

Evaluation of the Water Framework Directive in the Netherlands; costs and benefits



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*Evaluation of the Water Framework Directive in the Netherlands; costs and benefits
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W. Ligtoet, G.P. Beugelink, R. Franken

Contact

Willem Ligtoet: Willem.Ligtoet@pbl.nl

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Netherlands Environmental Assessment Agency.

P.O. Box 303

3720 AH Bilthoven

T: +31 30 274 27 45

F: +31 30 274 44 79

E: info@pbl.nl

www.pbl.nl

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Summary

Evaluation of costs and benefits of the measures proposed by the Dutch water authorities

Just as all the other European Member States, the Netherlands also has the obligation to implement the European Water Framework Directive (WFD). At the request of the Dutch Ministry of Transport, Public Works and Water Management, the Netherlands Environmental Assessment Agency (PBL) has executed a cost-benefit analysis and has evaluated the ambition level regarding the proposed WFD package of measures for improving the ecological quality of the Dutch surface waters. The WFD package of measures encompasses both the measures for the large national water bodies, as proposed by the national water authority (RWS), and the measures for the regional water bodies, proposed by the regional water authorities.

Extra costs of measures for WFD implementation are estimated at 2.9 billion euros

Investments in the complete RWS/regional package of measures total around 7.1 billion euros, to be spent during the 2007 - 2027 period. An estimated two thirds of the investments in the total package of measures is based on standing and already proposed policies. The extra investments for the WFD implementation are, thus, estimated at 2.9 billion euros. Of the total of 7.1 billion euros, the regional water boards are accountable for 5.4 billion euros, and the national water authority for 1.7 billion euros. The annual costs to society of the total RWS/regional package of measures, once all investments have been made, will come to 390 million euros per year, from 2007 till 2027. About 60% of these costs are to be paid by the water boards, 15% by the municipalities and 15% by the national water authority.

The extra expenses per household rise 0,7% annually during the 2007 – 2027 period; one third of this as a consequence of the WFD implementation.

Proposed measures focus on reaching ecological targets in 2027

Both the regional and national measures are to be implemented in phases. Between 65 and 70% of the total investment is expected to be made during the 2007 - 2015 period, which in fact means that the option of postponing the deadline for achievement of the targets by two six-year periods, until 2027, has been anticipated. The question is whether the expected increase in charges could be considered disproportionate and could, therefore, be sufficient reason for legitimising phased implementation up to 2027. Which level of ambition and effort the European Union will consider to suffice, is still uncertain.

Substantial ecological improvement expected, especially in regional water bodies

It is expected that implementation of the proposed measures will result in a substantial improvement in ecological quality, particularly in the Dutch regional waters. The expected improvement in ecological quality would mainly be the result of the widespread implementation of design measures, improving the hydro-morphological conditions of water bodies, such as the construction of nature-friendly river banks and fish ladders, and the remeandering of straightened brooks. The nutrient conditions are expected to improve only slightly.

Ecological targets will not be reached

For the regional waters, it is estimated that a maximum of 30 to 50% of the targets for WFD-relevant species groups could be achieved in 2027. When following the ‘one out - all out’ principle, an even significantly lower number of targets could be achieved. It, thus, seems improbable that the proposed targets for the regional waters can be achieved, by 2027. For the larger national waters, it is concluded that the proposed targets may be within reach, with the exception of the natural coastal waters. The package for the national and regional waters contributes only to some extent to the realisation of the required water conditions for internationally determined nature and biodiversity areas (Natura 2000).

Presenting the currently proposed targets for the regional waters to Brussels, may involve the future risk of failing to meet this obligation. This risk may be reduced by adapting the targets in a more realistic way for 2015 and 2021, based on the results of a monitoring programme, evaluating the effects of the measures.

Further improvement: design measures and ecological fish stock management most cost-effective

To obtain further ecological improvement and to reach more targets in the period up to 2015 or 2027, a number of additional design measures can be taken, the most cost-effective of which in streams/rivers, waterways/canals and ditches and in the ecological management of fish stocks (especially bream) in lakes. In 2027, it is expected that around 75% of the nutrient load of the regional waters will be derived from agricultural land. It is difficult, however, to reduce the nutrient load to regional surface waters, because of large amounts of nutrients which have accumulated in agricultural soils. The implementation of effect-oriented measures, such as helophyte filters, may significantly reduce the nutrient load, but the quantitative effects are still uncertain and the costs to the agricultural sector potentially high. However, reduction of the nutrient load is also important in mitigating the effects of climate change (the increasing risk of eutrophication). A more ambitious policy on manure use – such as a phosphate stop on phosphate saturated soils – as formulated in current recommendations, will be necessary to prevent further accumulation of phosphate in the soil and to reduce the nutrient load to surface waters, in the long run.

Benefits appeared difficult to be monetised; ecological quality is primary benefit of WFD

Improving ecological quality is the primary objective and, therefore, the most significant and desired benefit of the WFD. This benefit could not be monetised in this report due to a lack of underpinning evidence in available studies. A broad assessment of available studies concerning potential secondary and monetary benefits, such as effects on recreation, health and the fisheries sector, revealed that these benefits are either negligible or difficult to underpin with reliable data. Therefore, a full cost-benefit analysis could not be made. Nevertheless, the undeniable ecological benefits, resulting from the proposed measures, have been made clear, as well as the measures which are significant to producing these benefits, including the costs involved. This study also elaborates which additional measures would make an important contribution to the further improvement of the ecological quality.

Regulation costs WFD policy estimated at 300 to 350 million euros, between 2000 and 2009

In the Netherlands, many institutions are involved in water management. It is estimated that, on a yearly basis, over 400 FTEs (which represent about 45 million euros) are involved in the process of implementing the WFD. Another 45 million euros is spent, yearly, on research, engineering and the development of techniques and tools. The so-called regulation costs of the WFD amount to 300 to 350 million euros, between 2000 and 2009. That is about 10 to 12% of the total investment in WFD measures.

I Introduction

The aim of this study and the policy process

The Netherlands has the obligation to implement the European Water Framework Directive (WFD) as have all other European Member States. As an important step in this process, draft River Basin Management Plans (RBMPs) will be published at the end of 2008, followed by the final version at the end of 2009. In these plans, the government will describe how the Netherlands intend to achieve the WFD targets, based on the proposals by the 26 regional water authorities and the Directorate-General for Public Works and Water Management (RWS), responsible for the quantity and quality of the large(r) national water bodies, such as the main rivers and the coastal zone. The primary targets of the WFD are to achieve chemically clean and ecologically healthy surface water and chemically clean groundwater and to ensure that there is sufficient groundwater available for the needs of terrestrial nature. According to the WFD system, the quality of all surface waters should, officially, carry the qualification 'good', formally by 2015 but, on postponing the deadline by two six-year periods, by 2027 at the latest.

The Directorate-General for Public Works and Water Management (RWS) and the regional water authorities drew up a series of measures in 2007, to be implemented in the 2007 - 2027 period, to realise the targets of the WFD in national and regional water bodies, the so-called *RWS/regional package of measures*. Although the decision-making process of the regional water boards and the RWS is not yet complete, meaning that the targets and measures may yet be subject to further change in some areas, the PBL has carried out an assessment at the request of the Directorate-General for Water Affairs, focusing on providing an overview of the costs, the future effects of the proposed measures and the extent to which the targets could be achieved (PBL, 2008). This WFD ex-ante assessment aims to provide information for the debate in the Dutch House of Representatives, concerning implementation of the WFD and the proposed ambition level, as set out in the draft river-basin management plans.

Scope of the Water Framework Directive ex-ante assessment

Focus on ecological quality of surface waters

The proposed package of measures is, primarily, comprised of measures focusing on the ecological targets of the WFD, through the restoration and (re)design of water systems and the reduction of nutrient emissions to surface waters. This is, therefore, where the emphasis lies in this assessment. As far as the chemistry of surface water and groundwater is concerned, the assessment is restricted to providing information concerning the current state in relation to the environmental quality targets.

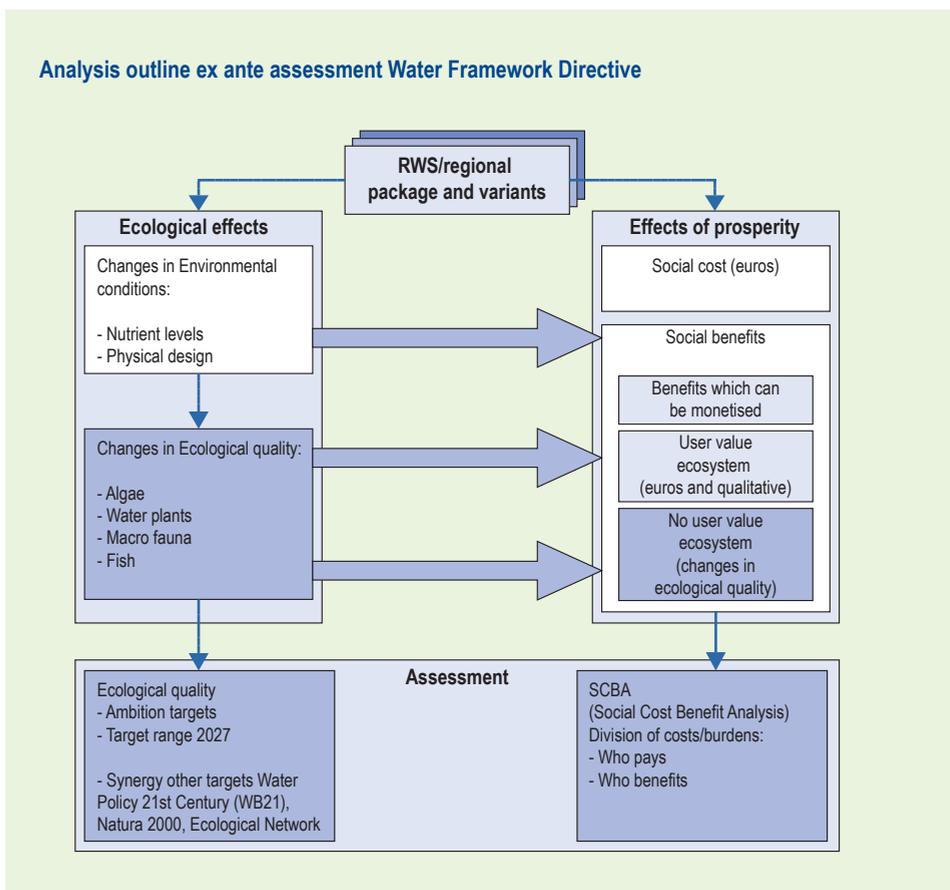


Figure 1 General structure of WFD ex-ante assessment.

The primary targets of the WFD ex-ante assessment are (Figure 1):

- to provide information on the ecological effects, expected achievement of targets and the costs and benefits of the proposed *RWS/regional package of measures*, and the resulting cost to citizens and businesses
- and to indicate to what extent the reduction of the nutrient load to surface waters can contribute to an improvement in ecological water quality and the costs thereof.

WFD measures difficult to distinguish in package of measures

Many of the proposed measures in the *RWS/regional package* contribute to both WFD targets and targets which fall under other policy areas, such as the *Dutch Water Management in the 21st Century (WB21)*, the *European Birds and Habitats Directives (Natura 2000 areas)*, the *Nitrates Directive* and the *Bathing Water Directive*.

As information about the links between specific measures and the relating policy field was lacking in the proposed package, it was difficult to distinguish WFD measures from measures based on standing water policy or on other policy fields. Therefore, in determining the effect of the package of measures on the ecological quality, those measures

which fall under standing and/or proposed policies and measures which can be considered specific to the WFD, had to be treated as one. However, based on additional information, a rough estimate is made of the particular costs of the package which can be attributed to the WFD and to standing water policy or to other policy fields.

Monetising benefits appeared difficult; primary benefit of the WFD is ecological quality

The preamble to the Water Framework Directive states that ‘water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such’. Therefore, the WFD focuses on the protection and management of all European waters and includes the complete system, from source to sea and from salt water to freshwater. Improving ecological quality is the primary objective of the WFD and, therefore, the most important desired benefit of the *RWS/regional package of measures*. This benefit is not quantified in this study, due to a lack of evidence in the studies available. Other, secondary benefits considered in other studies, including effects on recreation, health and the fisheries sector, turn out to be either negligible or difficult to justify.

Due to the lack of reliable estimates of the monetary value of various benefits, it has not been possible to conduct a complete cost-benefit analysis. Nevertheless, the undeniable ecological benefits of the *RWS/regional package* have been made clear, as well as the measures which are significant in producing benefits, the costs that they involve and the additional measures that would make an important contribution to the further improvement of the ecological quality.

2 WFD implementation: challenges for the Netherlands

The Netherlands is an artificial country, consisting largely of man-made water bodies. Around 40% of the area of the Netherlands is found below sea level. Low-lying areas are made habitable with man-made constructions like dikes, sluices and pumps and major alterations in the natural morphology and hydro-dynamics of water courses. An extensive network of ditches (approximately 300,000 km) and canals has been created to ensure adequate drainage of low-lying land. Moreover, canals have been dug and rivers canalised for transport purposes. Consequently, a large proportion of the water bodies in the Netherlands are what the WFD characterises as ‘heavily modified’ or ‘artificial’ (Figure 2). The only large body of water designated as a ‘natural water body’ is the coastal zone, including the Wadden Sea in the north.

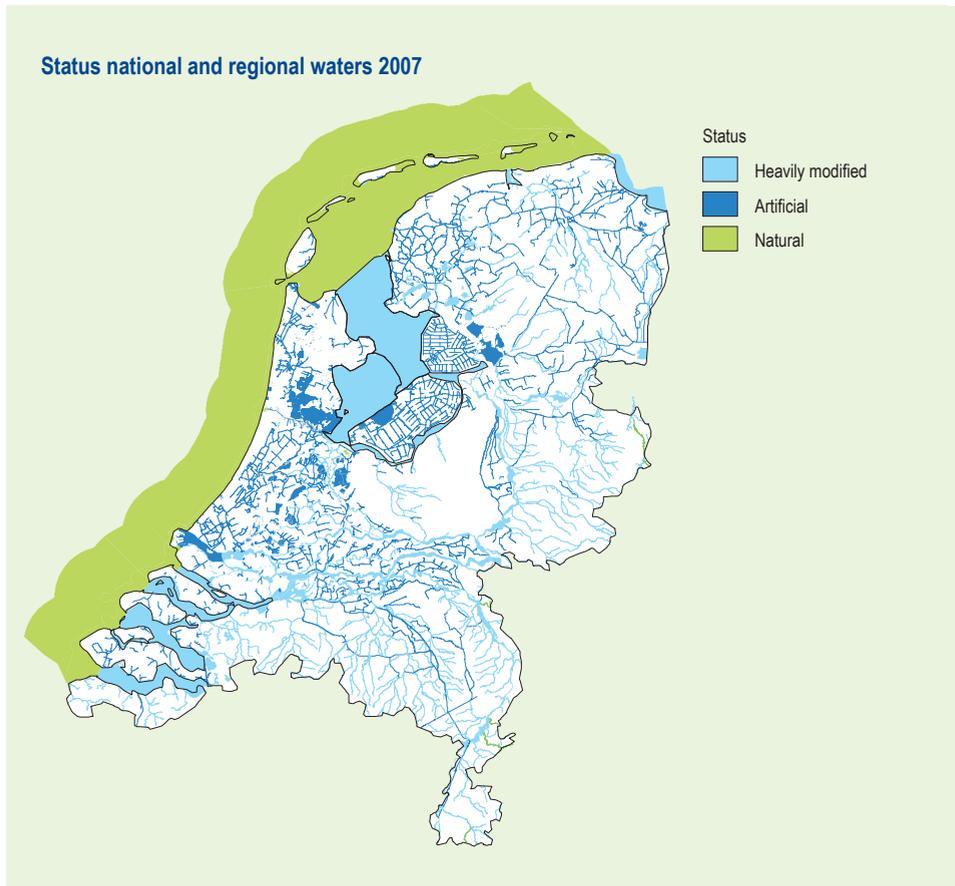


Figure 2 Situated in the delta of four rivers and, partly, below sea level, circa 95% of the water bodies in the Netherlands are designated as heavily modified or artificial. The main natural water is the coastal zone, including the Wadden Sea.

High environmental pressure

The Netherlands has the highest density of population, industry, livestock and transport in Europe. Precisely because of the pressures this imposes, the Netherlands is required to take technical measures that usually go beyond what is, on average, necessary in the European Union (EU) to meet European environmental quality standards. The burden posed on soil, groundwater, surface water and nature in the Netherlands, is currently the highest in Europe, due to acidification, nitrogen and phosphorus. These areas, in particular, pose difficulties for the Netherlands in meeting EU requirements (e.g., RIVM/MNP, 2004; MNP, 2005).

The intensity and environmental impact of Dutch agriculture per hectare are high, compared to other countries, both in Europe and elsewhere (e.g., MNP, 2006). The high cost of land and labour are offset by the high level of productivity per hectare and by labour productivity. The intensive forms of agriculture in the Netherlands have led to the highest level of over-fertilisation with nitrogen and phosphate in the EU and to the intensive use of pesticides. In certain other areas of Europe, where intensive livestock farming is also practiced, the nitrogen surplus per hectare is generally 30 to 50% of the surplus in the Netherlands. Although the nitrogen surplus in the Netherlands declined, substantially, between 1998 and 2002, compared to the other EU countries, it is still the highest (*Figure 3*).

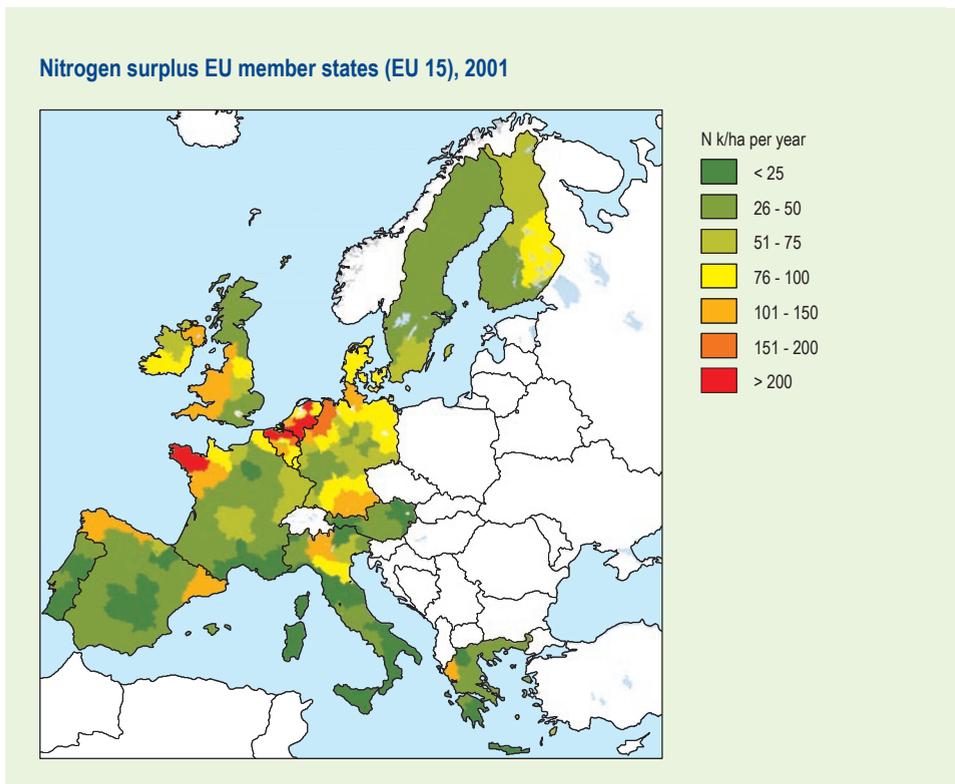


Figure 3 Regional nitrogen surplus in 2001 for EU15, calculations based on the Capri database (EC, 2007).

This is also the case for phosphorus (MNP, 2007). Concerning phosphorus, the situation in the Netherlands is also characterised by a large area of phosphate saturated agricultural soils, due to the accumulation of phosphorous over the last decennia.

In the period between 1992 and 1998, the area of phosphorus saturated soils was estimated at 56% of the total agricultural area (MNP, 2007).

In the present situation, due to the emission levels of nutrients, only 30 to 50% of the regional freshwater bodies reach the standards for the Good Ecological Situation (GES) (*Figure 4*).

Current ecological quality of surface waters mostly moderate; good conditions are rare Measured against the WFD standards for water plants, macro fauna and fishes, the current ecological quality of regional fresh surface waters included in the study (streams, lakes, ditches and waterways/canals) are largely classified as ‘moderate’ or ‘inadequate’. For these species groups, in only 5% of the regional waters the status is classified as ‘good’. For algae, though, a good status was found in about 50% of the regional waters. The current ecological quality in regional waters (2000-2005) is presented in *Figure 11*.

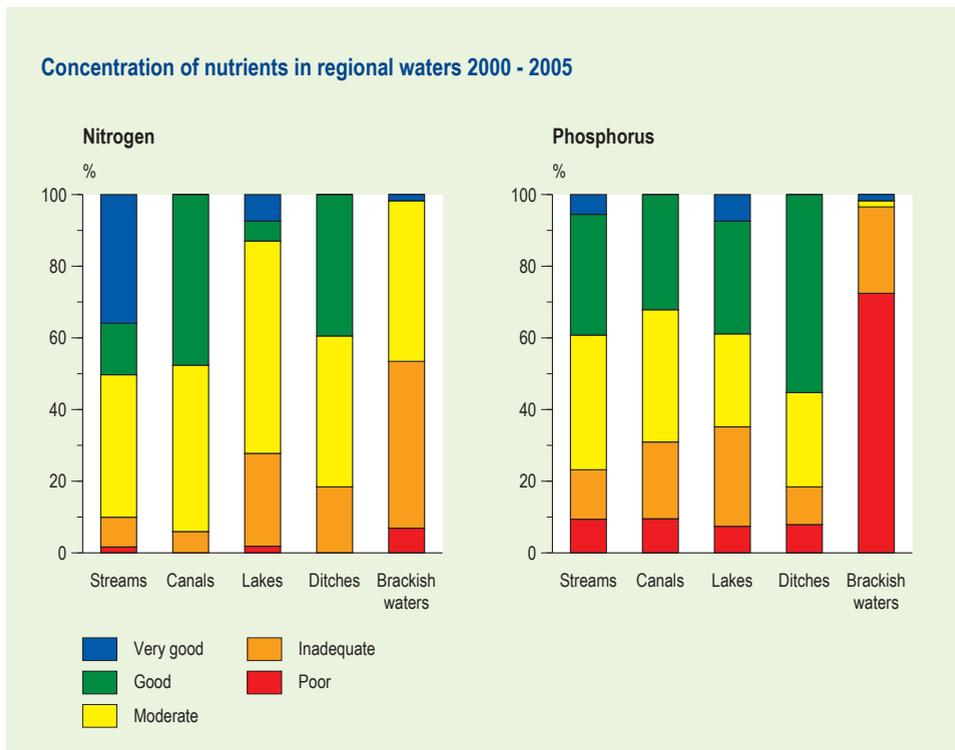


Figure 4 Present situation (mean over the period 2000 - 2005) for the nutrients nitrogen and phosphorus, in the most relevant types of water. For the heavily modified waters, streams and lakes, the nutrient concentrations are qualified, based on the standards for natural waters; for the artificial ditches and canals, standards are based on the developed values for Good Ecological Potential (GEP).

Just as for the regional waters, the ecological quality of many of the national waters is also classified as ‘moderate’, ‘inadequate’ or ‘poor’ for all WFD-relevant species groups, with the exception of algae. For water plants, macro fauna and fishes, the status of the water bodies is classified as ‘good’ in about 10 - 15%; for algae this is about 65%. The current ecological quality in national waters (2003-2006) is presented in *Figure 12*.

Text box WFD standards for ecological quality

Following the WFD procedures, the ecological targets for various water bodies are derived from so-called reference situations, being the almost undisturbed situation with natural hydro-morphological conditions and natural concentrations of nutrients and substances. The ecological quality is presented in terms of the “Ecological Quality Ratio” (EQR). The ecological quality of natural waters represents an EQR of 1 (*Figure 5, left panel*).

The ecological quality of surface waters is determined, based on four species groups in the WFD system: algae (phytoplankton), water plants (macrophytes), macro fauna (‘small aquatic animals’) and fishes.

In the Netherlands, standards have been developed for these species groups (the Ecological Quality Ratio, EQR), based on a natural reference condition. It has been agreed in the *Dutch National Consultative Committee on Water* that the status of natural waters (i.e. the Wadden Sea and some streams) and heavily modified waters (rivers, streams, lakes) is to be indexed by using these standards, based on the natural reference situations. The Good Ecological Status (GES, with an EQR of 0.6 as the lower limit) is an important reference point. The status of artificial water bodies (waterways and canals) is indexed, based on a chosen set of values for the Good Ecological Potential (default GEP, with an EQR of 0.6 as the lower limit; *Figure 5, right panel*).

Standards ecological quality of the Water Framework Directive

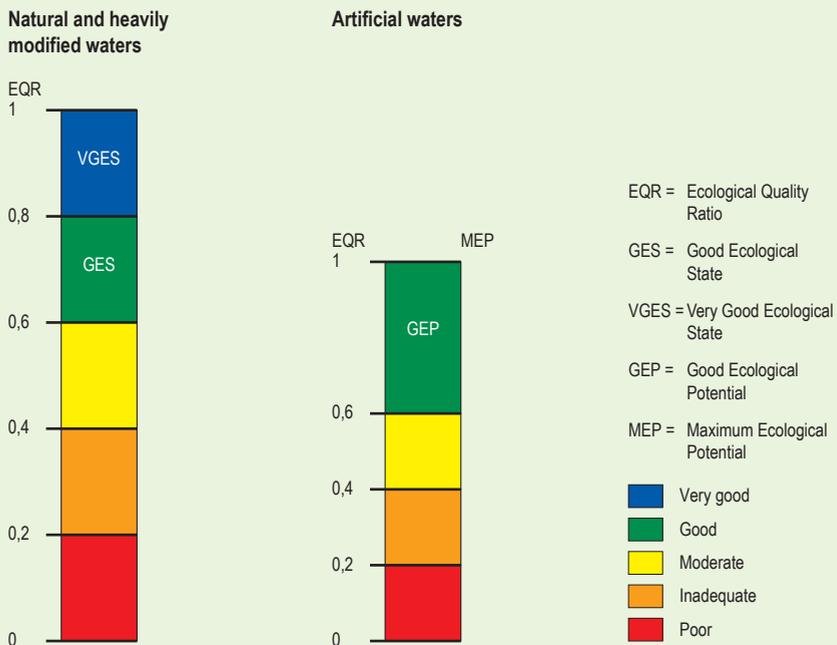


Figure 5 Standards for determining the ecological quality, based on the standards for natural and heavily modified waters (left panel) and artificial waters (right panel). For the natural and heavily modified waters classes of Ecological Quality Ratio (EQR) are fixed, using five colours and qualifications, ranging from ‘very good’ to ‘poor’. Classes for artificial waters are not fixed and are represented by only four colours and qualifications.

The WFD uses four species groups for assessing the ecological quality. For the final qualification of the ecological status of a water body, the WFD uses the ‘one out - all out’ principle.

This means that if even only one species group is below target quality, the water body will be classified according to this species group.

Artificial design and relatively high nutrient concentrations restrict ecological quality

The ecological quality of national and regional surface waters in the Netherlands is determined, to a significant extent, by the hydrology (e.g., flow velocity and artificial water level changes), the physical design of the water systems (e.g., damming and normalisation), the physical and chemical status of the water (e.g., oxygen levels and temperature) and by the nutrients nitrogen and phosphorus. The WFD regards the hydro-morphology and the nutrients as important indicators for the ecological quality of surface waters or their restoration. Analysis of the current situation shows that, for the macro fauna, water plants and fishes species groups, the water is classified as ‘good’ far less often than for algae, which would suggest that artificial design is more of a limiting factor than are nutrient levels.

International challenges

The Netherlands form a delta where four European river basins meet, namely, those of the Rhine, the Meuse, the Scheldt and the Ems (*Figure 6*). The quality and quantity of Dutch waters are, therefore, heavily influenced by the land use and emissions of substances in the upstream countries of Germany, Switzerland, Austria, Belgium, Luxembourg and France.

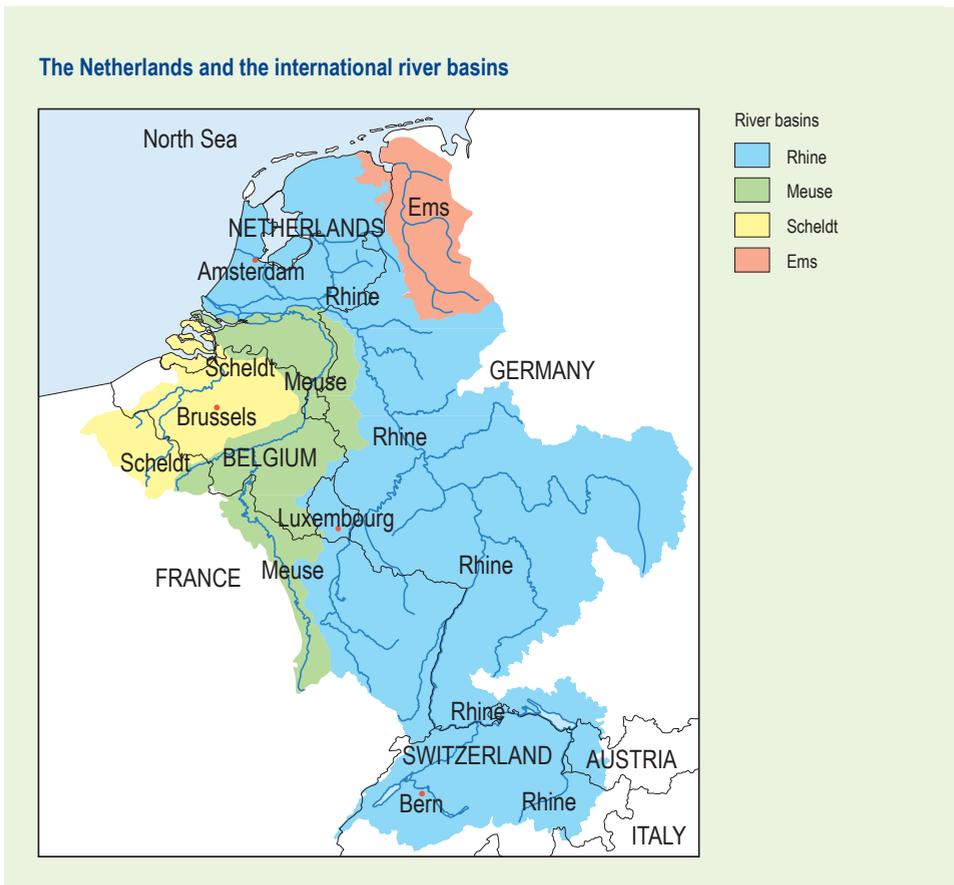


Figure 6 Position of the Netherlands in the river-basin areas of the Rhine, Meuse, Scheldt and Ems.

More than 75% of the phosphorus and nitrogen loads in the coastal zone of the Netherlands originates in other countries and the high water levels in the rivers of the Netherlands depend in part on the situation upstream (safety levels, water retention, water storage capacity, etc.), in the four river basins. On a regional scale, in the eastern and southern parts of the Netherlands, there are cross-border river basins, as well. Improving the water conditions in the cross-border systems on the national and regional scale, will mean a concerted effort on the international scale.

3 Main findings of the WFD ex-ante evaluation

Analysis of the RWS/regional measures package

Focus on habitat restoration and improvement of sewage treatment plants

A summary of the proposed measures for the regional and national water bodies is given in *Table 1*. For the regional water bodies, not all proposed measures are equally relevant to the ecological quality of the surface waters. Also, not all proposed measures for regional waters are easily translated into effects on ecological quality.

Measures which, for instance, result in a decrease in the bacteriological and organic load to surface waters (such as separating rainwater and sewerage overflow and the treatment of sewerage overflow; total investment over 1 billion euros) are not included, because the effect of these measures on the nutrient load is negligible (less than 1%) and usually very location-specific. This does not mean that such measures are unnecessary. Their necessity is primarily determined by, for example, the frequency and the extent of sewerage overflow and by location-specific circumstances, which fall beyond the scope of this research. ‘Other design, immission and management measures’ and ‘anti-groundwater depletion/re-wetting measures’ are not included, as they are too generally defined, or primarily relevant to terrestrial groundwater dependent ecosystems.

In total, this concerns a package of measures worth over 800 million euros. Also not included are the effects of unspecified projects on local inlet of water and freshwater flushing (about 300 million euros). As a result, the calculated ecological effects of the regional package of measures may be an underestimate of the actual effects on a local scale. On the scale of the water bodies, though, the estimated ecological effects are considered to be representative (see text box).

Thus, for further analyses, the regional package is divided into a sub-package with substantial ecological effect and a sub-package with little or unspecified effects on the ecological quality, in terms of the WFD system (nutrients and the species groups algae, macrophytes, macro fauna and fishes).

Measures for regional water bodies that could be incorporated in analysing ecological effects

The measures with substantial ecological effect, which have been proposed by the regional water boards, include the creation of a total of about 8,000 kilometres of nature-friendly river banks and remeandering, and over a thousand fish passes. To reduce the nutrient load to surface waters, the regional package of measures includes improving treatment at 168 sewage treatment plants (STPs), the implementation of 47,000 kilometres of manure-free zones, a change in agricultural function in areas totalling 5,000 hectares and the development of helophyte filters (marsh zones). Concerning investments, this encompasses about one third of the total regional package (1.9 billion euros; *Table 1*).

Table 1 Summary of proposed measures for regional water bodies (top) and national water bodies (below). Given are the expected investments in billion euros and the share of standing policies. Within the regional package, measures with substantial ecological effects and measures with little or unspecified effects are distinguished. See also text.

Type of measure	Investment 2007-2027 (billion €)	Estimated share of standing policies
Regional water bodies		
<i>• Measures with substantial effect on ecological quality of surface waters and WFD species groups</i>		
Construction of 8,312 km of nature-friendly riverbanks, reordering of streaming waters	929	519
Construction of 1,067 fish passes	102	14
Development of 534 ha of nutrient-filtering marshes	9	
Implementation of 47,000 manure-free buffer zones	34	1
Improvement of 168 Sewage Treatment Plants	746	449
Changing agricultural land use in 4,690 ha	53	53
Total	1,873	1,036
<i>• Measures with little or unspecified effects on ecological quality of surface waters and WFD species groups</i>		
Inlet/flushing/water level management (70 projects)	300	85
Measures against groundwater table deficit	201	201
Other design, immission and management measures	618	82
Disconnecting rainwater discharges/cleaning-up of sewage overflows	1,051	1,051
Dredging (1,3 x 106 m3)	332	332
Reducing emissions of other substances in 82 Sewage Treatment Plants	384	231
Water quantity and/or groundwater measures (388 small-scale projects)	553	553
Research, information activities and other projects	132	7
Total	3,570	2,542
Total	5,443	3,578
National water bodies		
185 Fish passes	71	-
Clear-water measures (emission control and 10,000 ha ecological engineering)	224	-
Reconstruction of 440 km nature-friendly banks	1,129	593
Development of 55 side channels, 1,150 ha floodplain reconstruction and 2,240 ha tidal flats	264	70
Total	1,687	663
Total package regional + national water bodies	7,130	4,241

Measures for the national waters (*Table 1*) also encompass, to a large extent, habitat restoration measures, such as the construction of 440 kilometres of nature-friendly banks, the digging of 55 permanent side channels, the lowering and restoration of about 1,100 hectares of river floodplains, the construction of 180 fish passes and the development of 2,200 hectares of tidal flats. Investments for this package amount to about 1,7 billion euros.

The proposed package includes no measures which focus on the reduction of manure use on agricultural land. The regional water authorities consider this not their responsibility, but that of national government.

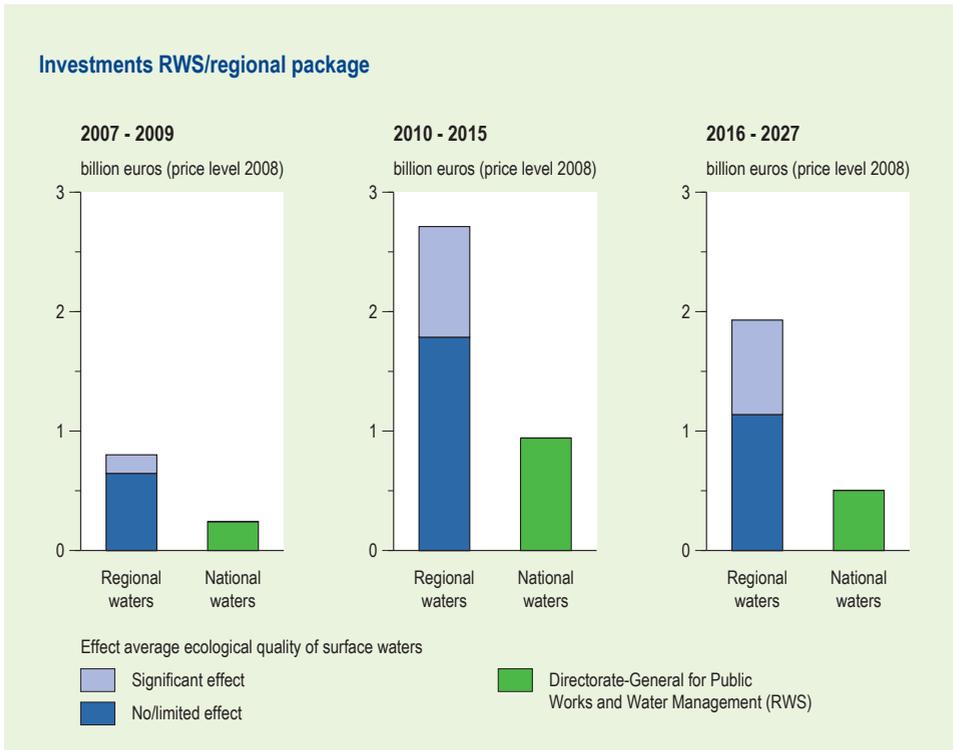


Figure 7 Phasing of investments for measures in the regional and national waters, as proposed by the regional and national water authorities.

Investment in the complete *RWS/regional package of measures* totals about 7.1 billion euros, to be made in the 2007 - 2027 period (*Table 1, Figure 7*). In addition, capital tax, management and maintenance costs will also have to be paid, reaching a maximum of about 390 million euros per year, by 2027. The regional water boards are accountable for about 5.4 billion of the 7.1 billion euros, about 65% of which is for measures to be implemented in the period up to 2015.

Investment in measures for national waters totals about 1.7 billion euros, about 70% of which concerns the period up to 2015. Phased implementation up to 2027, applies both to measures which are significant in determining ecological quality and measures which have a more indirect effect. It is expected that targets will be achieved by 2027, rather than by 2015, for both national and regional waters.

Despite the difficulty in making a distinction between WFD measures and other measures, a general estimate shows that two thirds of total investments in the package of measures for regional waters are in standing and proposed policies (including *Water Management in the 21st Century*, the *Bathing Water Directive*, the *Urban Waste Water Directive* and *Natura 2000*) (See *Table 2*). The package of measures for regional waters includes an extra investment of about 1.9 billion euros, in addition to standing and proposed policies (*Table 1*).

Table 2 Indication of the relationship between investments in proposed policies and extra WFD measures, between 2007 and 2027, for the RWS/regional package of measures. For regional waters, a distinction has been made between measures which have a substantial ecological effect (nutrients and design) and those which have limited to no effect. All figures are rounded.

	Proposed policy		Extra WFD		Total
	billion €	%	billion €	%	billion €
Regional waters					
Measures with a substantial ecological effect	1.0	53%	0.8	47%	1.9
Measures with a limited/ unknown ecological effect	2.5	69%	1.0	31%	3.6
Total regional waters	3.6	67%	1.9	33%	5.4
National waters					
Measures with a substantial ecological effect	0.7*	40%	1.0	60%	1.7
Total regional + national waters	4.3	60%	2.9	40%	7.1

* Concerns an estimate of measures which have a substantial ecological effect within the framework of Room for the River and the Meuse Works.

Yearly costs of RWS/Regional package, per actor, after 2027

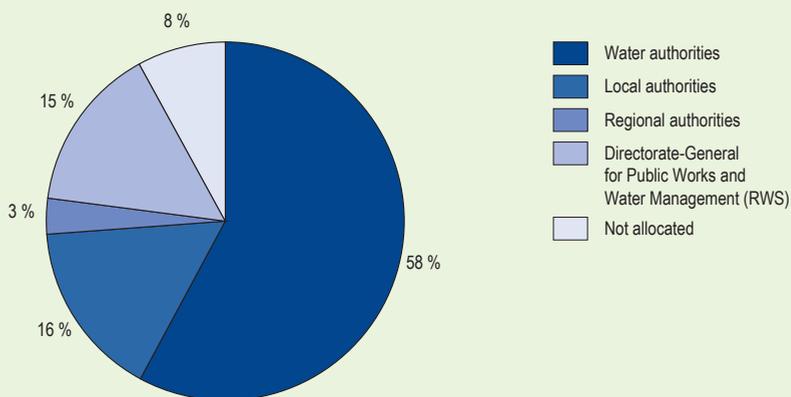


Figure 8 Annual costs of the RWS/regional package of measures, for the local and water authorities.

About two thirds of investments in the total package of measures is in standing and proposed policies

Of the measures which have a substantial ecological effect (also representing about 1.9 billion euros), about half are for proposed policies (Table 1), in particular for the construction of nature-friendly river banks (within the framework of *Water Management in the 21st Century*) and already proposed improvements in sewage treatment plants.

Annual costs to society are estimated at 390 billion per year by 2027

The annual costs to society of the total RWS/regional package of measures, once all investments have been made, will be 390 million euros per year, from 2027 onwards. About 60% of these costs are to be paid by the water boards, 15% by the municipalities and 15% by RWS (*Figure 8*).

The costs to the water boards will result in an extra increase in water-board charges of about 0.7% per year, during the 2010 - 2027 period. This will mean that the total revenue from water-board charges will be about 13% higher in 2027, than would otherwise be expected, based on autonomous developments. About 75% of this increase in charges is to be paid for by households, the rest by businesses. It is estimated that two thirds of the package of measures is attributable to proposed policies (*Table 2*). Therefore, the charge increase – directly attributable to investments made under the WFD – is considerably less than 0.7% per year. As far as postponing the objective deadline to 2027 is concerned, the question is whether the expected increase in charges can be considered disproportionate and can, therefore, be considered reason for legitimising phased implementation up to 2027.

Other than this, the largest autonomous increase in water-related charges, in the coming years is expected to be municipal sewerage charges (over 6% per year, averaged over the 2010 - 2027 period). The expected extra increase in municipal charges, resulting from the RWS/regional package of measures, is about 0.1% per year.

Expected ecological effects of the RWS/regional package of measures*Nutrient loads from abroad substantially reduced*

Based on the available information from the international river basin committees about measures to be taken in the four river basins, a substantial reduction in the nutrient load from abroad is to be expected. For the Meuse and Scheldt river basins, a reduction in the phosphorus load of 30 to 35% is expected, in the period up to 2027; for the Rhine and Ems river basins, a reduction of about 15% is expected. The load of nitrogen is expected to be reduced by 15% (Rhine, Scheldt, Ems) to 20% (Meuse), by 2027 (Witteveen+Bos, 2008). The decrease in nutrient loads primarily improves the water quality of the national waters and coastal zone. The inlet from national waters is only a minor contribution to the total nutrient load of the regional waters (less than 1%) and has little impact, except in specific local situations (PBL, 2008).

Improvement in water quality of regional waters, but targets will not be reached

By 2027, the nutrient load to regional surface waters will be 16% less for phosphorus and 24% less for nitrogen, compared with the current situation (*Figure 10*). The 24% reduction in nitrogen load would be the result of both the expected improvements in sewerage treatments and the proposed policy on manure use. The phosphorus reduction can only be reached through improvement of the sewerage treatment plants.

Tekst box: Assessing the ecological effects of the design and nutrient reduction measures

Developed ecological model

Within the Netherlands, an ecological model suitable for exploring and evaluating possible ecological effects of measures within the WFD was not available. A new ecological model was developed, especially for the ex-ante study, to quantify the effects of design measures and nutrient reduction measures on the Ecological Quality Ratio (EQR) of the four relevant species groups: algae, water plants, macro fauna and fishes. Using the best available monitoring data and the neural network as a statistical method for developing the model for four types of regional water bodies (streams, lakes, canals and ditches), a robust dose-effect model was created (Royal Haskoning, 2008).

In Figure 9, the conceptual structure of the model is given, showing a direct relationship between the present situation (biotic and abiotic), the impact of applied measures on the selected steering factors and the resulting change in EQR per species group. The predicting power of the model is high, as 60 to 80% of the actual monitoring data are predicted well within the range of 0.1 EQR. Using the same dataset, an additional analysis using Tree regression showed that the chosen steering factors in the model explain 80 to 95% of the variance within the species groups (Visser et al., 2008). In our study it is assumed that the predicting power and relevance of the steering factors also hold for the future situation.

Expert system ecological effects

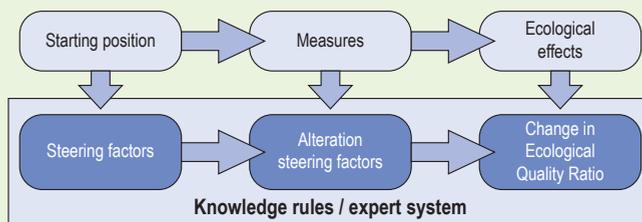


Figure 9. Schematic representation of the ecological model developed for the ex-ante study.

Available data

The regional waters in the Netherlands encompass 737 water bodies, composed of different water types. Due to the limited availability of data on the current situation, changes in ecological quality could only be determined for circa half of the regional waters (streams, lakes, waterways/canals and ditches). Brackish regional waters are not included in the analysis. The streams, lakes and waterways/canals included in the analysis are well distributed throughout the Netherlands and can be considered representative. However, this does not apply to ditches, as this water type includes a diverse range of water bodies in the west, the centre and the east of the Netherlands and is not representative of ditches in the peat and clay areas of the north and the west of the country. The national water bodies covered in this study, include nearly all water bodies; fresh, brackish, as well as salt waters.

As the available monitoring data up to 2005 are not based on the requirements of the WFD monitoring data, expert processing was needed to make the data suitable for use in the WFD framework.

Dealing with uncertainties

In all the analysing steps in the ex-ante study uncertainties occur, encompassing uncertainties in the present situation (see available data) and in the specification of measures, uncertainties and restrictions in scientific knowledge about dose/effect relations, and uncertainties in the estimations of the water authorities, concerning the feasible ambition levels for ecological quality. In the ex-ante study the ecological effects of the measures are quantified and an evaluation is given of the extent to which the proposed ecological quality targets may be within reach.

In quantifying the effects, their potential maximum effect was also explored, assuming a maximum efficiency of the measures. Concerning the physical design, measures (remeandering, construction of nature-friendly river banks) are presented for both the 'expected ecological quality' (effect of measure in water body proportional to total length of banks in the water body) and what could, potentially, be the 'maximum ecological effect' (effect of measure for 100% of water body) (see Figures 11, 12, 14 - 16). Concerning the effects of the considered additional measures to reduce nutrient loads, generally, the higher values for potential efficiency of nutrient reduction are used in the calculations.

Furthermore, in evaluating whether targets are likely to be reached, it is concluded that the target is 'possibly' within reach, if the calculated Ecological Quality Ratio (EQR) is within the range of +/- 0.05 of the proposed Good Ecological Potential (GEP): light green in Figures 11, 12, 14 - 16. Above GEP + 0.05, targets are qualified as within reach (dark green); below GEP - 0.05, targets are out of reach (red).

With this approach the estimated potential effects may be optimistic rather than pessimistic, making conclusions about whether or not the targets seem within reach, robust. (see for further discussion PBL, 2008).

Ecological effects of measures in the national waters have been estimated, based on expert judgement. Based on the maximum expected effect of the measures, in this study, we explicitly and carefully conclude that the targets might be within reach. A more scientific and model-based analysis, such as that for the regional waters, is needed for underpinning this qualification.

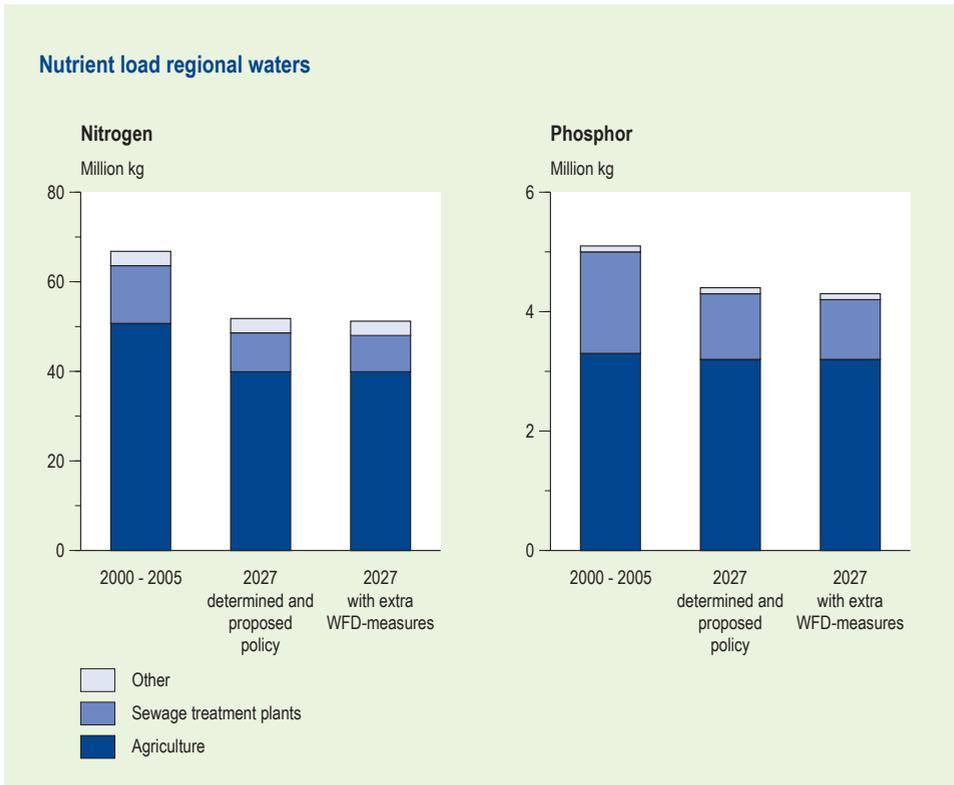


Figure 10 Expected changes in the nutrient load of regional waters, in the period up to 2027. As shown, the main effect is due to standing and proposed policy measures. Effects of the extra measures in the regional package are small.

The proportion of the total load attributable to sewerage plants is, therefore, reduced from a third to a quarter, and so, the relative share of nutrient load attributable to agriculture increases to about three quarters of the total. The realised emission reduction is expected to improve the water quality, by 2027, but still 40 to 50% of the regional waters are not expected to meet the nutrient standards (PBL, 2008).

Substantial improvement in ecological quality of regional waters

On implementation of the measures proposed by the regional water boards, the proportion of water bodies labelled as ‘good’ for the species groups of water plants, macro fauna and fishes, will increase from about 5% in the current situation to a potential maximum of 30 - 50%, by 2027 (Figure 11).

Linear water bodies in particular (streams, rivers, ditches and waterways/canals), in which ecological quality is very much dependent on design (nature-friendly river banks and fish passes), show significant improvement. Because water quality and/or nitrogen and phosphorus concentrations do not change very much, the score for the phytoplankton species group does not show much improvement.

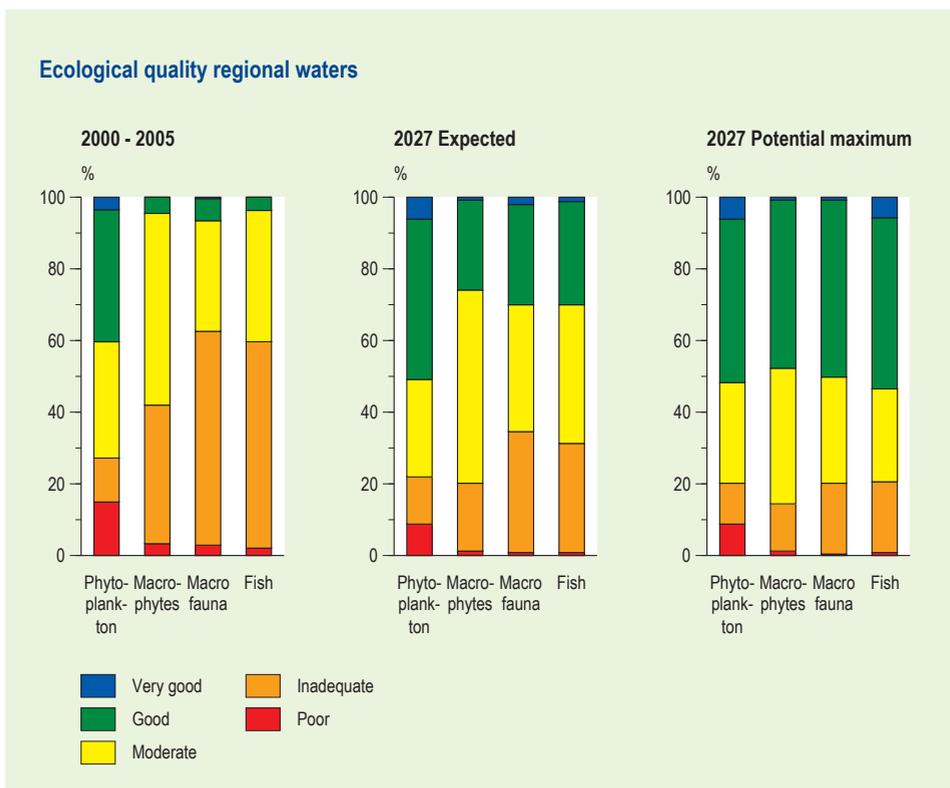


Figure 11 Actual, expected and, potentially, maximum ecological quality per species group in regional waters. '2027 Expected' refers to the ecological effects as a result of the expected use of measures. '2027 Potential maximum' refers to the ecological effects as a result of the maximum possible use of measures.

Improvement in ecological quality of national waters mainly in rivers

Ecological quality improves the most in rivers, especially for water plants (*Figure 12*). The proportion of situations labelled as 'good' for this species group, increases from 25% in the current situation to 50%, by 2027, following implementation of the measures. The average Ecological Quality Ratio (EQR) of the rivers increases from almost 0.4 to almost 0.5, with the value 0.6 representing Good Ecological Potential (*Table 3*). The ecological quality of canals, lakes and transitional waters shows little improvement. In transitional waters, the reduced nutrient load from other countries is only apparent as a marked improvement in phytoplankton. The ecological quality of coastal waters shows almost no improvement, as the measures are limited in the extent to which they address this

Ecological improvement mainly achieved through design measures

Although there is limited improvement in water quality, in the period up to 2027, the proposed measures allow for the realisation of a marked improvement in ecological quality. For regional waters, the design measures alone (which account for a little more than a quarter of the costs) enable the achievement of 80 to 90% of the change in ecological quality (average EQR) (*Table 3*).

Ecological quality national waters



Figure 12 Actual, expected and, potentially, maximum ecological quality per species group in national waters. '2027 Expected' refers to the ecological effects as a result of the expected use of measures. '2027 Potential maximum' refers to the ecological effects as a result of the maximum possible use of measures.

Table 3 Expected ecological improvement (EQR) and cost-effectiveness of the package of measures for the regional waters (top) and national waters (bottom). Changes in ecological quality (EQR) are weighted according to the surface areas of the water bodies.

	Improvement of ecological water quality (change of mean EQR)					Total	Increase in annual costs (billion €/year)	Average cost-effectiveness (million € per 0.1 increase of mean EQR)
	Streams	Lakes	Canals	Ditches	Mean EQR weighted according to surface area of water bodies			
Regional waters								
Present quality	0.47	0.49	0.42	0.36	0.44			
Expected change after implementation measures	0.08-0.14	0.06	0.08-0.16	0.09-0.30	0.08-0.16	150	100-200	
Expected effect of design measures	0.04-0.12	0.04	0.07-0.15	0.09-0.29	0.06-0.15	40	30-70	
National waters								
Present quality	0.38	0.43	0.56	0.47	0.45	0.46		
Expected change after implementation measures	0.11-0.15	0.05-0.06	0.04-0.06	0.04-0.05	0.01-0.02	0.05-0.07	65	100-150

Therefore, this part of the package of measures is much more cost-effective than the measures focusing on reducing the nutrient load to surface waters (primarily, through tougher measures for sewage treatment plants).

Proposed ambition levels of ecological targets and expected achievement of targets

Ambition levels proposed by regional and national water authorities

Targets have been set for each species group and water type. Targets for natural and heavily modified waters are indexed, using a natural reference condition in which the Good Ecological Status (EQR = 0.6) is an important reference point. For artificial waters (waterways, canals and ditches), a lower ambition level is incorporated in the standards. Targets for artificial waters are indexed, using a default value for the Good Ecological Potential (default GEP; EQR = 0.6). For artificial and heavily modified waters, the regional and national authorities may set their own GEP and, therefore, their own ambition level. The most recent targets are used in this report and date from 27 March 2008. *Figure 13* shows the presented ambition levels for artificial and heavily modified waters, including both the regional and national water bodies.

For many heavily modified waters Good Ecological Status is considered unachievable

For artificial waters (ditches and waterways/canals), the proposed target level is usually roughly equal to the default GEP (equivalent to an EQR value of 0.6, according to the standard for artificial waters). The proposed targets show a larger spread for the heavily modified waters (streams and small rivers). The target level is between the EQR values of 0.3 and 0.6, according to the standard for natural waters for a substantial number of water bodies, but lower values are also found. Therefore, the Good Ecological Status of 0.6 is, according to the water authorities, usually unachievable in the heavily modified waters. Information to substantiate this was not yet available at the time of this study.

Full achievement of proposed ecological targets in regional waters unlikely

Compared with the current situation, it is estimated that the percentage of targets achieved for the various species groups in regional waters will increase to a maximum of 40 to 60% (*Figure 14*).

Given the large uncertainty, and despite the substantial improvement in ecological quality following implementation of the package of measures, it is unlikely that all targets for regional waters will be achieved, by 2027. However, more targets may be achieved locally than is estimated for the regional level, due to measures not included in the calculation of the ecological effects.

Proposed ambition levels

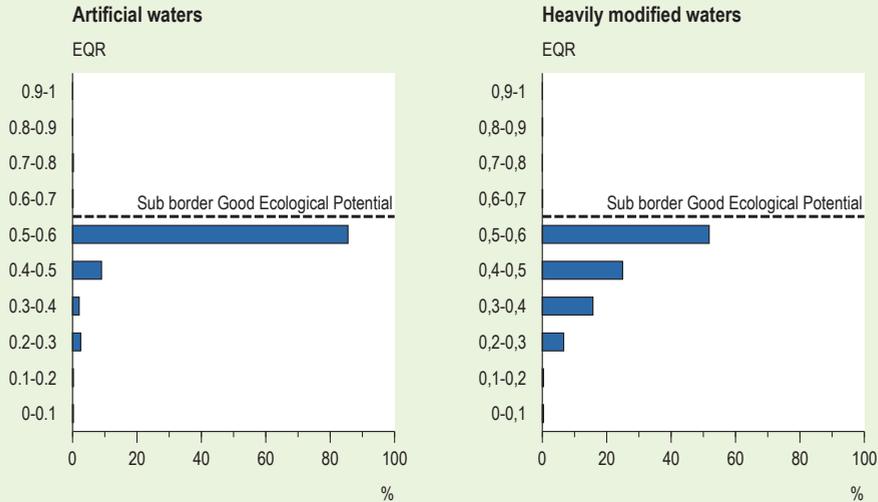


Figure 13 Ambition levels for artificial (at the left) and heavily modified waters (at the right).

Regional waters valued against Good Ecological Potential

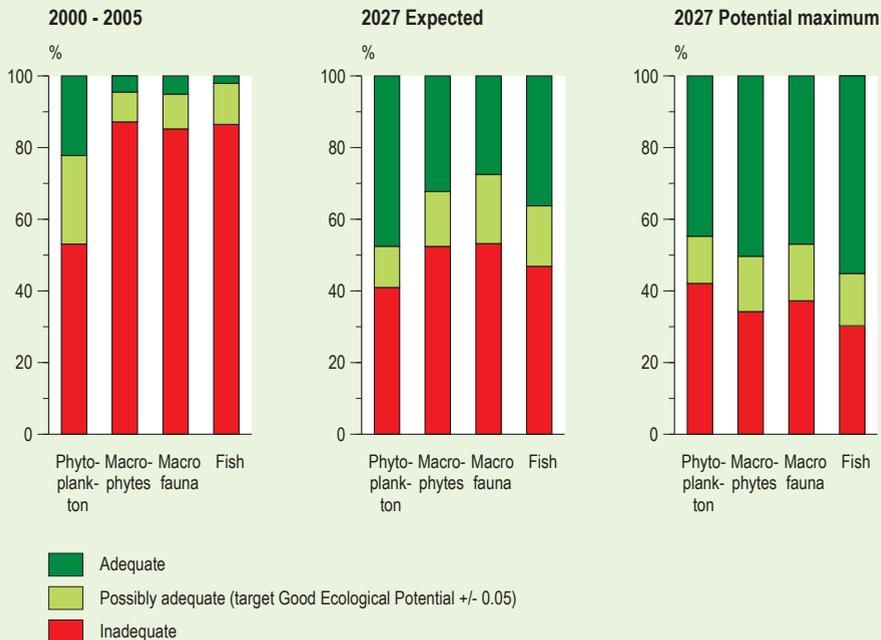


Figure 14 Expected achievement of targets (Ecological Potential), presented per species group.

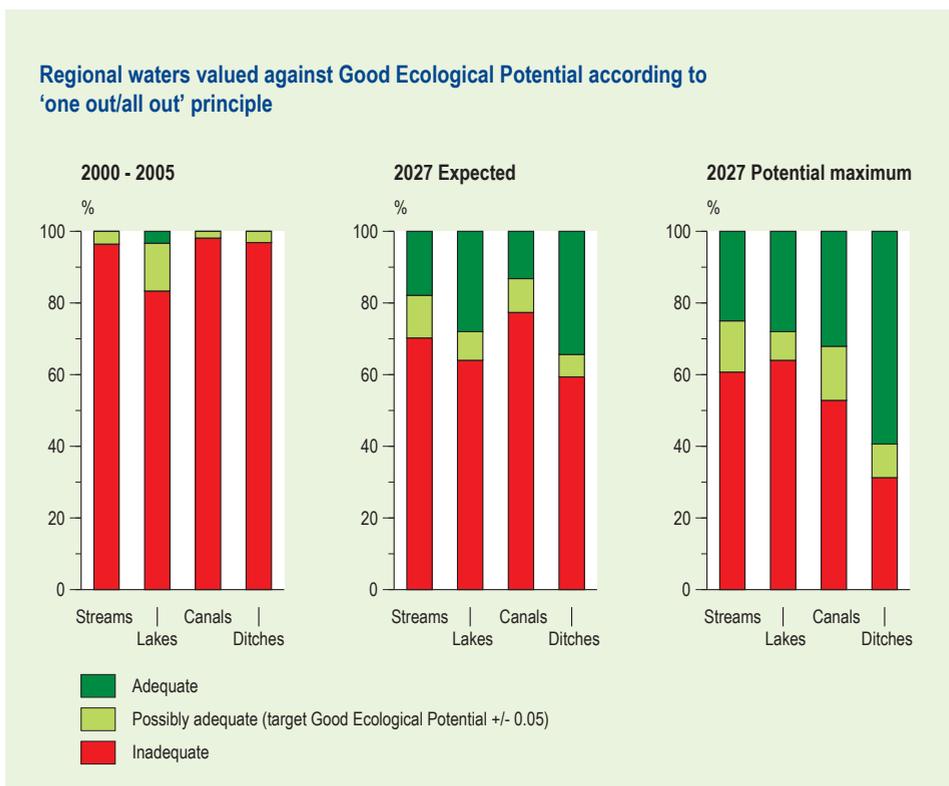


Figure 15 Expected achievement of targets (Ecological Potential) per water type, based on the 'one out - all out' WFD principle. This principle leads to a substantial lower achievement of targets.

Based on the 'one out, all out' WFD principle and the targets available for regional waters, the achievement of targets is by far not within reach, for all water types. Assuming maximum effectiveness of the proposed measures, only 40 to 60% of all water types will meet their targets (*Figure 15*).

Achievement of ecological targets for national water bodies possibly within reach

As for the regional waters, RWS applies a proposed target level to canals (artificial water), which is roughly equivalent to the default GEP value of 0.6. For heavily modified rivers and lakes, the proposed targets for the various species groups are, on average, between 0.4 and 0.55 (rivers) and between 0.3 and 0.45 (lakes), which is much lower than the standard for natural waters.

Based on the 'one out, all out' WFD principle and the standards for national waters, the full achievement of targets is almost within reach for artificial waters (canals) and heavily modified national waters (rivers and lakes), assuming maximum effectiveness of the measures (*Figure 16*). The GES remains the standard for natural coastal waters. These waters will probably not meet the GES targets, by 2027, even assuming the implementation of less ambitious targets for angiosperms (sea grasses).

National waters valued against Good Ecological Potential according to 'one out/all out' principle

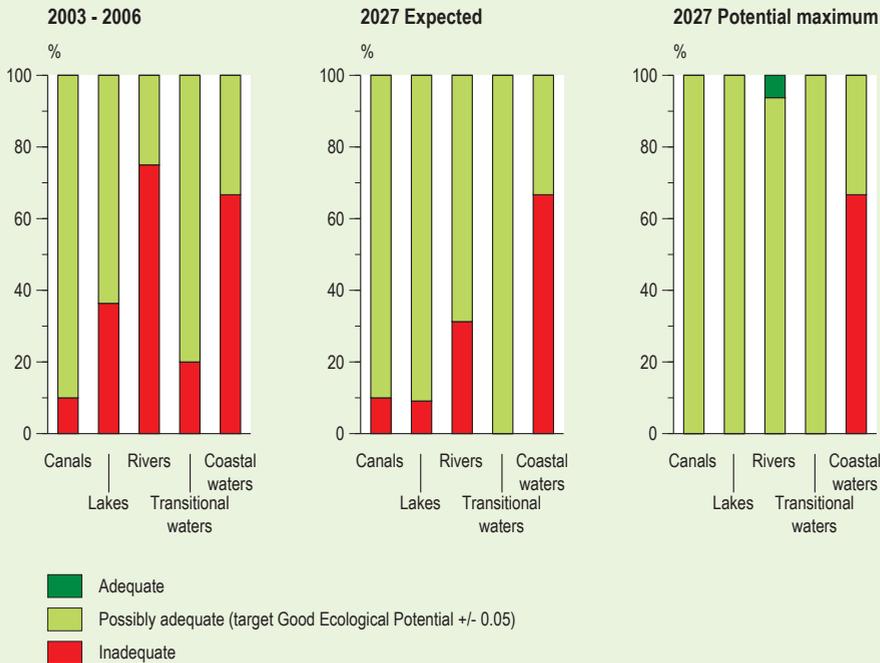


Figure 16 Expected achievement of targets per water type, based on the 'one out - all out' WFD principle.

Remaining challenges: further improvement of ecological quality

Improving ecological quality in regional waters requires additional design and nutrient reduction measures

The achievement of all targets for regional waters is, based on the calculated effects, unlikely. Therefore, it seems that the ecological ambitions are not sufficiently in line with the proposed measures. Entering the currently proposed regional targets for the reporting commitment towards Brussels, possibly involves the future risk of failing to meet this obligation. Depending on the required ambition level, there are two possible ways of achieving a better balance, for example, by changing the targets or by implementing more measures in the period up to 2027, which focus on design and/or on a reduction in the nutrient load.

Additional design measures and ecological fish-stock management most cost effective

It is expected that 50 to 60% of the regional waters will meet the phosphorus concentration target, by 2027. If the target level needs to be raised in the future, the obvious course is to increase efforts in the redesign of the present linear water bodies (streams, ditches

and waterways/canals) with, as far as streams are concerned, an expected greater ecological effect from remeandering, than from the construction of nature-friendly banks.

Ecological fish-stock management (bio-manipulation) in lakes and other water types, such as artificial waterways and canals, and the damming of lower reaches of streams, seem promising, additional measures for greatly improving ecological quality in the short term. Important lake systems – considered suitable for the implementation of this measure – include the *Frisian lakes*, the *Randmeren*, the *Loosdrechtse Plassen*, the *Nieuwkoopse Plassen* and the *Volkerak-Zoommeer*. Compared to other measures, the cost-efficiency of ecological fish-stock management seems very positive (Table 4; Witteveen+Bos, 2008).

As of 2027, it is expected that 75% of the nutrient load to the regional water systems come from agricultural soils (Figure 10). In the ex-ante study, the potential effects have been investigated of six additional measures, aiming at a further reduction in the nutrient load to regional surface waters (Table 4). However, the available knowledge is restricted, especially concerning measures for reducing emissions from agricultural soils, and the uncertainties about the potential effects are substantial. To explore whether any of the measures would, potentially, have a substantial effect, these effects are calculated using the higher values of the potential range of efficiency, mainly based on figures found in literature (PBL, 2008).

Based on the knowledge now available and with the assumptions applied, it is improbable that measures, such as mining of soil phosphorus by zero-P-application, increased drainage depth and manure-free zones will achieve a substantial reduction in the phosphorus load. With these measures, nutrient reductions of only 1 to 5% are found for both phosphorus and nitrogen and this level of reduction is hardly relevant for improving the ecological quality (Table 4).

Table 4 Expected ecological improvement (EQR) and cost-efficiency for measures that can be taken in addition to the regional package. Changes in ecological quality (EQR) are weighted according to the surface areas of the water bodies. Compare Table 3.

Regional waters	Improvement ecological quality (change in mean EQR)					Increase in yearly costs billion €/year	Mean cost-efficiency billion € per 0.1 increase mean EQR
	Streams	Lakes	Canals	Ditches	Total Overall change in mean EQR		
	Change mean EQR weighted according to surface area						
Additional measures							
- Sewage Treatment Plants	0.01	0.02	0.02	0.01	0.01	85	- ³⁾
- Wet buffer strips	0.01	0.04-0.05	0.03-0.05	0.02-0.04	0.03-0.04	355	900-1300
- Manure-free zones	0.00	0.02	0.01	0.01-0.03	0.01-0.02	68	- ³⁾
- Restrict drainage	0.00	0.00	0.00	0.00	0.00	90	- ³⁾
- Helophyte filters	0.04-0.05	0.13	0.11-0.13	0.07-0.14	0.09-0.11	600	550-650
- Mining op soil P ¹⁾	0.00-0.01	0.00	0.00	0.00	0.00	25	- ³⁾
Ecological fish-stock management ²⁾	0.00	0.04-0.07	0.00	0.00	0.01-0.02	1-3	10-20

¹⁾ Mining of soil phosphorus by zero-P-application

²⁾ Measure executed for 25 to 50% of the total surface area of the Dutch regional lakes. Source: Witteveen+Bos (2008).

³⁾ The expected ecological improvement is very little and uncertain, therefore it is senseless to calculate the cost-efficiency.

Of the variants that were investigated for further reducing nutrient loads, only the widespread implementation of wet buffer strips (4% of agricultural land) or helophyte filters (6% of agricultural land) seem to result in a significant reduction in the phosphorus load (15% and 40%, respectively) and the nitrogen load (18% and 50%, respectively) (PBL, 2008). With this level of reduction, substantial ecological improvements are found. Although the yearly costs of helophytes are higher than those of wet buffer strips, the cost-efficiency of the helophytes seems more positive.

Further reduction of nutrients appears difficult and costly

The analyses show that, assuming an intensity of manure use, according to the Dutch policy on manure use, and given the current level of phosphorus accumulated in the soil, nutrient reduction of any ecological significance is only possible if radical action is taken. However, the effects and applicability of the measures considered (such as buffer strips and helophyte filters), are still uncertain, and the estimated annual costs seem high (Table 4). Given the uncertainties and the possibility of high costs associated with these effect-focused nutrient measures, it is also necessary to consider the option of achieving the required nutrient reduction by a further reduction in the amount of manure applied. However, because the phosphorus accumulated in the soil will continue to leach, it will take many decades before stringent manure use (or even a stop on phosphate use) will result in a significant decrease in the phosphorus load from agricultural land to surface water. The choice between the area-specific implementation of effect-oriented measures (buffer strips, helophyte filters, and fish-stock management) or source measures, will partially depend on the importance attached to achieving the targets by 2027 and/or after this date.

The present Dutch manure policy will result in a further accumulation of phosphorus in the soil. A more stringent manure policy is, therefore, needed to prevent this from happening and to reduce leaching and run-off from agricultural land, in the long run (MNP, 2007).

Final Remarks

Synergy between WFD and other policies represents two to three billion euros

The fact that it is difficult to distinguish between WFD measures in the *RWS/regional package of measures* and those taken in other policy areas, suggests that there is a large amount of synergy between them. Other policy areas include the *Water Management in the 21st Century (WB21)*, the *Birds and Habitats Directives (Natura 2000 areas)*, the national nature policy (*National Ecological Network*), the *Nitrates Directive*, the *Bathing Water Directive* and the *Urban Waste Water Directive*.

As far as the two primary measures are concerned, (design measures and water-quality improvement measures), it is possible to conclude that about 2.7 billion euros (almost 40%) of the *RWS/regional package of measures* represent significant synergy between the WFD and other policy areas. A further unspecified amount is needed for improving water quality in Natura 2000 areas. The cost of the Nitrates Directive is not included in the *RWS/regional package of measures*.

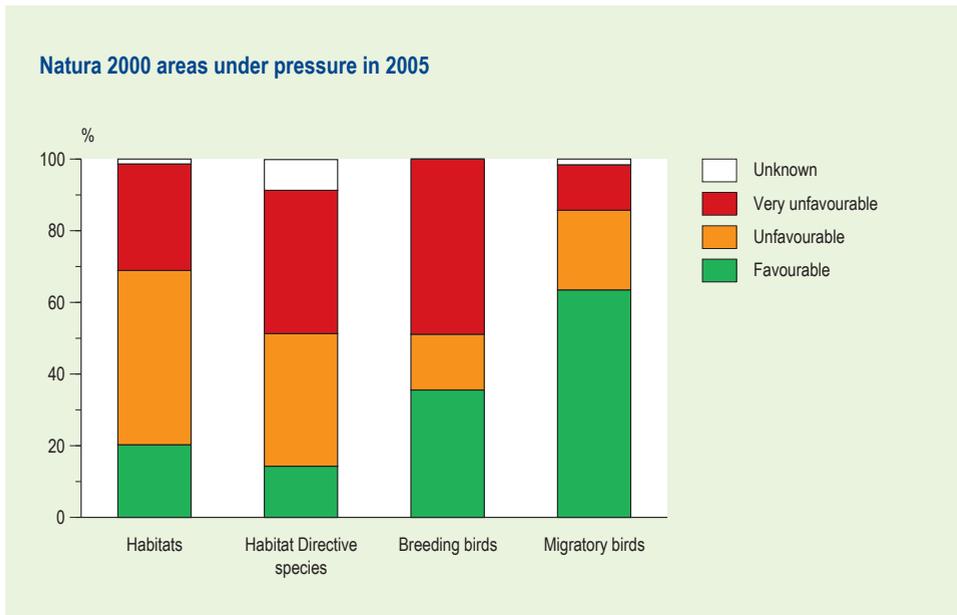


Figure 17 In 2005, 80% of the Natura 2000 habitats were in an unfavourable state (MNP, 2006).

Slight contribution to improvement in water quality in Natura 2000 areas

In the Netherlands, for about 80% of the surface area of the *Natura 2000* areas, the current situation does not meet the requirements for the preservation of the protected habitats (Figure 17). Despite efforts to reduce emissions from sewage treatment plants, the water quality in regional waters will improve only slightly, up to 2027, compared with the current situation. For sixty-nine *Natura 2000* areas, the quality of regional surface water is important for maintaining the habitat (streams, lakes and swamps) or the species for which the area is designated. In the current situation, in eight *Natura 2000* areas the WFD water body meets the GES or default GEP value for nutrients; following implementation of the measures, this increases to twelve areas. However, the process for determining the nutrient targets for the *Natura 2000* water bodies is still not complete, and so it is not yet possible to determine whether there should be extra policy tasks related to *Natura 2000* water targets.

The improvement in water quality in national waters is, primarily, due to measures taken in other countries. These measures (the construction of new sewage treatment plants or improvements to existing plants in Belgium, France and Germany) are explicitly taken to implement the WFD and so, for national waters, there is some synergy between WFD measures and improvements to water conditions in a few *Natura 2000* national water bodies (the *IJsselmeer*, the *Wadden Sea*, the south-west delta and the coastal zone).

The RWS makes a clear distinction, at national level, between WFD-focused measures and *Natura 2000*-focused measures and has, in addition to the package of measures for the WFD, drawn up a supplementary package of measures which contributes to the realisation of *Natura 2000* targets. These measures have not been included in the calculations of the WFD ex-ante assessment.

Groundwater deficit stress (desiccation) in Natura 2000 areas remains a major challenge
 Groundwater deficit stress (desiccation) in nature areas is a major environmental problem, in the Netherlands. The problem was first recognised in the eighties of the last century. At that time, about 400,000 hectares of nature area suffered from groundwater deficit stress. In 2000, only 3% was hydrologically restored; the policy target was 25%. So there lies a major challenge concerning the groundwater levels in nature areas. Therefore, in 2006, a list of priority areas for combating groundwater deficit stress (the so-called TOP areas) was drawn up within the framework of the *Rural Investment Budget* (ILG). About 25% of the desiccated *Natura 2000* areas is not included in this list. The areas not included in the TOP list will not reach the required groundwater conditions, by 2015, necessary for their conservation. Furthermore, the provinces claim that only around 80% of the TOP areas will fully recover from groundwater stress.

No agreements have yet been made on how to tackle groundwater stress after 2013, in those areas (including *Natura 2000* areas) not included in the TOP list, and it is not clear in the regional package of measures whether and when additional anti-groundwater-stress measures are to be implemented to improve water conditions in *Natura 2000* areas. It is, therefore, questionable whether the target of the *Ministry of Agriculture, Nature and Food Quality (LNV)* will be met, worded in the *Policy Vision for Nature Management* target, as ‘...to at least realise the necessary water quality for the *Natura 2000* areas, in 2015’.

Cost of restoring groundwater levels in desiccated Natura 2000 areas considerable
 The cost of restoring the desiccated *Natura 2000* areas is projected at 800 million euros, about half of which is available within the framework of the ILG. A minimum of an extra 400 million euros needs to be found, after 2013, for implementation of the remaining measures. Funds are seriously lacking, since the available budget for the entire TOP list totals only 457 million euros. An exploratory analysis shows that extracting groundwater for the production of drinking water can result in pressure on the conditions for conservation in *Natura 2000* areas. An initial estimate shows that the necessary reduction and/or transfer of groundwater-extraction sites will require about 1.8 billion euros. These measures and costs are not included in the calculations carried out in this study.

Policy challenges concerning chemical water quality and groundwater bodies

Exceedance for a limited number of priority substances and other relevant substances
 Based on provisional EU standards for priority substances in surface waters, the Netherlands has policy task for six substances (20% of the priority substances), five of which are priority hazardous substances, which require emissions eventually to be reduced to zero. Reducing the emissions of these substances, primarily, requires a European approach.

Based on the current environmental quality standards for the remaining (non-priority) relevant substances in surface waters, the Netherlands has a policy task for 6 of the 126 monitored substances. The six substances which exceed standards are zinc, copper, boron, sodium sulphate, vanadium and cholinesterase inhibitors. It is expected that the policy task regarding zinc and copper will be reduced, considerably, once the monitoring data is corrected for suspended matter and biological availability prior to assessment.

Based on monitored substances, the ecological effect on surface waters seems small

In all the possible monitoring locations for which the toxicity of exposure to the combination of substances was calculated, it appears that over 5% of species are inadequately protected at 35 locations. The potential toxicity at these locations is caused by the combination of a pesticide, zinc and copper. The effects of substances of which concentrations are below the detectable limit (i.e. many pesticides) could, of course, not be included in the toxicity calculation, which, in turn, could result in an underestimation when calculating the effects.

WFD list of substances does not fully protect drinking water

There are fifteen substances found in surface waters at a concentration higher than the drinking water standards allow. They form a problem in drinking-water production, although there are no WFD standards for these substances. In addition, another 171 substances have been recognised as a potential threat to the drinking-water quality; moreover, there is no standard for 91 of them (KIWA, 2008). This means that the implementation of the WFD does not result in cost savings in water treatment for the purpose of drinking-water production.

Limited measures concerning chemical water quality in RWS/regional package

All measures in the *RWS/regional package* that contribute to an improvement in chemical surface-water quality, amount to about 600 million euros.

Policy task for groundwater quality as yet unclear

The task concerning groundwater quality is as yet unclear, as no decision has been taken on the method for determining the threshold values of chemical substances in groundwater. Another policy task – for nitrate – continues after 2015, particularly in the south of the Netherlands.

Effects of climate change on the ecological quality of surface waters*The policy challenge will increase due to climate change*

Temperature increases and an increase in precipitation intensity will affect the ecological quality of the water system in various ways (shifting of species, mismatch of life cycles and increase in eutrophication). As far as eutrophication is concerned, climate change will probably increase the risk of unfavourable situations, which means that the policy task for tackling the negative effects of eutrophication is more likely to increase than decrease. In particular, the likelihood of eutrophication, algal bloom and lower oxygen concentrations will increase in the expected warmer and drier summers, because the water will remain in the rivers, lakes, streams and waterways/canals for greater lengths of time.

Limiting nutrient load is most important steering mechanism

As far as the direct and indirect effects of climate change are concerned, it is almost impossible to influence the expected temperature increase and change in precipitation patterns. The most important steering mechanism for contributing to a reduction in the influence of climate change on ecological quality, over the coming decades, is the mechanism determining the nutrient load of surface waters. As about three quarters of the nutrient load will come from agricultural land by 2027, intensity of manure use, as well as leaching and run-off mechanisms represent important steering opportunities.

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What are the costs and benefits of the Water Framework Directive in the Netherlands?

Just as all other European Member States, the Netherlands also has the obligation to implement the European Water Framework Directive (WFD). This requires a number of policy choices at the edge of economics and ecology: What are the Netherlands' ambitions regarding water quality? What is required by the WFD? Which ambitions are feasible and at what costs?

The proposed measures, taken by the water authorities in the context of the WFD proposals, will lead to a significant improvement of the ecological quality of Dutch surface waters. The expected improvement in ecological water quality would mainly be the result of the widespread implementation of design measures and improving the hydro-morphological conditions of water bodies. These measures seem to be cost effective. The benefits of the WFD primary consist of the improvement in the ecological water quality.

Although the ecological water quality is improving, it seems improbable that the proposed targets for regional water will be achieved by 2027. Also, the Natura 2000 sites will hardly profit from the proposed measures.

