Conclusions

In this study, a straightforward approach was followed to explore the impact of the WFD. The results show that it will be a hard task to achieve its objectives in the Netherlands and that the consequences will be considerable.

- Ambition level A implies a number of drastic interventions needed to obtain reduction objectives for nitrogen and phosphate. In a number of areas these objectives will not be met by means of measures in soil-specific agriculture.
- A generic application of ambition level B will not lead to a successful realization of the ecological objectives, not even if all soil-specific agriculture was to be taken from production.

The application of pesticides to potato crops is not expected to present any problems to the implementation of WFD ambition level A. For the implementation of ambition level B further emission reductions will be necessary, because in many places the drinking water standards cannot be reached without further actions. Whether this also applies to other crops or substances is not known. It should be noted that surface waters objectives are regularly exceeded for a number of chemicals.

The realization of the WFD calls for an integrated approach with respect to other directives in the appointed areas. The WFD may imply a number of consequences for manure policies; phosphate can often be regarded as a normative factor in the implementation of ecological objectives in surface water. Phosphate accumulation in soils often contributes considerably to phosphate losses to surface waters. The environmental impact of source-specific measures will therefore be limited. Effect-specific measures provide a larger perspective. Although the effects of such measures have not been recorded for Dutch circumstances, their estimated effects will have to be explored under different circumstances in order to formulate plans on catchment scale.

The necessary efforts that are needed to accomplish such ambitions are considerable, and may prove to be unattainable for all areas before 2015. A more realistic approach to these high ambitions would have to be based on the selection of a limited number of areas such as the Bird and Habitat Directive Areas. Small target areas allow for tailor-made solutions and specific measures. This method also implies a differentiated approach of the consequences for the agricultural sector. However, this exploratory study predicts only minor differences in socio-economic consequences between scale levels.

The ecological objectives will not be met even if all arable land were to be taken from production. Subsequent supply from the soil and external loads through seepage make closer scrutiny of the ecological references imperative.

Implementation of effect-specific measures, in order to achieve the environmental objectives, can simultaneously contribute positively to the recovery of morphology, nature restoration, landscape, recreation as well as fishery. An integrated approach towards the design and the implementation of these measures is highly recommendable. The cost effectiveness will need to be based on a quantification of all costs and benefits of all aspects. The result obligation of the WFD calls for the close elaboration of its impact and for sustainable methods for its implementation. (Political) Choices will have to be met to set the limits in terms of the implementation.
Preface

Here is a short report of the exploratory scenario study 'Aquarein; Impact of the European Water Framework Directive on agriculture, nature, recreation and fishery' which was carried out by order of the Executive Board on Rural Affairs of the Dutch Ministry of Agriculture and Fisheries (LNV). The objective of this study was to quantify all consequences of the European Water Framework Directive for policy fields of LNV. In this summary report the most important conclusions with respect to the implementation of the European Water Framework Directive (WFD) are summarized. This study does not present final conclusions, but should be regarded as an intermediate exercise in the further development of the WFD. The authors hope that it will offer us sufficient matter for discussions about the further development of the WFD.

An extensive description of the study can be found in the Alterra report 835 (in Dutch), 'Aquarein; Gevolgen van de Europese Kaderrichtlijn Water voor landbouw, natuur, recreatie en visserij'. Frank vd Bolt, Rik vd Bosch, Theo Brock, Petra Holligers, Coos Kwakernaak, Dorothée Leenders, Oscar Schoumans, and Piet Verdonschot. You can order the report by making €40,- payable to bank account nr. 36 70 54 612 (Alterra Wageningen), please enter the report nr 835. The English brochure of this summary can be ordered at info@alterra.nl.

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Introduction and objectives

The objectives of the European Water Framework Directive (2000) (WFD) focus on the amelioration of sustainable water use and the protection and improvement of the quality of watersystems. These objectives can be achieved by the termination or reduction of point losses and diffuse losses, the improvement of the ecological functioning of waters and the introduction of levies on water consumption. The WFD is focused on river basins including coherent watersystems. Although the implementation of the WFD is the responsibility of the Dutch Ministry of Ministries of Transport, Public Works and Water Management (MVW), it may also have consequences for the policy fields of the Ministry of Agriculture and Fisheries (LNV). For this reason LNV wants to take a position regarding the impact of the implementation and therefore has assigned Alterra to deliver a quick scan in order to gain provisional insight into the possible consequences of the WFD on agriculture, nature, recreation and fishery. A set of four scenarios has been formulated to enable all necessary steps of the implementation to be considered in order to obtain a good perspective on the possible effects and the potential options.

Recreation

Clean water and more natural surroundings improve recreational use and value. The effects of measures have been explored for a number of forms of recreation (Table 4). Although some measures can be said have a positive effect on the recreational value, others may have negative effects.

Table 4. Estimation of the effects of measures for several forms of recreation

<table>
<thead>
<tr>
<th>Measure</th>
<th>Day recreation</th>
<th>Stay recreation</th>
<th>Water Recreation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing load, applying techniques</td>
<td>S  Q  U</td>
<td>S  Q  U</td>
<td>S  Q  U</td>
</tr>
<tr>
<td>Environmentally friendly choice of crops</td>
<td>+  ?  0</td>
<td>0  0  0</td>
<td>+/0  +/0  +/0</td>
</tr>
<tr>
<td>Buffer strips</td>
<td>S  +  +</td>
<td>+  ?  0</td>
<td>+  +  +</td>
</tr>
<tr>
<td>Structure water system</td>
<td>+/0 +/0 +/0</td>
<td>0  0  0</td>
<td>+/0 +/0 +/0</td>
</tr>
<tr>
<td>Poor surface water systems</td>
<td>+  +/0 +</td>
<td>+  +  +</td>
<td>+  +  +</td>
</tr>
<tr>
<td>Purification through purification面具子</td>
<td>?/0 -/0 -/0</td>
<td>-  -  -</td>
<td>+  +  +</td>
</tr>
<tr>
<td>Transformation into natural landscape</td>
<td>+  +  +</td>
<td>0  0  0</td>
<td>+  +  +</td>
</tr>
</tbody>
</table>

S = Supply, Q = Quality, U = Use
- : negative effect
+ : positive effect
? : no effect
* : more research is needed
0 : concrete form of measures depends on the location
+ : positive effect

The measures will mostly affect day recreation and have less consequences for stay recreation and water recreation. Accessibility is a crucial factor in terms of the permission for the development of recreation in a particular area. Whether recreational opportunities will be exploited depends on their accessibility and location. The realisation of recreational objectives in terms of the WFD calls for further spatial planning on a regional and local scale.

Fishery

Fishery in coastal waters strongly determines the living circumstances of the fish as opposed to their natural habitat. The number of fishing quotas that can be regarded as normative to good ecological conditions (which will by definition deviate from natural conditions) remains a political option. Optimal fishing quotas which leave the ecosystem intact denote the ultimate boundaries. Considerable effort will be needed to achieve this situation for the IJsselmeer.

The fishery sector can contribute considerably to monitoring the WFD and the Bird and Habitat Directive. Bycatches form an important source of information about rare and migrating fish species which are important indicators in terms of ecological conditions.
Methods

In this tentative study, the most important stages of the implementation have been considered. The choices that were made during this process were handled in consultation with LNV. Moreover, LNV was also consulted on the delimitation of this study. It was decided upon that groundwater, protected areas, water management, transference of measures and other sources like urban areas and industry were to be excluded. The study was confined to nutrients and pesticides in freshwater systems.

The reference scenario for the year 2015 has been defined by LNV. The starting point is the current situation in water (quality, planning, management) and land use, subject to current policy commitments, i.e. policies that at present have been transformed into concrete measures. Policy objectives which have not yet been adopted into concrete measures, were left out of consideration.

The impact of the WFD were explored by means of four scenarios (Figure 1). The scenarios have been compiled out of two different classifications into areas/water bodies (scale levels) and two different levels of ecological objectives (ambition levels).

This method cannot automatically be used as an approach to pesticides. For this purpose a different methodology was designed on the basis of water functions and protection levels.

Areas, water bodies and water types.

To each area a water type was allocated. A proposal for the classification in water types was made available by Elbersen, et al., 2003. Because the characteristics of water types have been well-defined, it is possible to classify all waters. At a detailed scale level, the allocation of water types does not present any problems. In larger spatial entities more water types will be found within the same area. Choices will have to be made as to which criteria determine the allocation of water types to larger spatial entities. In this study the region-based approach was preferred; the water types which represent the catchment outlet points of a particular area have arbitrarily been picked to represent the larger area.

Landscape

The effects in relation to the landscape, the cultural history and geographical values can only be accurately determined within the context of one particular landscape. Whether the effect of one particular rule will be either positive or negative differs per landscape.

- Measures such as less manuring, different application techniques, or poor surface water quality have hardly any impact on the landscape, cultural history or geography.
- The transformation of arable land into grassland will greatly influence the landscape and the cultural history. As long as the original cultivation patterns are maintained by means of buffer strips, a positive effect can be expected.
- Allowing brooks to meander freely is of great geographical importance. Whether a brook will consequently follow the original drift of the river will strongly influence the negative or positive outcome of such measures.
- Land use changes have strong negative effects on the cultural history. Which shows that there is a strong relationship between cultivation patterns and the relief of the landscape: the historic interpretation of a landscape is highly compromised.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Landscape</th>
<th>Cultural History</th>
<th>Geographical values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased load</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Applying technique</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Corn to grass</td>
<td>- of +</td>
<td>- of +</td>
<td>0</td>
</tr>
<tr>
<td>Structure water system</td>
<td>- of +</td>
<td>- of +</td>
<td>- of +</td>
</tr>
<tr>
<td>Poor surface water quality system</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Purification through purifying swamps</td>
<td>- of +</td>
<td>-</td>
<td>0 of -</td>
</tr>
<tr>
<td>Transformation of agriculture into nature</td>
<td>- of +</td>
<td>-</td>
<td>0 of -</td>
</tr>
</tbody>
</table>

Table 3. Outline of the expected effect of additional measures. See text for explanation.

0 : negligible effect  
+ : positive effect  
- : negative effect  
- of + : can have both positive or negative effect, depending on the context within the landscape and the way it fits into. Further investigation is needed.

A comparison of the effects of the realization of the WFD against the interference with the historic-geographical relict ensemble and geological values is highly recommendable. Measures that fit into the present types of landscape and thereby add more value to it should be preferred.

Reference situation

Ecological objective

<table>
<thead>
<tr>
<th>Global scale</th>
<th>Detailed scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambition level A</td>
<td>Scenario 1</td>
</tr>
<tr>
<td>Ambition level B</td>
<td>Scenario 3</td>
</tr>
</tbody>
</table>

Target reduction

Measures

Social/economic impact

Further investigation is needed.

Further investigation is needed.

Further investigation is needed.

Further investigation is needed.

A comparison of the effects of the realization of the WFD against the interference with the historic-geographical relict ensemble and geological values is highly recommendable. Measures that fit into the present types of landscape and thereby add more value to it should be preferred.
Ecological objectives and ambitions

The WFD allows for a differentiation between water bodies, by making a distinction between ‘natural’, ‘heavily modified’ and ‘artificial’ waters. A measuring rod was introduced for measuring ecological functioning. The WFD requires that in 2015, a minimum ‘good ecological status’ (GES) for natural waters and a ‘good ecological potential’ (GEP) for heavily modified and artificial waters will be obtained. The WFD indicates that the actual ecological conditions of GES/GEP are allowed to deviate to a small degree from the values at ‘high ecological status’ (HES)/’maximum ecological potential’ (MEP). These two are considered to be the ecological frame of reference. Because slight deviations influence the minimum standard, not only these deviations should be examined but also the minimum standard. This study applies two ambition levels. Ambition level A represents GES/GEP, ambition level B represents the HES/MEP.

The HES and GES for natural waters will be compared by means of intercalibration (and will be adjusted when necessary) with the ambition levels for similar water types in other member countries. Economic arguments or the impracticability of adapting the hydromorphology can be criteria for marking heavily modified waters. The ecological functioning of these waters will have to be attuned to the hydromorphological situation. That does not automatically imply that higher concentrations will be allowed in these waters. Even for artificial waters only hydromorphological deviations are acceptable. The MEP/GEP for heavily modified and artificial waters should be based on a comparable natural water type. This implies that references for heavily modified or artificial water (MEP) can be compared to references for natural water (HES). The classification of ‘heavily modified’ or ‘artificial’ does not imply that the objectives can be set at a lower standard, but it leaves room for different interpretations.

The targets for nutrients for GES/GEP (ambition level A) or HES/MEP (ambition level B) can only be achieved when reduction objectives will be realized in accordance with aquatic ecological principles. Other criteria will also have to be taken into account. The effect-specific measure ‘water drift adjustment’ also results into better morphological and hydrological conditions. Measures from the perspective of water management were not taken into account in this study, changes in water management also affect terrestrial nature (which is highly water dependent).

Impacts of the WFD on nature, landscape, recreation and fishery

Nature

The measures that have been suggested in this study have additional positive effects on nature (see Table 2). Source-specific measures have limited additional effects on biodiversity. Effect-specific measures that focus on nutrients and pesticides contribute positively to biodiversity. These additional positive effects should also be taken into consideration in the implementation of the WFD.
The consequences of the WFD are considerable for agriculture: the realization of ambition level A requires a large number of measures (according to the applied method 2/3 of all arable land should be taken out of production and only 1/3 of the current agricultural area would remain untouched). A generic application of ambition level B will leave no future prospects for agriculture. The average fall in the Net Added Value (NAV) per hectare is small, but the fall in the total NAV is considerable because of the large decrease of the total agricultural area (Table 1). In a number of areas (especially in clay- and peat areas), ambition level A cannot be achieved even after taking the complete agricultural areas out of production. This is due to the natural conditions of diffuse losses from the soil and/or seepage. The question remains whether such ecological objectives are realistic for these areas. At ambition level B, the reduction objectives are nowhere obtained, also after taking the entire agricultural area from production.

The allocation of water types and the associated ambition levels determine the differences between the two scale levels. A further differentiation into more areas offers more possibilities for the differentiation of ecological aims and for the further development of an area-specific set of measures. The appointed scale levels are not distinctive in socio-economic impact, the differences in agricultural area and employment are small.

The water type and the ambition level determine the ecological objectives and the maximum concentrations. Maximum nutrient concentrations predominantly determine the impact of nutrients and pesticides in surface water, while they do not interfere with the ecological objectives. Acceptable nutrient concentrations vary per water body system. This does not apply to pesticides. Therefore, nutrients and pesticides need a different approach.

In this study, a normative guideline method for pesticides was explored on the basis of the function of water bodies. This method was also fitted for two ambition levels. It allows us to establish a relationship between the selected protection levels and water types for pesticides and follow a similar procedure as was used for nutrients. The applied method was intended to stimulate the discussion concerning the need for differentiated normative guidelines and to initiate the design of such a method for pesticides.

The water type and the ambition level determine the ecological objectives and the maximum concentrations. Maximum nutrient concentrations predominantly determine the impact of the WFD on agriculture. Water types have been defined for ambition levels as well as for the water quality objectives. The applied maximum concentrations do not substantially deviate from the current maximum target values. The concentrations vary in accordance with the water types. The actual area-differentiated normative guideline was determined by the water types. The WFD is designed to indicate regional differences, and offer tailor-made solutions.

### Sources and targets

The ratio between the chemical critical load (in terms of ecological objectives) and the load in the reference situation in 2015 is shown in each ambition level. The assumption was made that all sources should equally contribute to the realization of the reduction targets.

### Ecological and chemical water types

The WFD regulates a number of requirements about the chemical water quality. First of all, prioritized chemicals (which include a number of pesticides which are allowed in the Netherlands) should comply with European standards. In order to meet the ecological objectives, the WFD applies additional requirements to the chemical water quality. The concentrations of nutrients and pesticides in surface water should not interfere with the ecological objectives. Acceptable nutrient concentrations vary per water body system. This does not apply to pesticides. Therefore, nutrients and pesticides need a different approach.

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### The scope of this study was limited to pesticides and nutrients

By their nature, pesticides do not belong in ecosystems. Nutrients are materials that represent only a small part of a well-functioning ecosystem. Good ecological functioning depends on the hydrology, the morphology, the substances and the species within an ecosystem.

### Ambition level and scale

<table>
<thead>
<tr>
<th>Ambition level and scale</th>
<th>Agricultural area (%)</th>
<th>NAV/ha (%)</th>
<th>Total NAV (%)</th>
<th>Direct employment (%)</th>
<th>Indirect employment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference 2015</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Ambition level A, global</td>
<td>35</td>
<td>94</td>
<td>33</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Ambition level A, detailed</td>
<td>31</td>
<td>96</td>
<td>30</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Ambition level B, global</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ambition level B, detailed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 1. Agricultural area, NAV, total NAV and the direct and indirect employment for both scale levels and ambition levels as a percentage of the starting situation

Regional diversity will occur because water types determine the acceptable concentrations: in the South and East acceptable concentrations are higher than in the West of the Netherlands, because stagnant waters in the lower parts of the Netherlands are more permissive to nutrient transport than streaming brook systems. This explains why the most ambitious reduction objectives are set for the lower parts of the Netherlands. Shifting objectives, i.e., the transport from higher parts to lower parts, were not accounted for. They would lead to higher reduction objectives for sloping sandy areas.

Leaching of nitrogen and phosphate will have to be reduced to meet the water quality targets which are formulated in the ecological objectives. The reduction objectives for N as well as P are normative. Phosphate accumulation in soils mainly determines the leaching of phosphate. The environmental effect of source-specific measures will therefore be limited. Effect-specific measures provide a larger perspective, but the effects of such measures have not been recorded for Dutch circumstances. This information is needed to formulate plans on a regional scale. The effect of such measures on the emission reduction of nitrogen will be bigger, which means that phosphate will become indicative for the development of policies and planning.

The impact of the WFD has been processed for the present agricultural production and policy. However, major changes are expected in agriculture, due to the announcement of the European Court in October about the requirements for better manure policies in the Netherlands. In addition, the admission requirements for pesticides will be regulated by Brussels. Although the Netherlands play a leading role in the harmonization process, a number of pesticides will have to be taken from the market. At the same time, major changes are to be expected within the agricultural sector, and induce new ones. The realization of the WFD implies the introduction of a number of new sectors and/or effective specific measures in agricultural management.
Both pesticides and nutrients can react with sediment particles or can be decomposed in surface water systems. The concentrations of substances within the water system are determined by the interconnection of the water bodies, the location of the driving sources within the catchment, and the behaviour of the chemicals in surface waters. Higher quality restrictions at the driving source imply larger emission reductions. This study applies the average retention factors per area for nutrients, and chemical- and watertype-specific parameters for pesticides.

**Measures and consequences**

In accordance with the WFD, a distinction was made between source- and impact-specific measures. With respect to nutrients, the prospects for reduction objectives by means of source-specific measures seem limited within modern agriculture. However, source-specific measures are important pillars in pesticides management policies. The consequences of impact-specific measures have as yet not been recognized properly, the effectiveness ranges widely and is strongly influenced by local circumstances. The environmental effects and the costs of measures vary from local to regional scales. For this reason, the development of a water management plan for river basins has to be tailor-made and its implementation should be carried out on a regional scale. An integrated assessment together with other policy topics will also be necessary. In this study generic measures were applied at national level and at fixed effectiveness and costs. However debatable this approach may be, the aim of the study justified the method.

The socio/economic impact of these measures on the agricultural sector has been estimated. A good analysis of the socio-economic impact should be conducted at production level. In this study the impact was visualized on national scale under the assumption of fixed costs and turnovers per ha agricultural land.

From the results of this study and after carrying through the prospective scenarios the consequences of the WFD on the policy fields of LNV were diagnosed. Through this method, insight was gained into the steps that are necessary to realise the WFD and knowledge gaps have been identified.

The consequences of the WFD on the policy fields of LNV have been based on the results and examination of these scenarios. In addition, this method has provided insight into the necessary steps and has identified a number of knowledge gaps.

It has become clear that the screening of a prospective step-by-step plan on a national scale is not possible for pesticides. In Dutch agriculture, more than 250 operative substances, mixed in several combinations and applied to a large variety of cultivations, are applied. Furthermore the required ecotoxicological data are not available for all substances and a nationwide instrument to predict concentrations in several types of surface water has not yet been validated. The impact of the WFD with respect to pesticides has been explored on the basis of a model crop. Given the size of the particular area and the volume and diversity of the pesticide use, potato crops have been selected.

**Consequences WFD for agriculture**

**Pesticides**

In the applied normative guideline method, water quality objectives will not be exceeded at ambition level A with the exception of 1 out of 5 selected chemicals in the functional water group ‘national waters’. As a direct consequence of the current admission policy no exceedings are predicted at ambition level B for the functional water group ‘ditches’. In the functional water group ‘outlets’ and ‘canals’ for 1 out of 5 selected chemicals exceedings of the water quality standard are calculated and for ‘national waters’ for 3 out of 5 chemicals. The exceedings in the ‘national waters’ group are caused by the fact that at ambition level B the drinking water standard of 0.1 μg/L is effective. This standard has been generically determined for all resources and was not based on an ecotoxicological risk analysis. In areas where the intake of drinking water takes place close to the chemical source large emission reductions will be necessary. Reductions up to 70 - 90% can be realized by the improvement of the application techniques. Moreover, hazardous chemicals could be replaced by chemicals with more favourable environmental profiles. Another very effective nonchemical measure for potato crops is weed control by means of earthing up or milking. For potato crops, the costs of measures for emission reduction are estimated at tens of euros per ha per year, while milking costs are considerably higher.

**Nutrients**

The discrepancy between the loads in the reference situation of 2015 and the ecological requirements for the water quality (i.e. the reduction objectives) is already large at ambition level A (Figure 2). In a limited number of the areas, the objectives with respect to nitrogen will be met in 2015. For phosphate, the objectives in the reference situation will not be realized. The reduction objectives for ambition level A are extremely demanding and will be almost impossible to meet. For ambition level B the reduction objectives are even more ambitious.
Both pesticides and nutrients can react with sediment particles or can be decomposed in surface water systems. The concentrations of substances within the water system are determined by the interconnection of the water bodies, the location of the driving sources within the catchment, and the behaviour of the chemicals in surface waters. Higher quality restrictions at the driving source imply larger emission reductions. This study applies the average retention factors per area for nutrients, and chemical- and watertype-specific parameters for pesticides.

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Nutrients

The discrepancy between the loads in the reference situation of 2015 and the ecological requirements for the water quality (i.e. the reduction objectives) is already large at ambition level A (Figure 2). In a limited number of the areas, the objectives with respect to nitrogen will be met in 2015. For phosphates, the objectives in the reference situation will not be realized. The reduction objectives for ambition level A are extremely demanding and will be almost impossible to meet. For ambition level B the reduction objectives are even more ambitious.
The consequences of the WFD are considerable for agriculture: the realization of ambition level A requires a large number of measures (according to the applied method 2/3 of all arable land should be taken out of production and only 1/3 of the current agricultural area would remain untouched). A generic application of ambition level B will leave no future prospects for agriculture. The average fall in the Net Added Value (NAV) per hectare is small, but the fall in the total NAV is considerable because of the large decrease in the total agricultural area (Table 1). In a number of areas (especially in clay- and peat areas), ambition level A cannot be achieved even after taking the complete agriculture area out of production. This is due to the natural conditions of diffuse losses from the soil and/or seepage. The question remains whether such ecological objectives are realistic for these areas. At ambition level B, the reduction objectives are nowhere obtained, also after taking the entire agricultural area from production.

The allocation of water types and the associated ambition levels determine the differences between the two scale levels. A further differentiation into more areas offers more possibilities for the differentiation of ecological aims and for the further development of an area-specific set of measures. The appointed scale levels are not distinctive in socio-economic impact, the differences in agricultural area and employment are small.

In this study, a normative guideline method for pesticides was explored on the basis of the function of water bodies. This method was also fitted for two ambition levels. It allows to establish a relationship between the selected protection levels and water types for pesticides and follow a similar procedure as was used for nutrients. The applied method was intended to stimulate the discussion concerning the need for differentiated normative guidelines and to initiate the design of such a method for pesticides.

The water type and the ambition level determine the ecological objectives and the maximum concentrations. Maximum nutrient concentrations predominantly determine the impact of the WFD on agriculture. Water types have been defined for ambition levels as well as for the water quality objectives. The applied maximum concentrations do not substantially deviate from the current maximum target values. The concentrations vary in accordance with the water types. The actual area-differentiated normative guidelines was determined by the water types. The WFD is designed to indicate regional differences, and offer tailor-made solutions.

The scope of this study was limited to pesticides and nutrients. By their nature, pesticides do not belong in ecosystems. Nutrients are materials that represent only a small part of a well-functioning ecosystem. Good ecological functioning depends on the hydrology, the morphology, the substances and the species within an ecosystem.

### Sources and targets

The ratio between the chemical critical load (in terms of ecological objectives) and the load in the reference situation is the key figure that is used to determine the reduction objectives. For both ambition levels, the assumption was made that all sources should equally contribute to the realization of the reduction targets.

Regional diversity will occur because water types determine the acceptable concentrations: in the South and East acceptable concentrations are higher than in the West of the Netherlands, because stagnant waters in the lower parts of the Netherlands are more perpective to nutrient transport than stream systems. This explains why the most ambitious reduction objectives are set for the lower parts of the Netherlands. Shifting objectives, i.e. the transport from higher parts to lower parts, were not accounted for. They would lead to higher reduction objectives for sloping sandy areas.

Leaching of nitrogen and phosphate will have to be reduced to meet the water quality targets which are formulated in the ecological objectives. The reduction objectives for N as well as for P are normative. Phosphate accumulation in soil mainly determines the leaching of phosphate. The environmental effect of source-specific measures will therefore be limited. Effect-specific measures provide a larger perspective, but the effects of such measures have not been recorded for Dutch circumstances. This information is needed to formulate plans on a regional scale. The effect of such measures on the emission reduction of nitrogen will be bigger, which means that phosphate will become indicative for the development of policies and planning.

The impact of the WFD has been processed for the present agricultural production and policy. However, major changes are expected in agriculture, due to the announcement of the European Court in October about the requirements for better manure policies in the Netherlands. In addition, the admission requirements for pesticides will be regulated by Brussels, although the Netherlands plays a leading role in the harmonization process, a number of pesticides will have to be taken from the Dutch market. At the same time, major changes are to be expected within agriculture itself. The WFD can speed up these developments in the agricultural sector, and induce new ones. The realization of the WFD implies the introduction of a number of source and/or effect-specific measures in agricultural management.

<table>
<thead>
<tr>
<th>Ambition level and scale</th>
<th>Agricultural area (%)</th>
<th>NAV ha (%)</th>
<th>Total NAV (%)</th>
<th>Direct employment (%)</th>
<th>Indirect employment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference 2015</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Ambition level A, global</td>
<td>25</td>
<td>94</td>
<td>33</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Ambition level A, detailed</td>
<td>31</td>
<td>96</td>
<td>30</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Ambition level B, global</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ambition level B, detailed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The WFD regulates a number of requirements about the chemical water quality. First of all, prioritized chemicals (which include a number of pesticides which are allowed in the Netherlands) should comply with European standards. In order to meet the ecological objectives, the WFD applies additional requirements to the chemical water quality. The concentrations of nutrients and pesticides in surface water should not interfere with the ecological objectives. Acceptable nutrient concentrations vary per water body system. This does not apply to pesticides. Therefore, nutrients and pesticides need a different approach.

In this study, a normative guideline method for pesticides was explored on the basis of the function of water bodies. This method was also fitted for two ambition levels. It allows to establish a relationship between the selected protection levels and water types for pesticides and follow a similar procedure as was used for nutrients. The applied method was intended to stimulate the discussion concerning the need for differentiated normative guidelines and to initiate the design of such a method for pesticides.

The water type and the ambition level determine the ecological objectives and the maximum concentrations. Maximum nutrient concentrations predominantly determine the impact of the WFD on agriculture. Water types have been defined for ambition levels as well as for the water quality objectives. The applied maximum concentrations do not substantially deviate from the current maximum target values. The concentrations vary in accordance with the water types. The actual area-differentiated normative guideline was determined by the water types. The WFD is designed to indicate regional differences, and offer tailor-made solutions.

The scope of this study was limited to pesticides and nutrients. By their nature, pesticides do not belong in ecosystems. Nutrients are materials that represent only a small part of a well-functioning ecosystem. Good ecological functioning depends on the hydrology, the morphology, the substances and the species within an ecosystem.
Ecological objectives and ambitions

The WFD allows for a differentiation between water bodies, by making a distinction between ‘natural’, ‘heavily modified’ and ‘artificial’ waters. A measuring rod was introduced for measuring ecological functioning. The WFD requires that in 2015, a minimum ‘good ecological status’ (GES) for natural waters and a ‘good ecological potential’ (GEP) for heavily modified and artificial waters will be obtained. The WFD indicates that the actual ecological conditions of GES/GEP are allowed to deviate to a small degree from the values at ‘High ecological status’ (HES) or ‘maximum ecological potential’ (MEP). These two are considered to be the ecological frame of reference. Because slight deviations influence the minimum standard, not only these deviations should be examined but also the minimum standard. This study applies two ambition levels. Ambition level A represents GES/GEP, ambition level B represents the HES/MEP.

The HES and GES for natural waters will be compared by means of intercalibration (and will be adjusted when necessary) with the ambition levels for similar water types in other member countries. Economic arguments or the impracticality of adapting the hydromorphology can be criteria for marking heavily modified waters. The ecological functioning of these waters will have to be attuned to the hydromorphological situation. That does not automatically imply that higher concentrations will be allowed in these waters. Even for artificial waters only hydromorphological deviations are acceptable. The MEP/GEP for heavily modified and artificial waters should be based on a comparable natural water type. This implies that references for heavily modified or artificial water (MEP) can be compared to references for natural water (HES). The classification of ‘heavily modified’ or ‘artificial’ does not imply that the objectives can be set at a lower standard, but it leaves room for different interpretations.

Impacts of the WFD on nature, landscape, recreation and fishery

Nature

The targets for nutrients for GES/GEP (ambition level A) or HES/MEP (ambition level B) can only be achieved when reduction objectives will be realized in accordance with aquatic ecological principles. Other criteria will also have to be taken into account. The effect-specific measure ‘water drift adjustment’ also results into better morphological and hydrological conditions. Measures from the perspective of water management were not taken into account in this study, changes in water management also affect terrestrial nature (which is highly water dependent).

Higher nutrient concentrations and intensive dilution in seawater lead to the assumption that shifting objectives from fresh water systems will be of no consequence and that measures for fresh water systems do not influence salt water systems. The presence of unnatural substances in these waters may present bigger problems. So far the implementation of the WFD in the Netherlands has been focused on fresh water systems, more attention will have to be paid to salt- and transitional waters.

Table 2. Outline of future impact of additional measures. Measures 3 and 6 are not included into this table. See text for explanation.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Flora</th>
<th>Ongew.</th>
<th>Vissen</th>
<th>Amfibieën</th>
<th>Vogels</th>
<th>Zogdieren</th>
<th>Totaal biodiversiteit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. less manuring</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Corn to grass?</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Buffer strips 3m</td>
<td>-</td>
<td>++</td>
<td>0</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>4. Buffer strips 10m</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>5. Structure water system</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>6. Transformation of agriculture into nature</td>
<td>-</td>
<td>+++</td>
<td>0</td>
<td>+++</td>
<td>0</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>

Table 2: Outline of future impact of additional measures. Measures 3 and 6 are not included into this table. See text for explanation. 0 = no expected effect ++ = minor expected effect +++ = large expected positive effect + = very large expected positive effect ++ = more research needed
Methods

In this tentative study, the most important stages of the implementation have been considered. The choices that were made during this process were handled in consultation with LNV. Moreover, LNV was also consulted on the delineation of this study. It was decided upon that groundwater, protected areas, water management, transference of measures and other sources like urban areas and industry were to be excluded. The study was confined to nutrients and pesticides in freshwater systems.

The reference scenario for the year 2015 has been defined by LNV. The starting point is the current situation in water (quality, planning, management) and land use, subject to current policy commitments, i.e. policies that at present have been transformed into concrete measures. Policy objectives which have not yet been adopted into concrete measures, were left out of consideration.

The impact of the WFD were explored by means of four scenarios (Figure 1). The scenarios have been compiled out of two different classifications into areas/water bodies (scale levels) and two different levels of ecological objectives (ambition levels).

This method cannot automatically be used as an approach to pesticides. For this purpose a different methodology was designed on the basis of water functions and protection levels.

Areas, water bodies and water types.

To each area a water type was allocated. A proposal for the classification in water types was made available by Elbersen, et al., 2003. Because the characteristics of water types have been well-defined, it is possible to classify all waters. At a detailed scale level, the allocation of water types does not present any problems. In larger spatial entities more water types will be found within the same area. Choices will have to be made as to which criteria determine the allocation of water types to larger spatial entities. In this study the region-based approach was preferred; the water types which represent the catchment outlet points of a particular area have arbitrarily been picked to represent the larger area.

Further investigation is needed.

A comparison of the effects of the realization of the WFD against the interference with the historic-geographical relict ensemble and geological values is highly recommendable. Measures that fit into the present types of landscape and thereby add more value to it should be preferred.
Preface

Here is a short report of the exploratory scenario study 'Aquarein; Impact of the European Water Framework Directive on agriculture, nature, recreation and fishery' which was carried out by order of the Executive Board on Rural Affairs of the Dutch Ministry of Agriculture and Fisheries (LNV). The objective of this study was to quantify all consequences of the European Water Framework Directive for policy fields of LNV. In this summary report the most important conclusions with respect to the implementation of the European Water Framework Directive (WFD) are summarized. This study does not present final conclusions, but should be regarded as an intermediate exercise in the further development of the WFD. The authors hope that it will offer us sufficient matter for discussions about the further development of the WFD.

An extensive description of the study can be found in the Alterra report 835 (in Dutch), 'Aquarein; Gevolgen van de Europese Kaderrichtlijn Water voor landbouw, natuur, recreatie en visserij'. Frank vd Bolt, Rik vd Bosch, Theo Broek, Petra Hallegers, Coos Kwakernaak, Dorothée Leenders, Oscar Schoumans, and Piet Verdonck. You can order the report by making €40,- payable to bank account nr. 36 70 54 612 (Alterra Wageningen), please enter the report nr 835. The sum of €40,- includes taxes and dispatch costs. The English brochure of this summary can be ordered at info@alterra.nl.

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Introduction and objectives

The objectives of the European Water Framework Directive (2000) (WFD) focus on the amelioration of sustainable water use and the protection and improvement of the quality of watersystems. These objectives can be achieved by the termination or reduction of point losses and diffuse losses, the improvement of the ecological functioning of waters and the introduction of levies on water consumption. The WFD is focused on river basins including coherent watersystems. Although the implementation of the WFD is the responsibility of the Dutch Ministry of Ministries of Transport, Public Works and Water Management (MVVM), it may also have consequences for the policy fields of the Ministry of Agriculture and Fisheries (LNV). For this reason LNV wants to take a position regarding the impact of the implementation and therefore has assigned Alterra to deliver a quick scan in order to gain provisional insight into the possible consequences of the WFD on agriculture, nature, recreation and fishery. A set of four scenarios has been formulated to enable all necessary steps of the implementation to be considered in order to obtain a good perspective on the possible effects and the potential options.

Recreation

Clean water and more natural surroundings improve recreational use and value. The effects of measures have been explored for a number of forms of recreation (Table 4). Although some measures can be said have a positive effect on the recreational value, others may have negative effects.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Day recreation</th>
<th>Stay recreation</th>
<th>Water Recreation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction load/Applying techniques</td>
<td>S Q U</td>
<td>S Q U</td>
<td>S Q U</td>
</tr>
<tr>
<td>Environment/friendly choice of crops</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Buffer strips</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Structure water system</td>
<td>0/0</td>
<td>0/0</td>
<td>0/0</td>
</tr>
<tr>
<td>Poor surface water systems</td>
<td>+</td>
<td>+</td>
<td>+/0</td>
</tr>
<tr>
<td>Purification through purification marshes</td>
<td>+</td>
<td>+</td>
<td>+/0</td>
</tr>
<tr>
<td>Transformation into natural landscape</td>
<td>+</td>
<td>+</td>
<td>+/0</td>
</tr>
</tbody>
</table>

S = Supply, Q = Quality, U = Use
- negative effect
+ positive effect
? no effect
* more research is needed
0 concrete form of measures depends on the location

The measures will mostly affect day recreation and have less consequences for stay recreation and water recreation. Accessibility is a crucial factor in terms of the permission for the development of recreation in a particular area. Whether recreational opportunities will be exploited depends on their accessibility and location. The realisation of recreational objectives in terms of the WFD calls for further spatial planning on a regional and local scale.

Fishery

Fishery in coastal waters strongly determines the living circumstances of the fish as opposed to their natural habitat. The number of fishing quotas that can be regarded as normative to good ecological conditions (which will by definition deviate from natural conditions) remains a political option. Optimal fishing quotas which leave the ecosystem intact denote the ultimate boundaries. Considerable effort will be needed to achieve this situation for the IJsselmeer.

The fishery sector can contribute considerably to monitoring the WFD and the Bird and Habitat Directive. Bycatches form an important source of information about rare and migrating fish species which are important indicators in terms of ecological conditions.
Conclusions

In this study, a straightforward approach was followed to explore the impact of the WFD. The results show that it will be a hard task to achieve its objectives in the Netherlands and that the consequences will be considerable.

- Ambition level A implies a number of drastic interventions needed to obtain reduction objectives for nitrogen and phosphate. In a number of areas these objectives will not be met by means of measures in soil-specific agriculture.
- A generic application of ambition level B will not lead to a successful realization of the ecological objectives, not even if all soil-specific agriculture was to be taken from production.

The application of pesticides to potato crops is not expected to present any problems to the implementation of WFD ambition level A. For the implementation of ambition level B further emission reductions will be necessary, because in many places the drinking water standards cannot be reached without further actions. Whether this also applies to other crops or substances is not known. It should be noted that surface waters objectives are regularly exceeded for a number of chemicals.

The realization of the WFD calls for an integrated approach with respect to other directives in the appointed areas. The WFD may imply a number of consequences for manure policies; phosphate can often be regarded as a normative factor in the implementation of ecological objectives in surface water. Phosphorus accumulation in soils often contributes considerably to phosphate losses to surface waters. The environmental impact of source-specific measures will therefore be limited. Effect-specific measures provide a larger perspective. Although the effects of such measures have not been recorded for Dutch circumstances, their estimated effects will have to be explored under different circumstances in order to formulate plans on catchment scale.

The necessary efforts that are needed to accomplish such ambitions are considerable, and may prove to be unattainable for all areas before 2015. A more realistic approach to these high ambitions would have to be based on the selection of a limited number of areas such as the Bird and Habitat Directive Areas. Small target areas allow for tailor-made solutions and specific measures. This method also implies a differentiated approach of the consequences for the agricultural sector. However, this exploratory study predicts only minor differences in socio-economic consequences between scale levels.

The ecological objectives will not be met even if all arable land were to be taken from production. Subsequent supply from the soil and external loads through seepage make closer scrutiny of the ecological references imperative.

Implementation of effect-specific measures, in order to achieve the environmental objectives, can simultaneously contribute positively to the recovery of morphology, nature restoration, landscape, recreation as well as fishery. An integrated approach towards the design and the implementation of these measures is highly recommendable. The cost-effectiveness will need to be based on a quantification of all costs and benefits of all aspects. The result obligation of the WFD calls for the close elaboration of its impact and for sustainable methods for its implementation. (Political) Choices will have to be met to set the limits in terms of the implementation.

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Aquarein

Impact of the European Water Framework Directive on agriculture, nature, recreation and fishery