply and test ecological plan into the concrete sites but also work on the landscape quality. On the basis of these research, analysis and design, I sum up useful design strategies and principles to create eco-friendly, attractive and livable rural landscape in the Binnenveld. These strategies and principles are listed in the table on the right side. As you can see from it, principles for water system, green system and human system will be combined with landscape functions for ecology, living and production.

In the landscape plan, functions for ecology, living and production will be integrated both in the space and time. In the water system, wetlands are not only used for wastewater purification but also function as recreational spaces for local people. These wetlands will follow local textures and be embedded into local context. What's more, they will be connected as a continuous landscape experience and to strengthen local identity. In green system, vegetation is planted not only for ecological benefits, but also to improve the landscape quality. Besides landscape connectivity, how to create a beautiful and livable rural areas with vegetation is an important question. Traditional planting pattern and landscape pattern are conserved. Linear plantings, such as wind break trees are protected and developed. At the same time, as a useful tool vegetation can help us to create a better microclimate. Orientation and structure of planting are considered carefully to prevent wind in the winter and provide shadow in the summer. Traditional cultivation pattern, such as small scale strips cultivated lands, is conserved as well. The human system is based on the water and green system. Nice living environment and comfortable atmosphere are supported by water bodies and vegetation. All the considerations of the human system can be presented in the design for water and green system.

Table 9.6 Design principles

	Water system	Green system	Human system
Space for ecology	<ul style="list-style-type: none"> -construct wetlands in the upstream lands -develop buffer zones along the stream -take hydrology, soil, groundwater, land use as criteria to decide the suitable location 	<ul style="list-style-type: none"> -conserve valuable and suitable areas for meadow birds -develop green connectivity on the existing green structure -native species are preferred 	<ul style="list-style-type: none"> -decrease human activities in the eco-vulnerable areas
Space for living	<ul style="list-style-type: none"> -locate constructed wetlands in the frames formed by roads -form in local texture and embed into local context -combine with ditches to lend identity -work with natural elements and local materials -use as cooling elements -protect wind in winter -use as leisure spaces 	<ul style="list-style-type: none"> -form continued landscape experiences from stream, agricultural to hilly landscape -extension and strengthening of traditional landscape pattern -form open and closure landscape -follow traditional planting pattern -linear planting along roads to hide agricultural equipments -native species are preferred -protect wind in winter and direct it in summer -prevent solar radiation in summer and allow winter sun 	<ul style="list-style-type: none"> -provide accessible to wetlands and green and form more leisure spaces -form a continuous landscape experiences -recover the quiet and beautiful rural scenery -more community spaces
Space for production	<ul style="list-style-type: none"> -minimum occupation in agricultural lands 	<ul style="list-style-type: none"> -minimum occupation in agricultural lands -conserve traditional cultivation pattern 	<ul style="list-style-type: none"> -introduce diverse activities and economic incomes





Legend

- | | |
|---|---|
|  Constructed wetlands
Wetlands constructed in upstream and be used to purify wastewater |  Conserved meadows
Meadows with vulnerable plant species and conserve for meadow birds as habitats in the whole year |
|  Periodically conserved meadows
Meadows be conserved for meadow birds as habitats in the breeding period |  Riparian buffer zones
Vegetation strips to purify wastewater in second order and connect conserved meadows |
|  Groups of trees
Vegetation with pioneer species and diverse planting structure, to connect fragmented green structure and form green corridors |  Anthony pedestrain route
Paths aim to link constructed wetlands and form continous landscape experience |
|  Anthony roads
Native trees are planted along these roads to create beautiful landscape |  Wind break trees
Native trees in the linear forms to protect wind in winter |
|  Vegetation buffers
Vegetation on the boundaries of conserved meadows and urban areas to diminish negative impacts of urbanization and infrastructures |  Possible ways for birds' movement
Possible connections from western sides to eastern side |
|  Old groups of trees |  Ditches |
|  Water bodies |  Buildings |

Figure 9.65 Landscape plan for the 2015

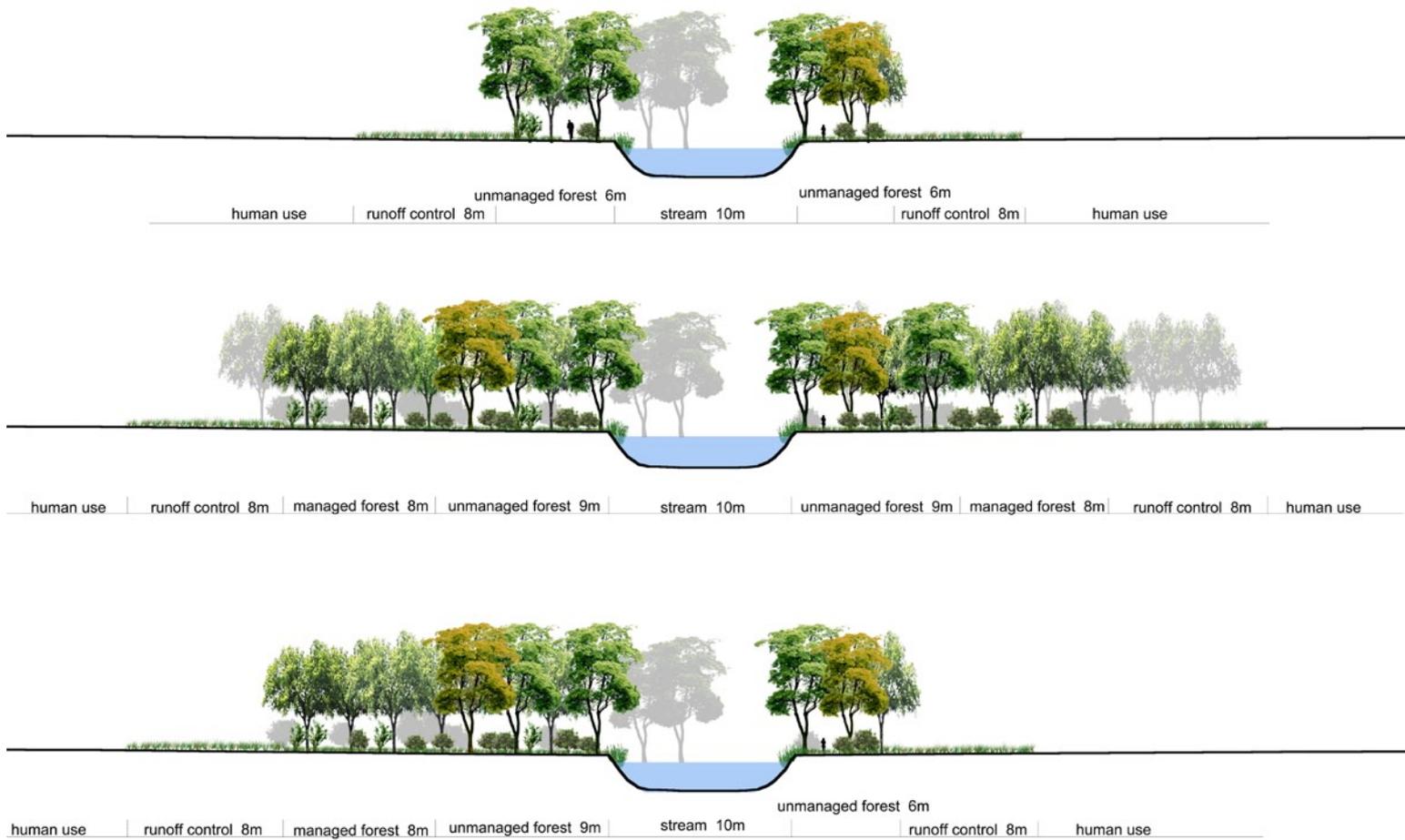


Figure 9.66 Three types of profiles

Unmanaged forests	Reduce water temperature Provide corridors for meadow birds movement
Managed forests	remove sediment and nutrients from runoff and subsurface flow
Runoff control	Concentrated flows are converted to dispersed flows, decrease water flowing velocity, enhance infiltration and removal of sediments

There are three types of profiles for buffer zone along the stream. In the ecological plan, riparian buffer zones functions as "machine" of water purification and corridors for meadow birds' movement. Because different land use along the stream, sources of water pollution are different. They require different structure of buffers to purify. For phosphorus pollution, runoff control is better but forests are necessary for nitrogen removal. Because managed forests are proposed to be cut after a period to remove pollutants stored in the trees. Unmanaged forests are proposed to keep the landscape connectivity and reduce water temperature. Integrate with the human system, people's experiences along the stream should be considered. The buffers should provide natural environment, leisure spaces and also views to the surrounding environment.



Figure 9.67 Current situation

Figure 9.68 Future images





Figure 9.69 Current situation

Figure 9.70 Images for the future



In the wet areas, there are several areas proposed to be conserved as the habitats for meadow birds. Most of them are occupied by pastures nowadays. Agricultural activities will form disturbances in the nesting period. At the same time, there are some valuable and rare species in parts of them and should be conserved. Conservation of these habitats will increase the biodiversity. People can be visible accessible to these conserved areas.



Landscape development in the timeline

The figure in the left side shows design strategies for the landscape development in the timeline.

(1) Water system

From 2010 to 2015, water system in the region will be transformed into water purification system with constructed wetlands, buffer zones and grassed waterways. Then, start from 2015, improvement of water quality in the wetlands will provide opportunities for wildlife living. Structure of wetlands will be modified into natural freshwater marshes. Natural boundaries will be suitable for various wildlives. Come to 2050, flooding will be a problem due to the global climate change. To find spaces for water storage, there are three ways. Firstly, marshes can be used to store runoff from upstream land. Secondly, stream will be unchannelized. Meandering streams can reduce the speed of water flow and provide more space for water storage. Finally, floodplains are planned according to the expectation of flooding in the next 50 years.

(2) Green system

From 2015, green network has been developed. The development of green system in the future mainly presents on the successional growth of vegetation, and diverse and climax vegetation species.

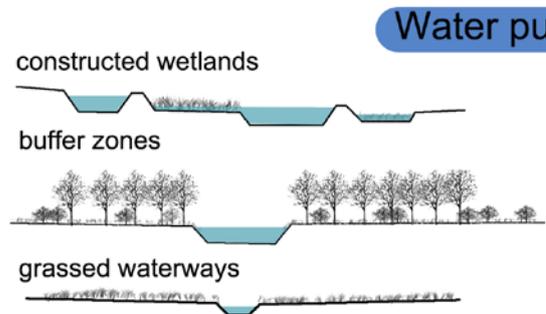
(3) Human system

Nowadays, intensive agriculture occupies the most parts of the region. Production as a major activity, will damage the environment. Based on my design, new landscape functions for living and recreation will be integrated into the region. They will change local people's life styles and create diverse economic sources. Agriculture will experience the transformation from intensive agriculture to extensive agriculture, and finally reach to organic agriculture. Human's relationship with the environment will not be consume environment for production but to protect the natural environment and seek for the development together.

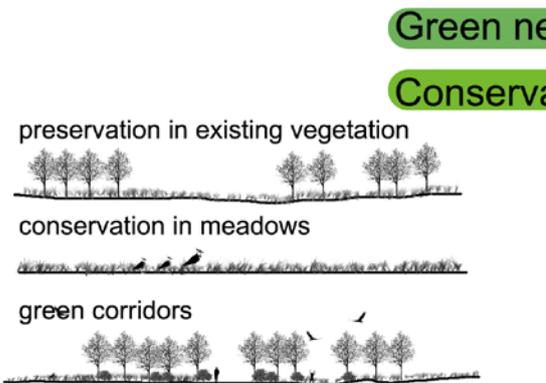


2010

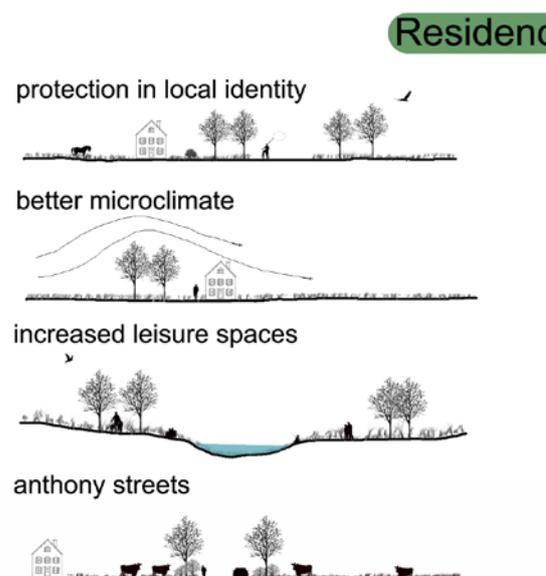
Drainage system



Fragmented green structure



Production (intensive agriculture)



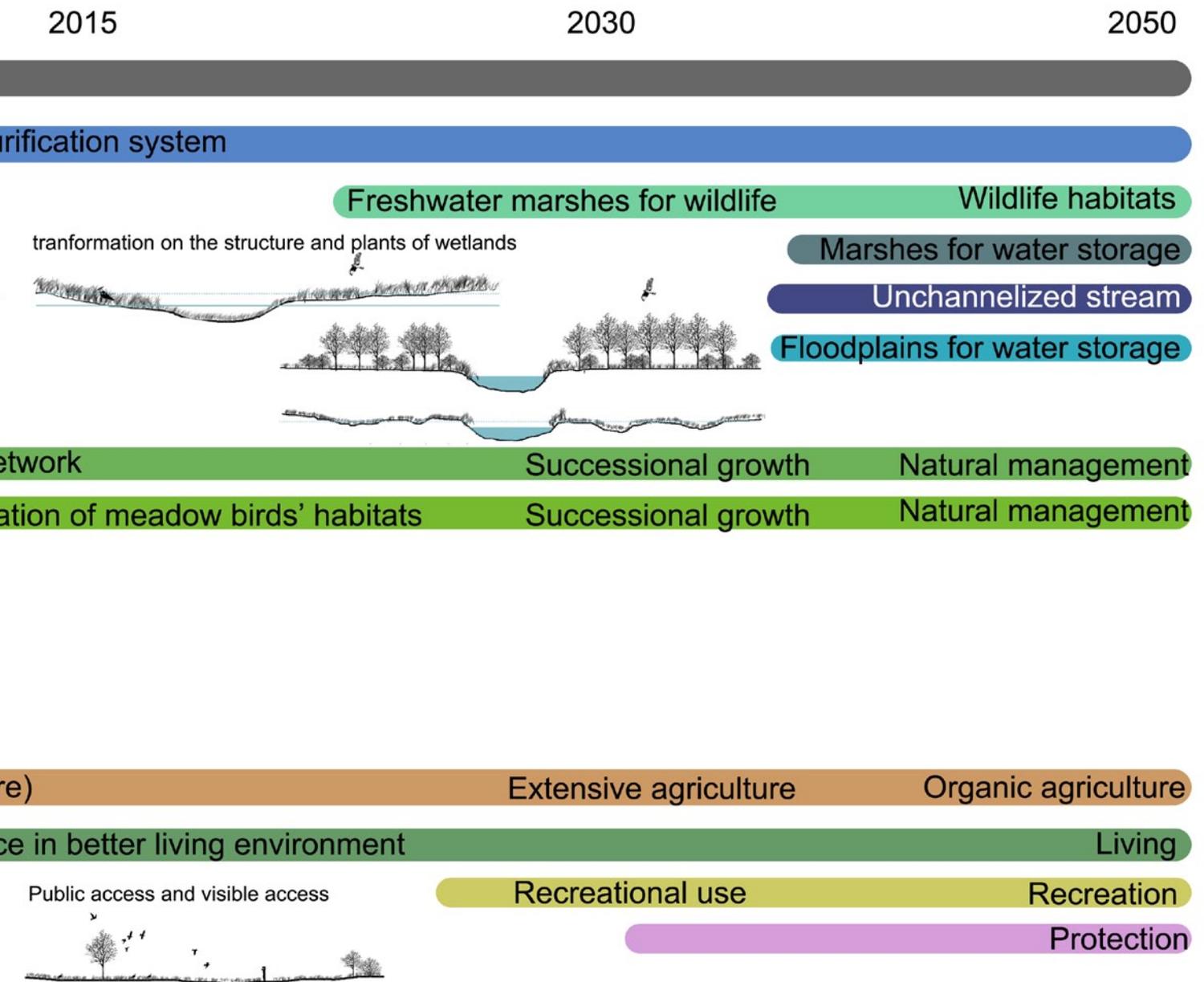
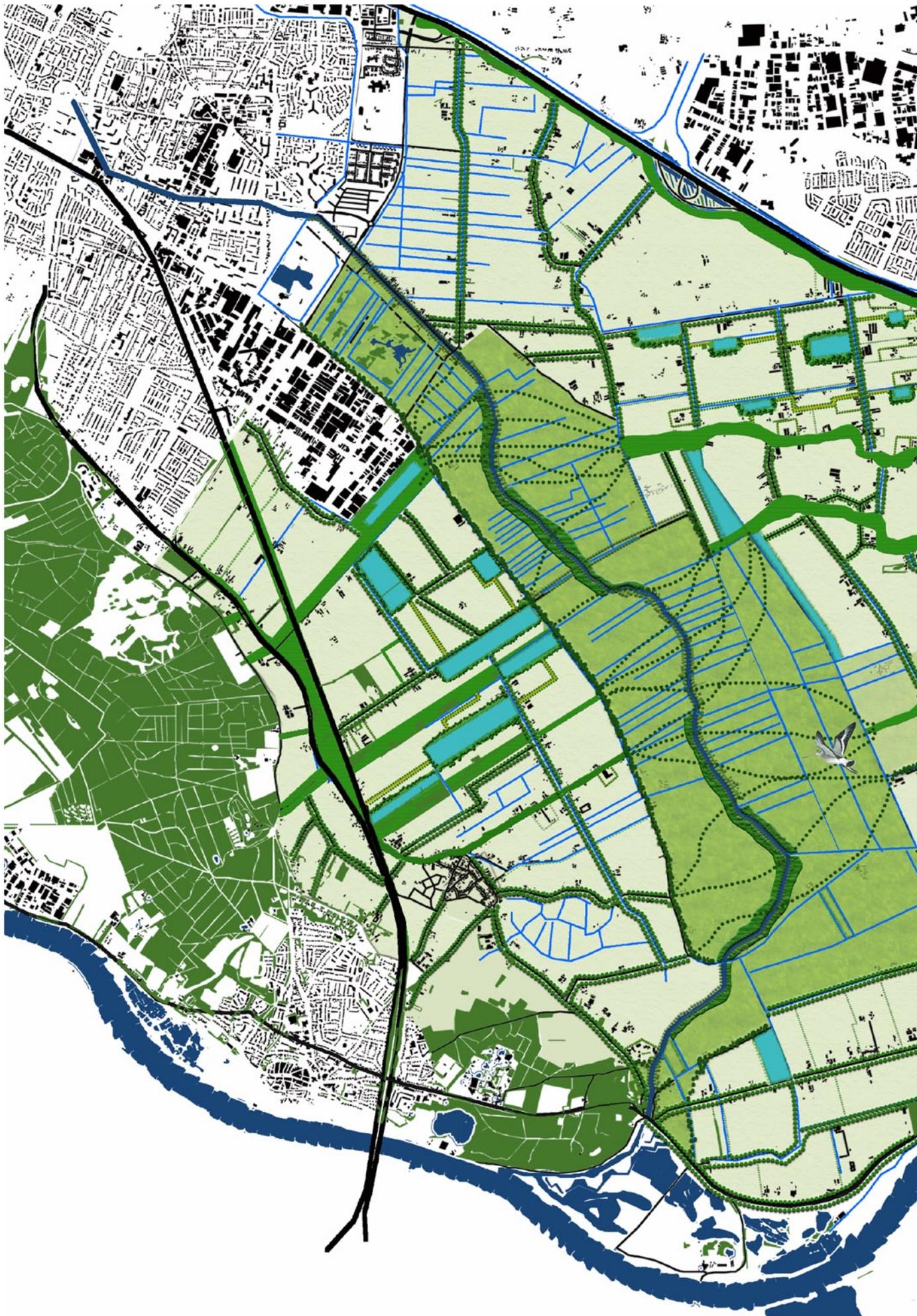
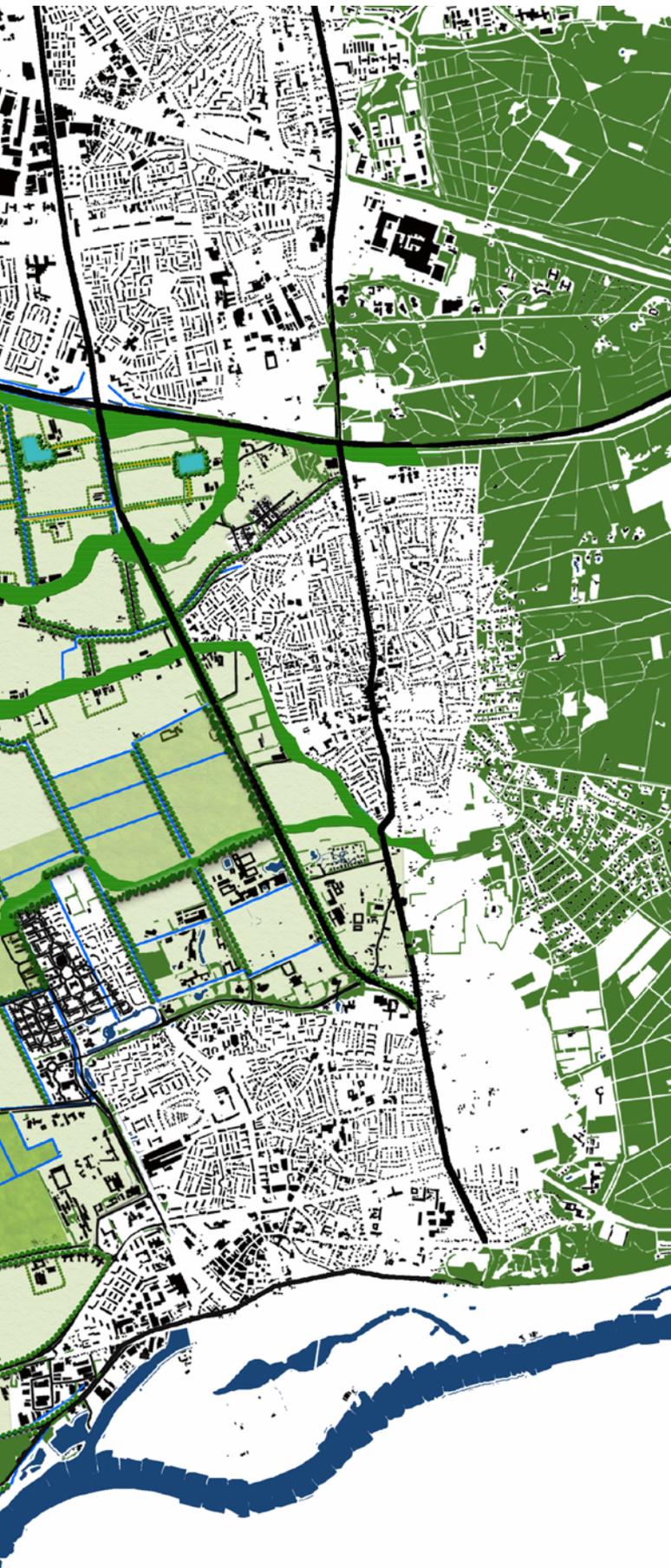


Figure 9.71 Strategies for landscape development in the timeline

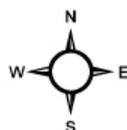


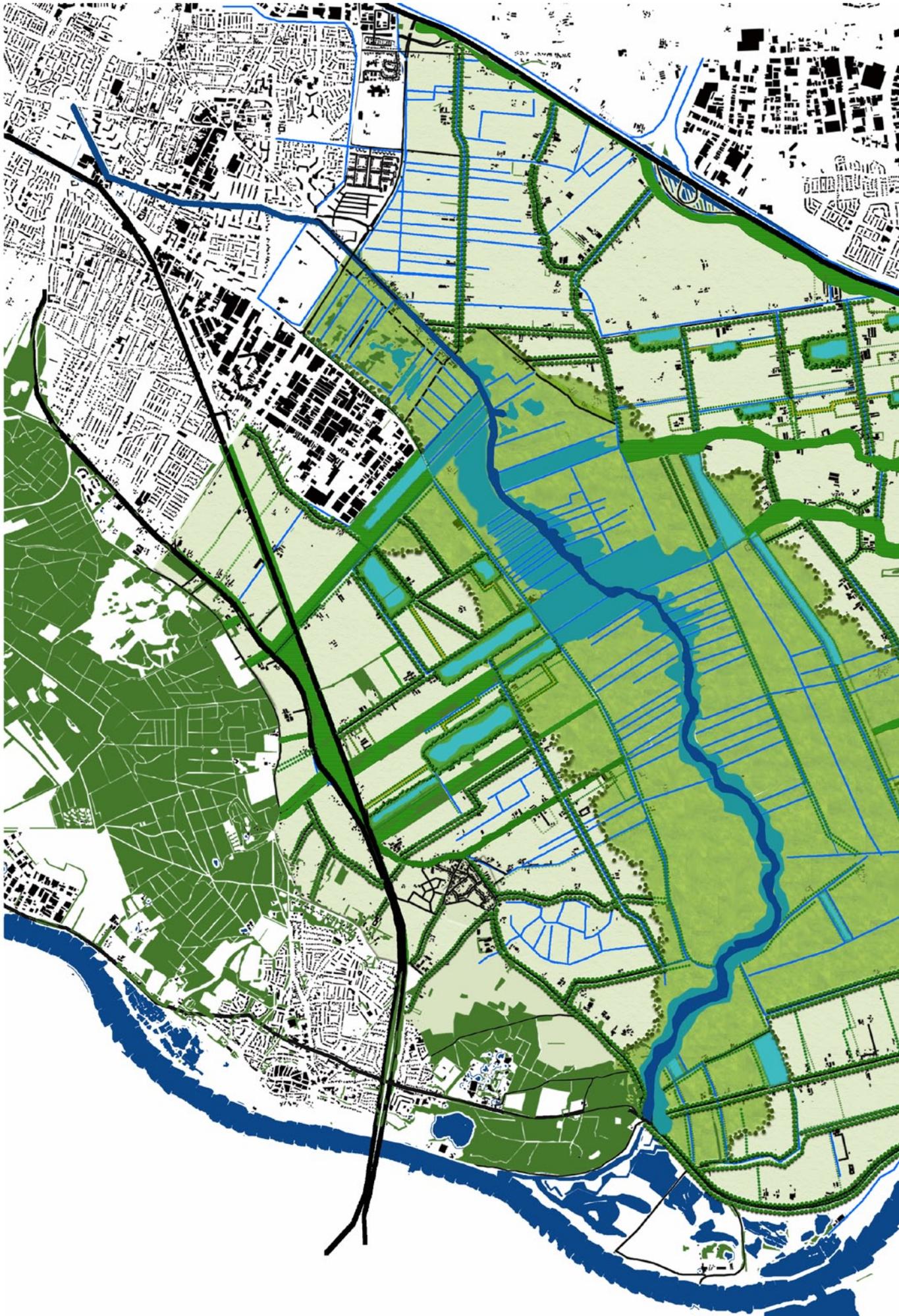


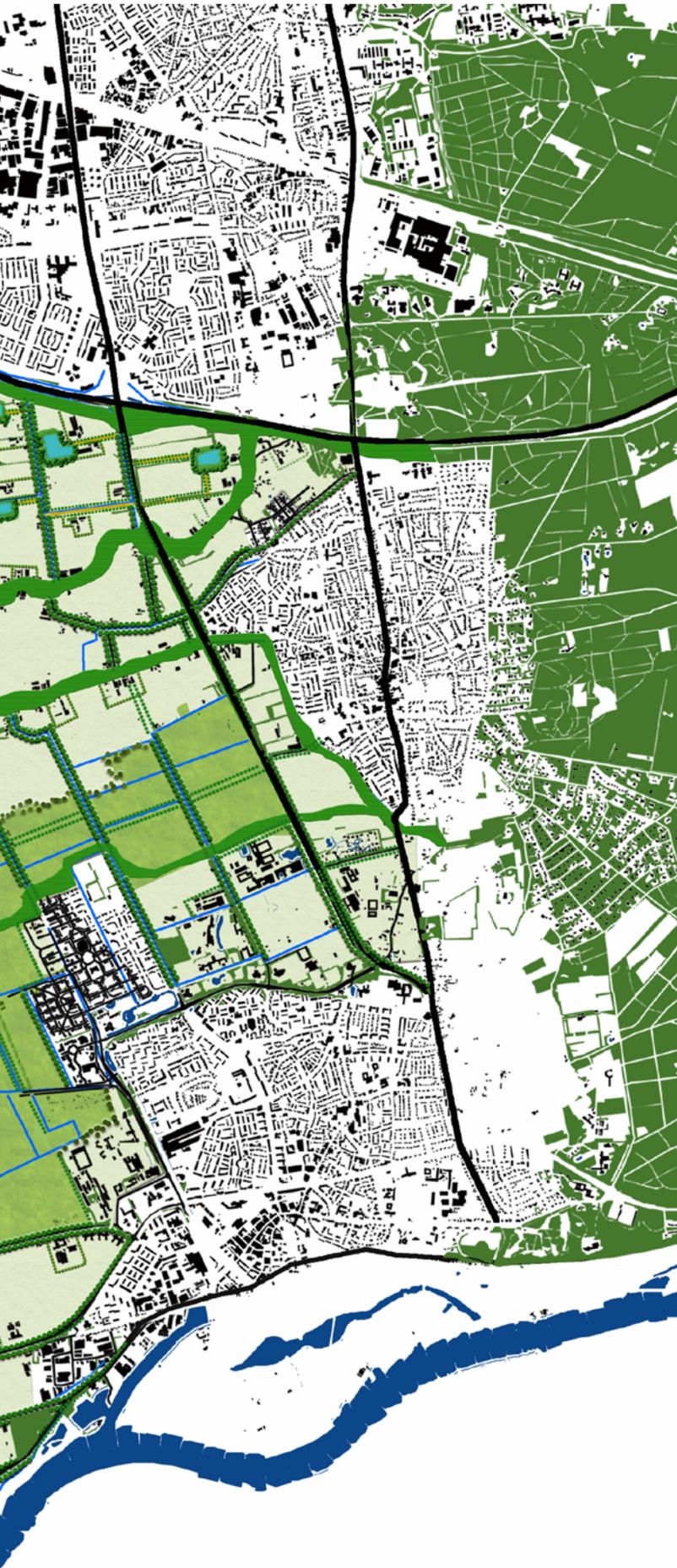
Legend

- | | |
|--|---|
|  Freshwater marshes |  Conserved meadows |
| Transformation from constructed wetlands to freshwater marsh. They will be natural habitats | Meadows with vulnerable plant species and conserve for meadow birds as habitats in the whole year |
|  Periodically conserved meadows |  Riparian buffer zones |
| Meadows be conserved for meadow birds as habitats in the breeding period | Vegetation strips to protect aquatic environment |
|  Groups of trees |  Aquatic plants |
| Successional growth and transform from pioneer species to native species. | Plants to provide better aquatic environment and habitats for biodiversity |
|  Wildlife habitats |  Vegetation buffers |
| Vegetation surrounding marshes and provide habitats for wildlife. | Formed on the boundaries of conserved meadows and urban areas |
|  Anthony roads |  Anthony pedestrian route |
| Native trees are planted along these roads to create beautiful landscape | Paths aim to link constructed wetlands and form continuous landscape experience |
|  Wind break trees |  Garden trees |
| Native trees in the linear forms to protect wind in winter | Trees or hedgerows on the boundaries of gardens or farms to create small scale lands |
|  Possible ways for birds' movement | |
| Possible connections between two sides of conserved areas | |
|  Old groups of trees |  Ditches |
|  Water bodies |  Buildings |

Figure 9.72 Landscape plan for the 2030







Legend

- | | |
|--|---|
|  Unchannelized stream |  Flood plains |
| Transform channelized stream into natural and meandering pattern | Provide spaces for flood |
|  Freshwater marshes |  Conserved meadows |
| Natural marshes for water storage and support endangered or threatened plant and animals species | Maintenance of the conserved meadows in th whole year meadow birds as habitats in the whole year |
|  Groups of trees |  Vegetation buffers |
| Natural manage on the native and climax vegetation | Formed on the boundaries of conserved meadows and urban areas |
|  Wildlife habitats |  Aquatic plants |
| Manage and develop to provide habitats for wildlife. Create spaces for leisure activities | Plants to provide better aquatic environment and habitats for biodiversity |
|  Anthony roads |  Anthony pedestrain route |
| Native trees are planted along these roads to create beautiful landscape | Paths aim to link constructed wetlands and form continous landscape experience |
|  Wind break trees |  Buildings |
| Native trees in the linear forms to protect wind in winter | |
|  Garden trees |  Ditches |
| Trees or hedgerows on the boundaries of gardens or farms to create small scale lands | |
|  Old groups of trees | |

Figure 9.73 Landscape plan for the 2050

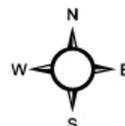




Figure 9.74 Current situation

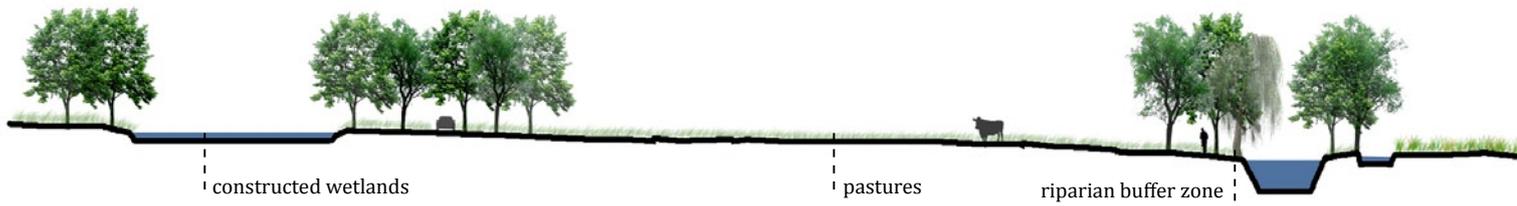


Figure 9.75 Images for the 2015



Chapter 9 Detailed design & landscape plan

In 2015, landscape along the stream will be different. Buffer zone has been developed along the Grift. In this viewpoint, because the surrounding lands are not used for agriculture intensively, pollution on water are not serious. Buffers will present in the form of tree line and provide open views. The pasture in the eastern side, Bennekommer meent, has a large number of valuable plant species. It will be conserved as the habitats for meadow birds first. The western side of the stream will be conserved in the nesting period of meadow birds.

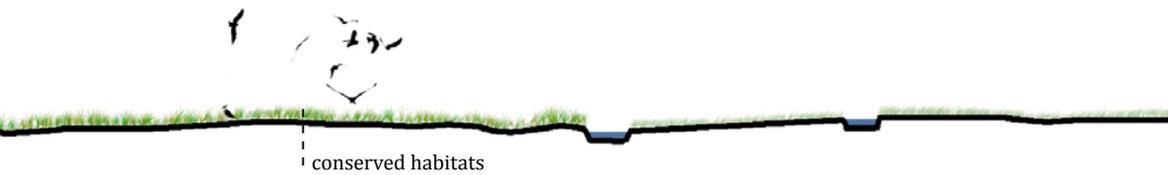
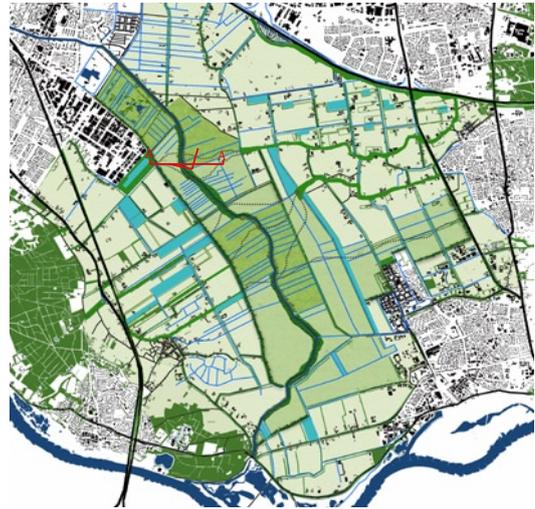
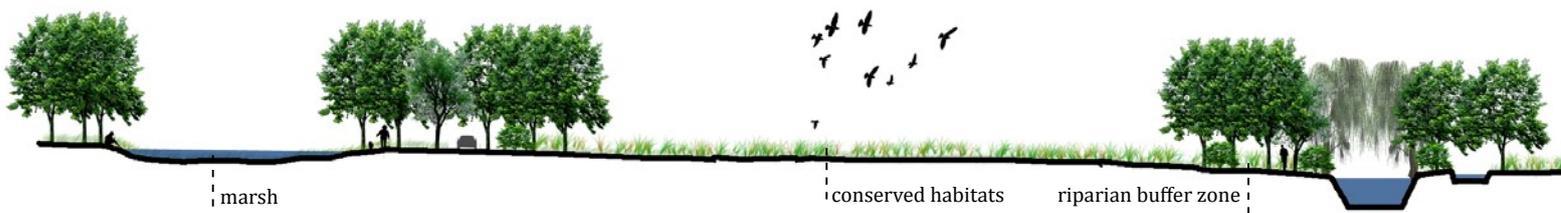


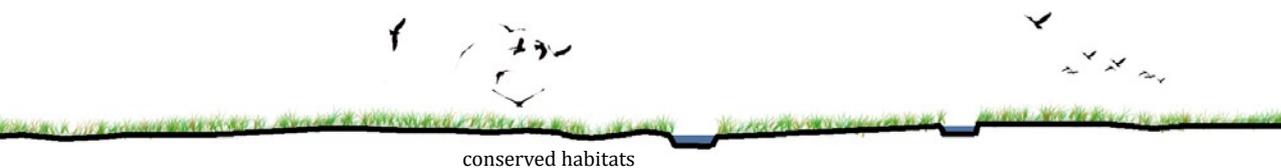


Figure 9.76 Image for the 2030





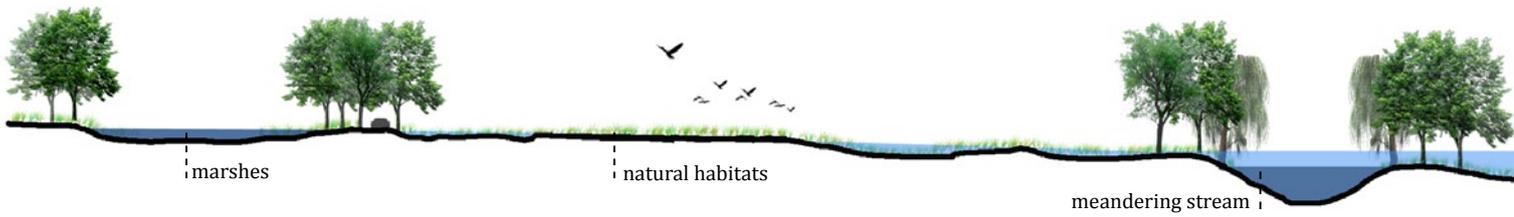
In 2030, the buffer along the stream will successional grow. There are an increasing diverse of plant species. With the transformation from intensive agriculture to extensive one, requirements on the lands for agriculture will be decreased. The western side of the stream will be conserved as the habitats of meadow birds as well.

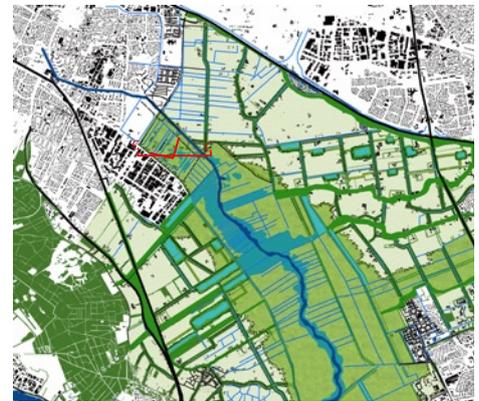


conserved habitats



Figure 9.77 Image for the 2050





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Chapter 10

Conclusion

10.1 Conclusion

10.2 Discussion and further research

10.1 Conclusion

With the fast changing in the social and economic conditions, there is an increasing number of uniformity in the rural landscape. The urbanization and monofunctional agricultural land use cause several conflicts and block the sustainable development of rural areas. A lot of documents and projects in the rural areas provide us the right perspectives to develop the rural areas into good living conditions, and a lively social structure with a strong sense of identity, a properly functioning ecosystem and an attractive landscape. However, concrete methods and approaches to work in the landscape is lacking. What' s more, due to the special position rural areas occupy, they should not only provide resources for human consuming, but also function as the habitats for wildlife. Hence, how to integrate various landscape functions is an important question. Landscape architecture, as an interdisciplinary, integrative and critical life science by design, can be used to solve it. To conclude, there was a gap here as: the lack of landscape applications.

Hence, major research question is: *How can my studying area be developed into a sustainable and attractive region, where negative impacts from urbanization and intensive agriculture will be decreased, and various landscape functions be developed and integrated in a sustainable way?* Works to answer this question can be divided into two parts: (1) development of design strategies, principles and methods; (2) application on the case study area: binnenveld, in the netherlands. In this chapter, I will give a critical review on these works and present the main results of this thesis.

(1) Development of design strategies, principles and methods

First, design strategies, principles and methods developed in this thesis will be presented. They can based on my answer of the research question:

What sustainable and innovative design principles and methods can be applied to solve problems and develop landscape functions?

I did general theoretical research on the concept of sustainable development, ecology and landscape ecology at the starting. They provide me some sights on the possible developing perspectives of rural areas, i.e. multifunctional landscape. Then, transform these theories into landscape design, some landscape strategies and a set of design principles are proposed.

Landscape strategies

There are two landscape strategies developed in the chapter 8 for water purification system and greenways network.

Water purification system

According to my literature study, two alternatives are proposed for water purification system, one is the construction of several upstream wetlands and the other one is to develop a large wetland in the downstream. They will

produce different influences on the ecological, living and productive functions of landscape.

Greenways network

A greenway approach is proposed to improve the landscape connectivity in the study area. To develop the greenways network, a set of questions should be answered in order: a. What are key and indicating species in the field? b. What do habitat requirements of these species? c. What are habitats characteristics of the region? d. Where are suitable habitats for these species? e. How to conserve and develop these habitats?

Locate landscape strategies

To locate these landscape strategies on the case studying area, the suitability analysis can be used as a method. The suitability analysis is based on the site conditions and requirements of landscape strategies. Suitability analysis is mainly applied in the large scale. It can help us to understand and master the plan in the regional scale.

Design on the local scale

Strategies in the regional scale should be transformed into concrete design in the local scale and embedded into the local context. Landscape strategies should be applied in the designs for several representative sites. Selection of these representative sites should be critical and based on the purposes of detailed design. In general they have different site conditions, landscape appearances and urgent in the problems. Problems there should be typical.

Design principles

To fill the gap: the lack of landscape applications, a set of design principles should be abstracted from my representative designs. These design principles will be applicable on other similar locations as well. These principles include considerations of functions for ecology, living and production.

-Construct wetlands in the upstream lands

Constructed wetlands at the source designed and operated specifically for treating wastewater emanating from concentrated livestock.

Effects: pollution control in the sources, less runoff pollution and erosion,

-Develop buffer zones along the stream

Buffer zones provide wastewater treatment from a variety sources. They are represented by buffer strips of riparian wetlands along permanent streams. It provides treatment with less concentrated, aggregate wastewater from a variety sources, and also produce ancillary benefits

Effects: pollution control, lower temperature of the stream, better landscape connectivity, recreational spaces

- Conserve valuable and suitable areas for rare species

Areas, suitable for rare wildlife or have valuable plant species should be conserved.

Effects: better natural environment, better biodiversity

- Develop green corridors

Based on the current situation of vegetation distribution, green corridors should be developed to connect the landscape. A green network is proposed.

Effects: better landscape connectivity, better biodiversity

- Build buffers between urban and rural areas

Vegetation buffers can be developed in the middle of urban and rural areas. They can diminish the negative impacts of urban areas on the rural parts and provide recreational spaces.

Effects: better rural landscape, more recreational spaces

-Working with natural elements and local traditions

Sense of place will provide people feelings of belonging and at home. local materials and traditions can be critical put into use to connect places to the past time and wake up people's memories.

Effects: Feeling of belonging

- Respecting a vernacular sense of order

New landscape elements can locate in the frame of traditional landscape, follow the landscape texture and embed into the local context. The traditional landscape pattern should be conserved and strengthened.

Effects: stronger local identity, better acceptance of designs

-Form diverse landscape experiences

Diverse landscape experiences can be formed by the sequences of various landscape spaces. It will arise people's interesting on the sites.

Effects: more interesting experiences, more usage of the sites

- Make the landscape accessible

The landscape can be walkable and visible accessible. People like to experience the landscape by themselves. Roads system should be considered carefully.

Effects: more attractive, more interesting experiences

- Create comfortable atmosphere

Microclimate is not only a problem in the urban areas, but also in the rural ones. Comfortable atmosphere can be created with the vegetation and water bodies. Wind in the winter should be prevented and shadow should be provided in the summer.

Effects: more comfortable living and leisure spaces

- Minimum occupation in agricultural lands

Occupation on the agricultural lands will cause conflicts with production and decrease the acceptance of local peasants on the design. In the process of designing, occupation on the agricultural lands should be calculated carefully.

Effects: better acceptance of the design

- Introduce diverse activities and economic incomes

Diverse activities will change people's life styles and opinions on their lands. various economic incomes will relieve them from agricultural incomes, and transform from production into protection

Effects: more protection in natural environment

(2) Application on the case study area: binnenveld, in the Netherlands

To apply and test these landscape strategies and principles, binnenveld in the Netherlands was used as case study. It gave the research practical meaning and answered the research question:

How to plan and design for the studying area as a showcase to verify aforementioned principles and methods?

First, in the regional scale landscape strategies were developed for water purification system and greenways network. Suitability analysis can help us to master the locations of landscape strategies. The criteria of suitability are based on the site conditions and concrete requirements of landscape strategies. After suitability analysis, ecological plan was proposed. The water purification system consists of constructed wetlands in the sources and buffer zones along the stream. The central wet parts of the binnenveld are conserved as the habitats for meadow birds and green corridors are suggested to improve landscape connectivity.

Then, research and design will be developed in the local scale. In this scale, design will be more concrete about how to transform these landscape strategies and methods into sites design and embed them into the local context. Design in this scale will not only aim to improve biodiversity, but also consider about human's requirements on their environment. An attractive and livable rural landscape will be presented in the concrete design. De kraats and de meent & kampen were used as showcase to apply and test these principles. Problems of water pollution and decline in biodiversity are solved. Traditional landscape is conserved and local identity will be strengthened. A comfortable microclimate is created to make sites more livable.

Finally, back to regional scale, landscape plan is proposed according to the previous research and designs. Various design strategies and principles have been synthesized here and produced the landscape plan in final. The landscape plan for the binnenveld integrated all considerations of ecology, living and production together. These landscape functions were integrated and create an eco-friendly, attractive rural landscape in the binnenveld. Possible development of landscape in the timeline is expected. Water system will change from drainage system in the nowadays to purification system in 2015. Then, start from 2015, structure of wetlands will be modified into natural freshwater marshes. To 2050, the stream will be unchannellized and floodplains will be planned to prepare for global climate change. The green system in the future mainly presents on the successional growth of vegetation, and diverse and climax vegetation species. Agriculture will experience the transformation from intensive agriculture to extensive agriculture, and finally reach to organic agriculture. Human's relationship with the environment will not be consuming the environment for production but to protect the natural environment and seek for the development together.

(3) Personal learning goals

In the beginning of this thesis, I explained my personal background and learning goals. I said that I want to learn more about sustainable and ecological planning, not only on the concepts and theories but also about how to transform them into practices. What's more, I would like to learn more ideas of what is the role of research and how to integrate research and design. During the process of thesis, I have learned a lot in these aspects.

At first, I learned basic theories and concepts of sustainable development, ecology and landscape ecology. To transform them into practices, I developed landscape strategies and principles based on the literature study. I have been clear about how wetlands purify wastewater and how to construct them in diverse site conditions. I have learned the strategic framework to develop greenways network and modified it into my studying areas. In the whole process of thesis, I also realized that landscape design consist of design forming and ecological process. Hence, what we should do as landscape architectures is to combine ecological design of the landscape with the social nature of our landscape perception. As Nassauer said that "If we probe the social language of landscape form and learn these conventions of landscape appearance, we can use these conventions to label ecological function. (Nassauer 1992)"

Then, due to my personal background, knowledge of research by design is lacking. How to develop a strategic structure of research and design is a challenge for me. Study on the theories of landscape planning and design help me to overcome it. The research framework proposed by Steinitz, which include six different questions, give me the basic understanding of how to organize the landscape project. The triplex model, layer approach, and sociophysical model taught me that the landscape appearances are drive by their physical environment and also social perspectives. The interactions of the natural and social system can be the starting point to analysis landscape in deeply. Then, in the literature studying, I did research on possible design strategies and principles to create an eco-friendly, attractive rural landscape. The application and test of them into the concrete designs help me to evaluate these design strategies and principles. In this process, I have been clear about the relationship between research and design. What's more, I realized the significances of research and design in different scales and transformation in them. Various scales will require different landscape analysis, research and have different design objectives. Transformation of research and design in different scales can help us to integrate various landscape functions and make a comprehensive plan.

10.2 Discussion and further research

This thesis provides an ambitious landscape plan for the Binnenveld, which aims to develop the region into eco-friendly and attractive rural areas. This part provides some discussion on my research and points for further research.

Firstly, as the master thesis of a landscape architecture student, there is no constraint on all the possible difficulties. The plan offers a positive image on all the possibilities and chances for the region to develop. It pays much more attention on the ecological benefits, spatial quality instead of political system. There are a lot of political documents indicates the perspectives for rural development. This work follows these perspectives but discussion with government is lacking.

This work covers designs in different scales and transformation in them. The landscape plan is proposed in the regional scale, and two detailed designs are presented in different landscape units. However, concrete designs for each part of the region cannot be completed. Chapter 9 (Detailed designs & landscape plan) illustrates how the plan will be transformed into concrete designs on different scales. It includes designs in the local scale and also illustrations for the green corridors or constructed wetlands. I believe it makes the vision much easier to understand.

This work is mainly based on the literature studies and my interpretative analysis. The historical development and landscape analysis are based on the maps analysis, literature studies, fieldwork and interviews. The design strategies and principles are major from literature review. In my research, the references study is lacking. For diverse design strategies and principles, I have learned from several similar cases. They provide me inspiring ideas of how to use these principles and what about the results. However, no one reference provides me a perspective or direction for the region development because I cannot find a case faced to the similar extent. Therefore, I recommend developing the region as a showcase for rural sustainable development.

I did a calculation on the required sizes of constructed wetlands to purify wastewater in chapter 9. To work on it, numbers for organic load generated per farm per day are necessary. However due to accurate figures on them are not available, or at least not available to me, I did the computation on the basis of average number of livestock waste and nutrient production per animal and average number of animals per farm in Binnenveld. The results based on it are not so accurate.

The proposed plan is a vision for the region development instead of a ultimate design. It can be a starting point and perspective for plans and designs in the region. Behind the plans and designs, there is a way of thinking and an landscape approach to design, which are general and can be applied in most rural areas. What's more, the landscape plan is developed for the binnenveld, but the landscape strategies and principles to solve problems can be applied in other cases faced to a certain extent, problems related to the urbanization and intensive agricultural land use.

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