Green- blue veining: agro-biodiversity as innovation for sustainable agriculture

Client: Ministerie van VROM

ECORYS Nederland BV

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Summary

The Hoeksche Waard is a predominantly agricultural region in The Netherlands characterized by a green and open landscape that is of national importance and has special “National Landscape” status. A series of workshops, commissioned research and consultations have taken place over the last few years in order to establish green-blue veining in this region. This paper summarizes the results of these dialogues and highlights the socio-economic and scientific research by Alterra, ECORYS Netherlands B.V., Witteveen+Bos B.V. and the various other contributors. It will demonstrate the vision of the different groups striving to create green-blue veining, the strategies that have been used, the problems faced and the experiences they have had.

Green-blue veining is a network of vegetation and water (green and blue respectively) embedded within an agricultural area in order to create benefits for agriculture, nature and society as a whole. In agricultural landscapes, natural pest control is a way to achieve more sustainable and cleaner types of agricultural practices with less dependency upon pesticides. The green-blue network or semi-natural mosaic structure of non-crop landscape elements act as a source of natural enemies, which lead to reduced crop damage by insect pests. Green-blue veining also provides a number of other benefits, including enhancing the landscape quality of the countryside, increasing biodiversity and reducing the negative environmental impacts of current farming methods. Green-blue veining will be used to provide an environment where natural enemies of crops can live and survive in the Hoeksche Waard, thus creating a natural form of pest control in the region.

Alterra research institute has researched the specific conditions for the green-blue network, not only in terms of the spatial distribution of the different elements, but also in terms of plant species composition, vegetation structure, and in terms of vegetation management. The robust elements are the heart of this network, consisting of the present system of dikes, creeks and road verges in the region. To reinforce the effect of the robust landscape elements, a series of fine elements will be created by farmers that will manage their field margins in such a way that it will link up with the robust elements to establish a green-blue network of sufficient density. There are a variety of quantity- and quality standards for the green and blue landscape elements that must be met for the network to be effective in pest control. Adjustments to current farming practice will for example include leaving field margins to grow longer, planting suitable species and monitoring for undesired species. Such changes in agricultural management will be reinforced by local authorities responsible for the robust elements including creeks, dikes and roads that will have to manage these features to appropriate standards.
The ownership of the robust and fine elements in the network is in the hands of different parties and authorities. This means a co-ordinated approach is needed for the successful transformation of these elements into a green-blue network. In order to weigh up the costs associated with these efforts against the benefits that will be derived from them - and also to see which parties bear different costs - a societal cost-benefit analysis (SCBA) of green-blue veining in the area was performed by Witteveen + Bos and ECORYS Research and Consulting. The SCBA compared present values of all benefits less those of related costs and included the expected direct, indirect and external effects of green-blue veining that were all expressed in euros. The SCBA will be able to help the stakeholders to select the appropriate strategy, measures and inputs that maximize the benefits of green-blue veining.

The results showed that the benefits of green-blue veining outweigh the costs in all three different types of implementation variations that were given consideration in the analysis. The analysis also showed that of the different scenarios, the scenario that gave the best net present value of the benefits was the one in which the area is developed for recreation as well as farming and agrobiodiversity (scenario 3). A sensitivity analysis of the results of the SCBA showed that the most important factor for the realisation of benefits is network density. This means that for the benefits of green-blue veining to materialize it will require a sufficiently close network of elements. The SCBA also showed that the costs of green-blue veining do not fall evenly amongst the different responsible parties. Options to spread the costs more evenly by constructing appropriate financial solutions have also been highlighted including making use of available subsidies.

The development of green-blue veining in the Hoeksche Waard is likely to be of international importance as this unique process has implications for other regions that are striving for greater agricultural sustainability. There is genuine enthusiasm for the process amongst the various players in the region and which is furthermore borne out by the available research.
1 Introduction

1.1 Background to this report

The report before you presents the results of a number of years of work to increase the agricultural sustainability in the Hoeksche Waard by means of innovative green-blue veining. Commissioned by the Dutch Ministry for Housing, Spatial Planning and Environment, a number of studies into functional agrobiodiversity by green-blue veining have been carried out by Alterra research institute. Following on from this research, a societal cost-benefit analysis (SCBA) of green-blue veining in the Hoeksche Waard was performed by Witteveen+Bos B.V and ECORYS Netherlands B.V. This brochure presents the results of these analyses, which sets out the scope, justification and measures needed to create a network of green-blue landscape elements that effectively support sustainable agriculture in the Hoeksche Waard.

Green-blue veining

Green-blue veining is a term that has been applied in the Netherlands to refer to a landscape network of vegetation and water (green and blue respectively) elements that provides habitats for wildlife and enables the dispersal of flora and fauna. Green-blue veining contributes to agrobiodiversity and to generating sustainable farming methods. The way it does this is through providing habitats and refuge networks for different flora and fauna that can now survive in previously uninhabitable areas. This increases the opportunities for species to become established in an area, some of which will be the natural enemies of crop pests, thus providing a service to farmers. This means that a more sustainable alternative to pesticide application can be used to suppress and control pest insects.

By increasing the number, quality and spatial arrangement of the green-blue elements in the landscape of the Hoeksche Waard there will be more opportunities for natural enemies of pests to establish themselves in agricultural areas. The natural enemies of pests do require sufficient habitat to survive.

Value of green-blue veining

The benefits of green-blue veining lie in the added-value of the increased quality of the landscape, the fact that environmental quality is enhanced, the value of biodiversity for conservation, and the benefits of moving towards sustainable farming practices. An overall value of agrobiodiversity lies in its ability to contribute towards sustainable farming - the main priority of the various stakeholders in the Hoeksche Waard.
Green-blue veining in the Hoeksche Waard is a way to encourage and give a needed impulse to agrobiodiversity and ultimately to develop a sustainable agricultural sector in the region.

The area’s unique open character is created and managed by traditional agricultural practices and it is now the intention to reinforce this special characteristic of the landscape by increasing agrobiodiversity through green-blue veining. With enthusiastic collaboration by citizens, agrarians, nature conservation organisations and local authorities, the area is striving to make agrobiodiversity a cornerstone of agricultural policy. The following chapters explain in more detail the unique opportunity and measures that are to be taken to deliver sustainable farming in this region of the Netherlands, which can be viewed by international policy makers and practitioners that are trying to establish sustainable forms of agriculture elsewhere in the world as a pioneering project that they will be able to learn from.
2 The Hoeksche Waard now

2.1 Agricultural region with a unique landscape

The Hoeksche Waard is a unique, agricultural landscape covering an area of about 30,000 ha and is a predominantly farmed region. It is located just south of the city of Rotterdam and is highly appreciated for its open and green spaces that have been shaped by the agricultural methods practiced there for many years. The area is intertwined with a network of dikes, creeks and other landscape elements that contribute to its unique character and valuable ascetic properties. The landscape supports several functions including recreation, agriculture and nature. Along many of the creeks in the area, projects have been started to increase the quality of nature. The Hoeksche Waard is designated as National Landscape, which signifies the cultural heritage that the landscape provides to its inhabitants and to visitors.

Figure 2.1 The Hoeksche Waard: photo of a creek in the agricultural landscape; and map of the location within The Netherlands

The attractiveness of the area is highly valued by its inhabitants who have expressed their willingness to preserve the green and open character of the Hoeksche Waard. Stakeholders are collaborating to generate the best available knowledge on sustainable farming and agrobiodiversity to develop the region into an agricultural area that can support biodiversity.

The diagram below depicts the existing network of robust elements in the form of dikes and creek banks and fine elements in the form of pond banks and field edges.
Green-blue veining will allow the opportunity to increase agrobiodiversity throughout the area and will further enhance the unique landscape. In addition there are other network properties in the Hoeksche Waard that include a system of bike and foot paths that attract the recreational public and can contribute to tourism in the area. The green-blue network will hopefully also create many opportunities for additional recreation as a result of a more attractive landscape.

2.2 Current management and stakeholders

The Hoeksche Waard is an agriculturally-intensive area and so provides employment to many farmers, but there are other stakeholders that cooperate together to manage the area as well. The development of sustainable farming and achieving high quality landscape ecology will similarly be carried out by a number of organisations that will work together with farmers in the area. Examples of organisations that administer regional projects are the Commission of the Hoeksche Waard, the Landscape Agency for the Hoeksche Waard, the Provincial government of Zuid-Holland (South-Holland) and the Ministry for Housing, Spatial Planning and Environment (Ministerie van VROM). As in most predominantly agricultural landscapes the majority of the private land is managed by farmers that are also organised into agrarian unions. In turn, the majority of the publicly-owned land is managed by the Water Agency Holland Delta (Waterschap Hollandsche Delta).

There have been a number of successful projects carried out in the Hoeksche Waard by parties cooperating together that concentrate on ecological management of various robust,
green and blue elements. These have focussed on establishing a suitable environment for biological pest control to develop and have required the input from many parties.

One such pilot was the FAB experiment that aimed to make better use of the functional biodiversity of the South-East corner of the Hoeksche Waard through the involvement of local agri-business. The results were very encouraging as within the first year the number of various functional organisms such as spiders, flies and beetles were found both at the edge of agricultural plots and towards the centre of fields as well – a clear indication of the positive effects for pest control of establishing suitable habitat within the agricultural landscape.

Similarly, in 2005 there were a total of 200 km of field margins developed to attract wildlife, which was part of a large project initiated by the Rietgors Institute, The Water Management Body for South-Holland, Delta Nature Management, and the Landscape Management Body for South-Holland.

The successful outcome of these types of projects gives further impetus to relevant management organisations in the area to discuss future cooperation initiatives with each other. This is the kind of cooperation that will be required if in the near future they must manage the robust elements to provide further opportunities for natural enemies of pests to find suitable habitat in the agricultural landscape and in so doing contribute towards the goals of sustainable farming.

1 Rapportage FAB 2005, www.lto.nl/fab
3 A vision of the future in the Hoeksche Waard

3.1 Farming as shaper of the countryside and landscape

It is clear that farming has given the Hoeksche Waard the beautiful, open landscape that is so characteristic of the area. Farming is also crucial to the future of the region and it is for this reason that efforts are being made to sustain farming as a way of life and as a shaper of the countryside and landscape for the years ahead. Efforts to make farming more sustainable can be done by making farming more friendly for flora and fauna, in other words by creating an ecologically-dynamic agricultural system that gives opportunities to functional species to live there and simultaneously provide farmers extra benefits by predating on the natural enemies of the farmers’ crops.

3.2 Green-blue veining: the benefits

Green-blue veining provides chances for different flora and fauna to colonize agricultural areas and is one of the preconditions for a sustainable agricultural system. The following tables systemize the benefits that will be realised in the Hoeksche Waard if green-blue veining is successful. The first table describes the network benefits, which arise from the network of green-blue elements in the entire area, while the second table describes the benefits accruing from single elements.
### Table 3.1 Overview of network effects and benefits from green-blue veining

<table>
<thead>
<tr>
<th>Effects of the network</th>
<th>Physical effect</th>
<th>Welfare effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adding green and blue elements:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaner natural areas</td>
<td>Enjoyment of living in houses with views over the landscape (only applicable to houses outside built-up areas)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enjoyment of living in houses within a radius of the landscape (within built-up areas)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exploitation of extra recreational opportunities</td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Inheritance value</td>
<td>Inheritance value (1 or 2 layers)(\text{(wat zijn die lagen?)})</td>
</tr>
<tr>
<td>Cultural history</td>
<td>Inheritance value</td>
<td></td>
</tr>
</tbody>
</table>

**Management of green elements geared towards natural pest control:**

<table>
<thead>
<tr>
<th></th>
<th>Physical effect</th>
<th>Welfare effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in insecticide use</td>
<td>Saved insecticide costs</td>
<td></td>
</tr>
<tr>
<td>Reduction of insecticide residual in food</td>
<td>Public health benefits</td>
<td></td>
</tr>
<tr>
<td>Clean water</td>
<td>Avoided water purification costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Returns due to fish increases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inheritance values</td>
<td></td>
</tr>
<tr>
<td>Better soil quality</td>
<td>Saved costs on fertilisers due to better quality soil-life</td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Inheritance values</td>
<td></td>
</tr>
<tr>
<td>Productivity: bee production</td>
<td>Income from honey</td>
<td></td>
</tr>
</tbody>
</table>

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### Table 3.2 Overview of effects and benefits from individual elements

<table>
<thead>
<tr>
<th>Effects of individual elements</th>
<th>Physical effect</th>
<th>Welfare effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field margins</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean water due to uptake of N and P by vegetation.</td>
<td>Avoided purification costs</td>
<td></td>
</tr>
</tbody>
</table>

**Extra benefits for field margins along ponds and creeks**

<table>
<thead>
<tr>
<th></th>
<th>Physical effect</th>
<th>Welfare effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean water because of drift reduction</td>
<td></td>
<td>Avoided water purification costs for drink water</td>
</tr>
<tr>
<td></td>
<td>Income because of increases in numbers of fish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inheritance values</td>
<td></td>
</tr>
<tr>
<td>Clean water due to fertiliser reduction</td>
<td></td>
<td>Avoided water purification costs for drink water</td>
</tr>
<tr>
<td>Erosion reduction due to better soil retention</td>
<td></td>
<td>Avoided sanitation costs</td>
</tr>
</tbody>
</table>

**Benefits from grey landscape elements (public foot paths and bike paths etc.)**

<table>
<thead>
<tr>
<th></th>
<th>Physical effect</th>
<th>Welfare effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>No benefits from individual elements, only from network benefits of recreation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Benefits of red landscape elements: historical architecture**

<table>
<thead>
<tr>
<th></th>
<th>Physical effect</th>
<th>Welfare effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inheritance</td>
<td></td>
<td>Living pleasure for homes with historical characteristics</td>
</tr>
</tbody>
</table>

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*Because of a) adding green elements and b) using fewer insecticides, biodiversity will increase.*
3.3 Green-blue veining: a leader in innovation

The Fourth National Environmental policy Plan of the Netherlands set the farming sector the task of reinventing itself to facilitate sustainable development. This is a quest to give agriculture sufficient economic perspective, to make it environmentally-friendly and to invigorate the surrounding rural areas. The starting point for this thinking is that there is plenty of room for innovation to flourish in the agricultural sector, especially as natural processes have the potential to be utilized more effectively than at present, and in addition, that farming practices have the potential to be more sustainable too.

In the Hoeksche Waard they are leading the way in this quest. Natural enemies need arable fields and semi-natural vegetation. In agricultural landscapes, this vegetation is often present in a network of linear landscape elements, - the green-blue veining.

Thanks to the close network of dikes and creeks the Hoeksche Waard is ideally suited for natural pest control. Furthermore, the nature areas in the Hoeksche Waard and in the outer-lying area can reinforce the potential for green-blue veining. Of course there will be a lot of changes required to the design and management of the land too. For example it will be necessary to reduce the intensity of sheep grazing on the dikes, which otherwise reduces the shelter the vegetation can provide for natural enemies of pests.

Green-blue veining is an innovative example of the kind of ‘out of the box’ thinking that is generating so much momentum in the drive towards sustainable farming. Green and blue elements in a farming region provide safe havens for organisms that can act as enemies of natural pests and suppress disease that may otherwise occur to crops. Furthermore, green-blue veining adds to the beauty of the landscape, it contributes to landscape renewal, increases biodiversity and provides opportunities for small-scale recreational activities that can be enjoyed by tourists as well as local people.

The following diagram represents a map of the Hoeksche Waard with information on the basic networks, landscape elements and projects from which green-blue veining will be built upon.
The work being done in the Hoeksche Waard is a front-runner of the kinds of innovative solutions that introduce functional applications of nature for the benefit of the economy, society and the environment. The local actors in the region are striving towards sustainable farming by 2015 and maximising the chances for nature.
4 Requirements for green-blue veining

4.1 General requirements

The spatial, quantitative and qualitative requirements for the functioning of green-blue veining in natural pest control were developed by Alterra and discussed with relevant stakeholders in two consecutive workshops. In general, green-blue veining works by providing additional habitat and refuge so that flora and fauna can live and survive in an area. In the Hoeksche Waard, the habitat is made up of vegetation on dikes, creek banks, road verges, field margins, and of water sources in streams, ponds and creeks to support a diversity of insects, beetles and other fauna. In particular, what are needed are large, robust green and blue elements that act as a source for biodiversity. If there are not enough robust elements or they are not large enough, then it is necessary to add finer elements to the landscape so that the flora and fauna still have chances for dispersing between the robust and fine elements and can survive in this way. Major pest insects in arable fields are: aphids, thrips and slugs. Important natural enemies are ladybirds, hoverflies and parasitic wasps. For most natural enemies, the larvae are the predators of pest insects. The adults need nectar and pollen and shelter from extreme weather conditions. Food and shelter are found in semi-natural elements. Without those green-blue elements natural pest control is not possible. The spatial density of the green-blue network is essential for efficient natural pest control to make sure that natural enemies are within reaching distance of arable fields.

4.2 Robust elements supported by fine elements

Green-blue veining consists of robust elements (min. 25 m. wide, e.g. dikes, creek banks, small woodlots) and fine elements (min. 3½ m wide, e.g. field margins, ditch banks), which have different functions in natural pest control. Both function as habitat, from which insects can disperse into fields, but robust elements also function as sources for passive dispersal over large distances. The network of robust elements thus function as the main ‘arteries’ for natural pest control and can be integrated with the fine elements that function as veins.
4.3 **Green-blue infrastructure already exists**

The area of the Hoeksche Waard is a good starting point for using green-blue veining for natural pest control/sustainable farming practice. Robust elements function as habitats as well as source areas for natural enemies of pests and there already exist a large number of such robust landscape elements in the form of dikes, creek banks, nature development projects, etc. in the region. These will be invaluable in creating the best circumstances for green-blue veining.

The present network of robust elements will need to be managed according to certain criteria to function effectively as source areas for natural enemies of pests. There are *quantitative* standards for the amount of surface area and breadth that must be attained and *qualitative* standards in terms of species’ assemblages and management techniques. The mobility of the natural enemies is limited. Therefore the distance between crops and green-blue veining should not be too large. By active movement the insects can move about 50 m from their habitat in green-blue veining into the fields. Currently the dikes in the Hoeksche Waard satisfy the quantitative requirements as they are generally broad enough, but change is needed in the qualitative aspects of the dikes. Furthermore, creek banks are generally too small in the Hoeksche Waard while they also do not yet have the necessary quality. However, nature development projects in the area do satisfy the quantitative criteria for the amount of surface area, but it is generally not known whether they satisfy the quality demands.

4.4 **Robust elements**

The table below sets out the qualitative criteria for robust elements that will need to be met. For an optimal situation, both the quantitative and qualitative standards of the robust elements need to be met. The existing network of dikes and creeks makes it possible that all areas within the Hoeksche Waard could potentially be covered by source areas.
### Table 4.1 Qualitative standards for robust elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Planting</th>
<th>Species standards</th>
<th>Management standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dike slopes</td>
<td>Grass with herbs</td>
<td>50% of grass taller than 20 cm (summer &amp; winter)</td>
<td>Continuously flowering in growing season</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mow only half the breadth each time <strong>or</strong> Extensive grazing (low cattle density) <strong>or</strong> Intensive grazing in small sections</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Designed/mixed flower seeding*, remove after mowing <strong>or</strong> Mowed flower-rich margins outside fence (2 m wide)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intensive grazing in small sections <strong>or</strong> Designed/mixed flower seeding*, remove after mowing <strong>or</strong> Mowed flower-rich margins outside fence (2 m wide)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Designed/mixed flower seeding*, remove after mowing <strong>or</strong> Mowed flower-rich margins outside fence (2 m wide)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intensive grazing in small sections <strong>or</strong> Designed/mixed flower seeding*, remove after mowing <strong>or</strong> Mowed flower-rich margins outside fence (2 m wide)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mowed flower-rich margins outside fence (2 m wide) <strong>or</strong> Designed/mixed flower seeding*, remove after mowing <strong>or</strong> Mowed flower-rich margins outside fence (2 m wide)</td>
</tr>
<tr>
<td>Creek banks</td>
<td>Reeds and rough/tangled growth/vegetation on creek banks</td>
<td>50% left in winter</td>
<td>Continuously flower-rich in growing season</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reef zone mowed 50% each year on one side of creek only</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>After mowing tangled growth/vegetation seed with appropriate flower mixtures* <strong>or</strong> Embankments to be developed into flower-rich biotope</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Varied plant pattern, phased pruning, appropriate cutting – some yes, some no. <strong>or</strong> Embankments to be developed into flower-rich biotope</td>
</tr>
<tr>
<td>Woods and wood plots</td>
<td>Trees and shrubs</td>
<td>Diverse in species type and age</td>
<td></td>
</tr>
</tbody>
</table>

* The composition of flowers must be geared towards stimulating ichneumon flies and wasps, wasp-fly’s, beetles, but not moths and butterflies.

The illustration below shows an example of phased management applied to a road verge.

**Figure 4.1 An illustration of phased and differentiated management**

Mow frequency in a broad verge:

- A: mow at least two times per year
- B: mow once per year in spring
- C: mow once per year in the autumn
- D: mow once every two years
- E: do not mow

**Differentiated management** (differing in space): A, B+C, D and E.

**Phased management** (differing in time): B and C
4.5 Fine elements

Fine elements include field margins, ponds and road verges and play an equally important role in pest control. Their sphere of influence is smaller than that of the robust elements, but still serves as vital habitat. The important point is that for them to be effective it is necessary that they are not spaced too widely apart. This is because of the fact that the natural enemies can only travel up to a certain distance (10s of metres) into the field. In essence this means that there is a maximum breadth that a field parcel can be depending on the availability of robust elements nearby. The tables below shows the quantitative standards required for fine elements to function as habitat.

Table 4.2 Width standard:

<table>
<thead>
<tr>
<th>Linear</th>
<th>Breadth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.5 m</td>
</tr>
</tbody>
</table>

Table 4.3 Spatial standard (max width of field parcel (meters)):

<table>
<thead>
<tr>
<th>Zone breadth surrounding source area/robust (m)</th>
<th>Habitat</th>
<th>Source/Robust</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum breadth of field parcel (m)</td>
<td>150</td>
<td>&lt; 1000</td>
<td>&gt; 1000</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

The source area or equivalent robust element acts as habitat within 150 m distance so that no extra fine elements are necessary.

Making the transition to a sustainable form of agriculture by developing green-blue elements requires a certain amount of knowledge and planning on the part of all stakeholders. What could be derived from the series of workshops was that the ambition and eventual strategy for green-blue veining will not be dependent on any pre-conceived agreements. What is certain is that all the stakeholders will need to play their part to manage future green-blue veining. The following chapter briefly describes the strategies that have been considered to implement green-blue veining to enable the transformation of the region.
5 Strategies for developing green-blue veining in the Hoeksche Waard

5.1 Strategies for developing green-blue veining

The strategies for developing green-blue veining in the Hoeksche Waard were developed by Alterra and discussed with relevant stakeholders in a number of workshops. The pre-existing green-blue infrastructure in the Hoeksche Waard is actually a very good starting point as the region is gifted with many landscape features that can be utilized for green-blue veining. However, not all of these elements are presently managed for the purpose of pest control and will require a coordinated approach to implement the necessary changes at a network scale. Four strategies to realise the final outcome of a network that caters to natural pest control have been considered and are outlined below. Important to note is that the different approaches are not mutually exclusive, but instead show the possibilities available and lend direction to the discussions about the way to move forward. In addition, the strategies were used as a basis for the cost-benefit analysis described in chapter 6.

The strategies outlined can be split into two themes: spatial strategies comprising “robust elements first” and “fine networks” and the organisational strategies comprising “sub-regions” and “bundling stakes”.

Robust elements first
The robust landscape elements that include dykes and creeks will be managed with a view to introducing biological control in the entire area. The shift in management style will not require reconstructive surgery on a grand scale, but the correct management of the robust elements are an imperative step for an eventual successful outcome.

Figure 5.1 Examples of robust elements in the Hoeksche Waard
**Sub-regional approach**
In this approach, the management of robust elements in the sub-regions of the Hoeksche Waard will be directed to enable biological control. This strategy simultaneously focuses on the development of a network of fine elements for the same purpose. This strategy has the added advantage of providing lessons for other sub regions during the transition process, but potential benefits of working outside the sub-regions will most likely not be realised in this strategy.

**Bundling of stakes**
At the heart of this approach is an efficient organisational strategy that involves the various owner and management stakeholders that all will strive for the parallel development of a network of fine elements. Achieving a highly coordinated mowing regime for example can considerably cut costs as can control and monitoring coordination.

**Fine Networks**
This strategy involves the development of fine elements along side current field margin projects spread over the Hoeksche Waard. Expansion of fine elements would in this case only be carried out that enable linkages to the wider green-blue network.

![Figure 5.2 Pictures of flowering field margins used as part of a fine element network](image)

**5.2 Conditions for success**
It was clear to see from the workshops that there was a great deal of enthusiasm to develop green-blue veining for natural pest control. In order to kick-start and steer the transformation of the Hoeksche Waard, the stakeholders made some recommendations that should be taken on board.

**Organisational Structure**
It was felt necessary to have the progress and quality of the various activities monitored and a director’s role clearly defined in order to obtain the best results for green-blue veining. It was also recommended that there be scope for horizontal and vertical management direction as well as active input by politicians and steering committees that can bring added-value in terms of their governance experience.
It was thought that the water organisations (Waterschap Hollandse Delta) are naturally placed to perform a director’s role considering their ownership and management of so much of the green and blue elements in the area.

**Effective Communication**

It was deemed that communication with the rest of the Hoeksche Waard and with the rest of the Netherlands is a prerequisite for successful implementation. Citizens and stakeholders should be able to express their wishes with regard to the development of the area as was the case in a recent project called Biodiversity for and by Citizens set up by the Ministry of Housing, Spatial Planning and Environment. Well justified decisions about the chosen measures should be clearly communicated to stakeholders in the entire area.

**Monitoring**

Currently the FAB project monitors levels of pests and their predators and will need to be extended to the other sub-regions undergoing development. This enables the progress of the project to be judged for its effectiveness.

**Links to current initiatives**

In the framework of the Field Margins project there have been approximately 200km of ecologically functional field margins laid down in the Hoeksche Waard. It is important to integrate this process with the development of biological control projects and specifically to balance the seed mixture of the field margin project with the optimum conditions needed for a focus on pest control.

**Double number of ecologically managed dykes**

Considering that dikes form an integral part of the robust network it was decided that the Landscape organisation of the Hoeksche Waard would double the amount of ecologically-managed dikes in the region as the current area occupied by such dikes is 40 ha. In addition, it is also planned to transform half of these into ecologically-managed dikes with an emphasis on natural pest control.

**Project-based approach**

It was recommended that pilot areas provide educational opportunities for other projects that will implement the steps needed to create a good network for biological control. Moreover, these areas are to be evaluated for their effectiveness in reaching the goals of biological control with the timing and remit of any evaluation to be set at the commencement of the project.

**Cost Benefit Analysis**

In order to study the societal costs and benefits that flow from the green and blue veining in the Hoeksche Waard it is helpful to carry out a systematic inventory of short-term and long-term effects by means of a Societal Cost benefit Analysis (SCBA). Green-blue veining in the Hoeksche Waard will need initial investments, but also will need to be paid for and managed in the long term, which implies financial obligations to certain involved parties.
As will be described in the following chapter, measuring how the costs and benefits will be distributed across different stakeholders and across different geographical and temporal scales provides a basis from which any uneven distribution can be compensated through an appropriate financial construction.
6 Cost benefit analysis

6.1 Three alternative scenarios

Costs and benefits of green-blue veining need to be measured to evaluate whether the return to society is worth the investment costs of the actions required by the various stakeholders. The societal cost-benefit analysis (SCBA) that was applied in the Hoeksche Waard was performed by Witteveen+Bos and ECORYS Research and Consulting that have developed the methodology for SCBAs for the Dutch government in the recent past. The SCBA basically looked at three possible development scenarios and compared them to each other. The three alternatives all centred on the theme of increasing agrobiodiversity in the region but with various differences in the application and measures to be chosen. These scenarios are loosely based on the four strategies to establish green-blue veining that have already been described in this report. The three scenarios were:

1. Optimal situation for agrobiodiversity: scenario where private and public space is used to create the necessary standards for green-blue veining as set out by Alterra. This is effectively combining robust and fine elements to achieve green-blue veining.
2. Investment in public space only: situation where agricultural land is not used but public land is used to create the minimum standards and norms for effective agrobiodiversity and biological control. This is effectively an approach that would rely on developing robust elements only to achieve green-blue veining.
3. Optimal situation for agrobiodiversity, agriculture and recreation: this scenario of the development of green-blue veining includes focussing on recreational opportunities – set up on public and private land and facilitated by global positioning systems (GPS).

6.2 Results of the SCBA

The results of the SCBA are shown in the table below. The net present values (NPV) of each alternative are shown and were calculated with a time horizon of 100 years\(^3\). The SCBA results reflect the Dutch situation and do not include international effects such as increases in international tourism.

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\(^3\) This refers to the number of years into the future that the costs and benefits were discounted – using a discount rate of 4%. For some effects a risk factor of 2% was added.
Table 6.1  Costs, benefits and balance per project alternative (net present values in millions of €)

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>64.8</td>
<td>25.6</td>
<td>89.2</td>
</tr>
<tr>
<td>Benefits (network)</td>
<td>102.4</td>
<td>50.8</td>
<td>133.1</td>
</tr>
<tr>
<td>Benefits (individual)</td>
<td>8.9</td>
<td>0.5</td>
<td>10.2</td>
</tr>
<tr>
<td>Balance</td>
<td>46.5</td>
<td>25.7</td>
<td>54.2</td>
</tr>
</tbody>
</table>

The overall conclusion of the SCBA was found to be that all three scenario’s deliver benefits that outweigh the costs of green-blue veining in the Hoeksche Waard. In particular it was found that scenario number 3 delivered the best net present value while scenario 2 delivered the least net present value. The difference between these two scenarios was calculated to be €30 million while the difference between the first and third scenario was only €8 million.

This ranking of scenarios according to net present value was in line with the ranking according to the benefits that each scenario delivered. However, the ranking according to the least-incurred costs was found to be reverse: scenario number 3 cost the most while scenario number 2 was the least expensive. Furthermore, the same reversal of the results was found to hold true if analysed according to the returns on investment of each scenario. This implies that scenario number 2 involves the least risk given that it is associated with the lowest costs and the least return per unit invested.

The largest benefits were found to be derived from the extra value associated with living in the enhanced landscape that the green and blue vein in the Hoeksche Waard will produce and the benefits derived from future generations being able to enjoy a cultural landscape and increased biodiversity in the region.

The SCBA was able to show that any benefits accruing from all three scenarios are reliant on a sufficient network of robust and fine elements that together create the desired levels of agrobiodiversity that in turn induce biological control mechanisms. In other words, the size or intensity of the network is the key to establishing any benefits that are to be generated from green-blue veining. The implication of this final conclusion is that cooperation between parties is a necessary condition for the establishment of a sufficiently intense network.

**Sensitivity analysis**

It was necessary to subject the results of the SCBA to an analysis of what would happen if the assumptions built into the SCBA about the state of the economy, the discount rate, the property prices etc. proved to be different to the forecasts. An example of one such analysis is shown in the following table; in this case, what would happen if the property value increases in the Hoeksche Waard did not rise as expected?
Table 6.2 Costs and benefits with 50% lower property value increase (net present values in millions of €)

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original result</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>64.8</td>
<td>25.6</td>
<td>89.2</td>
</tr>
<tr>
<td>Benefits</td>
<td>113.4</td>
<td>52.4</td>
<td>145.5</td>
</tr>
<tr>
<td>Balance</td>
<td>46.5</td>
<td>25.7</td>
<td>54.2</td>
</tr>
<tr>
<td>Result with property percentage 2x lower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>64.8</td>
<td>25.6</td>
<td>89.2</td>
</tr>
<tr>
<td>Benefits</td>
<td>82.4</td>
<td>36.9</td>
<td>114.5</td>
</tr>
<tr>
<td>Balance</td>
<td>17.6</td>
<td>11.3</td>
<td>25.3</td>
</tr>
</tbody>
</table>

The results show that although the value of the benefits is reduced there is no significant change such as a negative balance.

Of the various sensitivity analyses that were carried out, the factor of most importance is network benefits. This applies to all three project alternatives. This means that if there is no network of sufficient scope or of sufficient intensity then there will not be any benefits either. Alternative 2 is particularly sensitive to this problem since in this alternative relative few measures are taken and are done so over a large area. Cooperation between several parties is required if a sufficiently dense network is to be guaranteed. Investing in a sub-region will therefore deliver the same positive results as the MKBA predicts subject to there being a sufficiently dense network.

6.3 Effects on different Stakeholders

*Water and regional authorities largest net cost-bearers*

On the basis of the differences in the stakeholders’ share of land that will be required for green-blue veining, the costs and benefits for each group were calculated. The results showed that the water agencies would carry the greatest net cost burden in all three project alternatives which is in line with their larger share of the ownership of robust elements in the region; while the regional authority would also incur a substantial portion of the costs. Households in the Hoeksche Waard saw the largest benefits allocated to them due to the fact that their property values would rise. The farmers in the Hoeksche Waard were found to be in absolute terms the most important cost bearers, but that this would be nearly-fully mitigated by the benefits derived from avoided costs of traditional pest management, rises in real estate value and eventual recreational revenue streams.

*Possible financial constructions for green-blue veining*

To even out the burden of the costs, different parties in the Hoeksche Waard will have to finance the veining in such a manner that it is equitable, fair, manageable, and effective. Considering that there are large benefits to be derived for the owners of property in the Hoeksche Waard it will be necessary to collect some of the costs from this group as well.
This can be done most fairly by increasing water and council taxes in the area and will help pay for the management costs of green-blue veining and compensate the council and the water agencies whose responsibility it will be.

The financial solution for the investment costs that farmers will incur is best solved through the use of specific subsidies that are allocated by the government for nature development and maintenance. Examples of subsidies that can be used include SAN, ILG/POP and provincial funds. A less well-used, but innovative solution for generating money could take the form of a regional fund where vested stakeholders will be paid from.

The solutions all have to be evaluated for the degree of sustainability, whether there is a problem in connection with EU state-support rules, the degree of bureaucracy that is incurred and whether the entire package is justifiable to all parties concerned.

\[\textit{i.e. is the financial solution available in the future over the long-term?}\]
7 The future of sustainable farming in the Hoeksche Waard

Scope and potential
The research and measures taken up until the current time frame has shown there is a
great deal of scope to scale-up green-blue veining to include the entire region, making use
of the experience and the knowledge generated thus far. It will be able to increase
agrobiodiversity, create a unique landscape within a framework of sustainable agriculture,
richer cultural heritage, and an increase in economic diversity. The SCBA has also shown
that it pays to invest in green-blue veining in the entire region if a sufficiently close
network of elements can be realised to generate the full benefits.

Numerous benefits
Green-blue veining will increase the suitability of the Hoeksche Waard for natural pest
control Greater use of the robust and fine elements by a variety of birds and small
mammals and invertebrates will not only increase natural pest control, but will also
increase the quality of the nature. The landscape that will result will increase house prices
in the region, provide green areas for enjoyment by the public and will generate extra
recreation. Tangible aesthetic benefits of biodiversity will be evident in the preservation
of an attractive farming landscape in which tourism and recreation can take place. Under
these circumstances, the introduction of biodiversity provides an opportunity to preserve
plants of cultural significance as well as reinforcing the open and singular landscape
properties for cultural heritage benefits.

Moving forwards
What began as a series of supporting measures for sustainable farming in the area of the
Hoeksche Waard has grown into a cohesive set of actions that is being driven forward by
enthusiastic stakeholders that will generate many benefits. The cooperation between these
various organisations will increase even further in the future as there is great momentum
to achieve the right conditions for sustainable farming practices. Of course the challenge
remains to find the ideal financial solution for implementation on a sufficient scale and to
relay the experience of the Hoeksche Waard to others.