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Environment Centre
Odense

LAYMAN'S REPORT

Odense Pilot River Basin

*Pilot project for river basin
management planning*

Water Framework Directive Article 13



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Foreword

The present report is a layman's report prepared by the Odense Pilot River Basin project – a project aimed at demonstrating river basin management planning pursuant to the Water Framework Directive using Odense River Basin as an example. The main aim of the report is to present in a general manner a concrete example of the implementation of the Water Framework Directive's planning provisions exemplified by a specific case – a river basin management plan for Odense River Basin. In Denmark, the Water Framework Directive has been transposed into national legislation via the Environmental Objectives Act. The report thus also relates to the provisions of Danish legislation.

The present layman's report is based on the main project report "Odense Pilot River Basin. Pilot project for river basin management planning. Water Framework Directive Article 13".

The aim of the pilot project and the published reports has been to demonstrate and test the methodology laid down in the Water Framework Directive, from initial characterization of surface waters and groundwater, to the establishment of environmental objectives based on reference conditions to preparation of a programme of measures optimized on the basis of economic cost analyses and cost-effectiveness. In order to be able to achieve this aim it has been necessary to operate with provisional environmental objectives as the results of the EU intercalibration process for environmental objectives are not yet available.

The present layman's report and the main report "Odense Pilot River Basin. Pilot project for river basin management planning. Water Framework Directive Article 13" are available for download on the project website www.odenseprb.ode.mim.dk, which also provides further information about the project and the planning process.

The Odense Pilot River Basin project has been carried out by Environment Centre Odense under the Danish Ministry of the Environment – and earlier by the Nature Management and Water Division of the former Fyn County – in an open process with the participation of two external advisory boards (a national and a regional), an external technical expert group and an environmental economics expert group. A large number of stakeholders and institutions have thus made significant contributions to the project.

Odense Pilot River Basin is part of an international network of pilot river basins that exchange knowledge and experience between water management authorities in the various EU Member States and with the EU Commission.

Danish Ministry of the Environment, Environment Centre Odense, June 2007

The Water Framework Directive in brief

In autumn 2000 the EU Parliament adopted a framework directive on protection of the aquatic environment – the Water Framework Directive.

The Water Framework Directive aims to protect all bodies of surface water (watercourses, lakes and coastal waters) and groundwater, subdividing surface water bodies into five classes of ecological quality (“High”, “Good”, “Moderate”, “Poor” and “Bad”) and groundwater bodies into two classes (“Good” and “Bad”). Surface water bodies and groundwater bodies both have to achieve “Good quality”, or “Good status” as it is referred to in the directive (Figure 1). Terrestrial ecosystems directly dependent on the aquatic ecosystems, for example mires and coastal meadows, are also encompassed by the provisions of the Water Framework Directive.

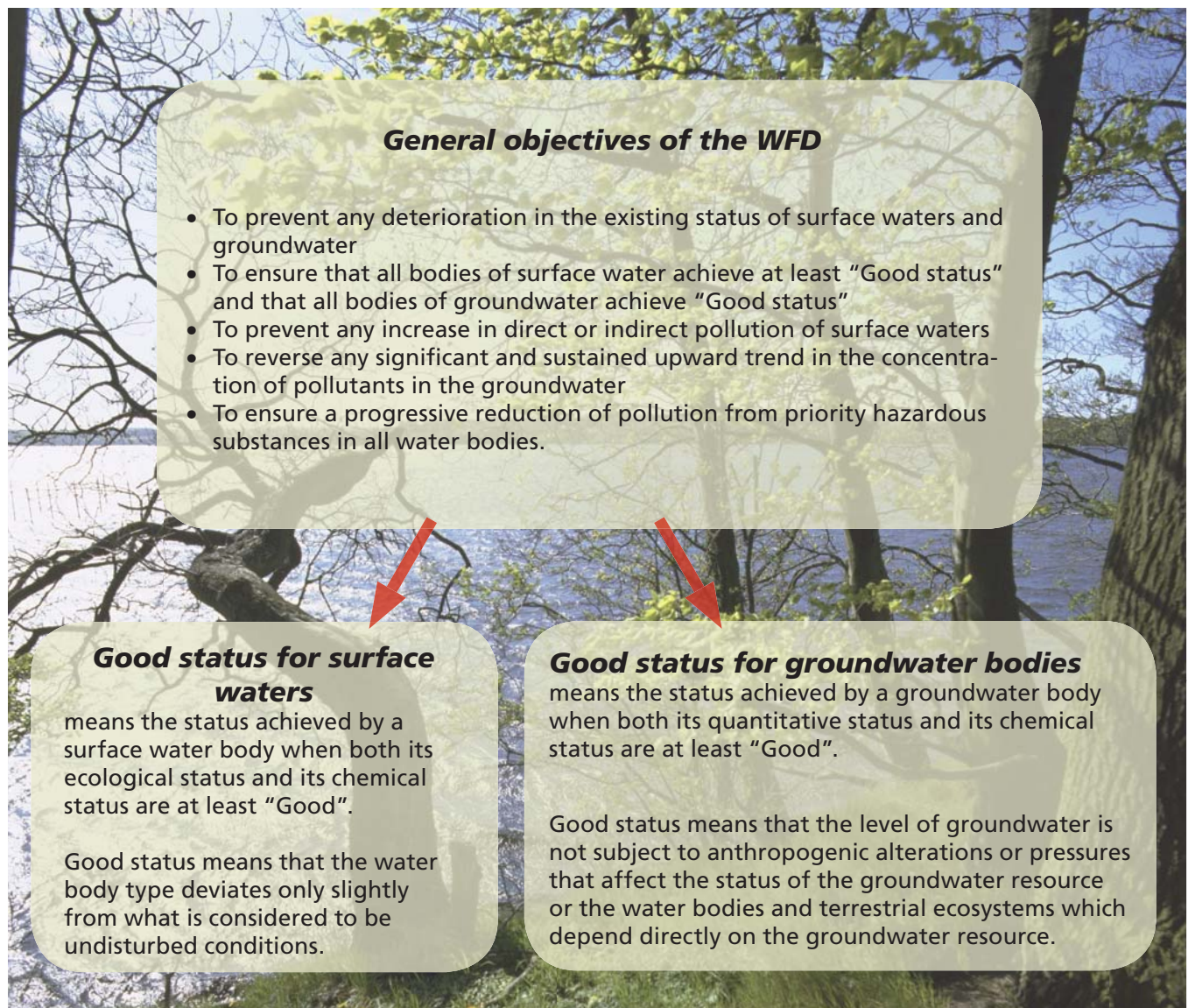
The Water Framework Directive requires that water should henceforth be administered in units based on subdivision into naturally defined river basins instead of existing administrative boundaries, for example municipal boundaries.

In Denmark, four river basin districts have been designated encompassing 23 natural river basins.

A good example of such a naturally defined river basin is Odense River Basin. This drains into Odense Fjord and encompasses the River Odense, 14 large lakes and a wealth of small lakes and many watercourses, groundwater bodies and wet ecosystems. At the same time, the basin spreads across seven different municipalities.

Figure 1: Objectives of the Water Framework Directive.

Photo: Ole Malling.



The Water Framework Directive in brief

The Water Framework Directive lays down a timetable for implementation that stretches over a 15-year period from 2000 to 2015, at which time the directive's environmental objective that all water bodies must achieve at least "Good status" must be fulfilled. The timetable for Danish implementation of the Water Framework Directive (Environmental Objectives Act) is summarized in Box 1.

Implementation of the Water Framework Directive is already well underway in Denmark. The Environmental Objectives Act, which is the law that transposes the Water Framework Directive into Danish legislation, was passed in 2003. One of the first major tasks, preparation of the baseline characterization of the river basins (also called the Article 5 Analysis), was performed over the period 2004–2006 (Box 1). The next major task is preparation of a programme of measures and a river basin management plan for each of the individual river basins. The individual river basin management plans are to be collated as a single river basin management plan for each river basin district. This work has to be completed by 2009 at the latest, whereafter the river basin management plans have to be implemented over a three-year period.

During the process the public are to be invited to participate. The first instance is during the second half of 2007, when the public can contribute ideas and proposals regarding the preparation of the river basin management plans and programmes of measures. Later, in 2009, the public can submit comments regarding the draft river basin management plans and programmes of measures.



The River Odense at Kratholm. Photo: Bjarne Andresen.

Box 1: General timetable of the Water Framework Directive/Environmental Objectives Act.

- 2000: Adoption of the Water Framework Directive by the EU.
- 2003: Transposition of the Water Framework Directive into Danish legislation (Environmental Objectives Act) and identification of river basins and designation of the water management authorities responsible for the basins.
- 2004: Preparation of the Article 5 Analysis, including characterization of the river basins, registration of protected areas and an assessment of the risk that water bodies will fail to achieve their environmental objectives with the measures already adopted.
- 2007: 2nd half-year: Idea phase for preparation of river basin management plans and programmes of measures during which the public can contribute ideas and concrete proposals.
- 2008: Publication of the draft river basin management plans and programmes of measures.
- 2009: 1st half-year: Second public participation phase during which all stakeholders can comment upon the draft river basin management plans and programmes of measures.
- 2009: Final adoption of the river basin management plans.
- 2012: Programmes of measures to be operational.
- 2015: At minimum "Good status" to be achieved by all surface waters and groundwater bodies.
- 2016: A new river basin management plan period begins.

Pilot project for Odense River Basin

Implementation of the Water Framework Directive thus entails a comprehensive planning process incorporating public participation at several stages. With its new and integrated water management measures the Water Framework Directive is one of the most significant pieces of legislation of our time in the aquatic environment area.

In order to identify any problems associated with implementation of the Water Framework Directive and ensure best possible uniformity of implementation among Member States the EU Commission initiated a number of activities in 2001 aimed at supporting the process of implementing the directive.

One of these activities was the designation of certain river basins as pilot river basins in which the local water management authority tests implementation of certain of the activities laid down in the directive ahead of the official timetable. Odense River Basin was selected as the Danish pilot river basin. The Danish Environmental Protection Agency thus invited the present local water management authority, Environ-

ment Centre Odense (part of the Danish Ministry of the Environment), and the former local water management authority, Fyn County, to carry out the test implementation in Odense River Basin (Figure 2).

The baseline characterization of Odense River Basin was thus prepared ahead of the official timetable together with a quantitative assessment of the various sources of pollution and the establishment of environmental objectives. The pilot project has also accorded particular attention to the problems concerning agriculture and the aquatic environment. The preliminary inventory of necessary and possible measures was subjected to a cost-effectiveness analysis in order to ensure that the improvements needed to enable the water bodies to meet "Good status" are achieved as cheaply as possible.

The experience and knowledge gained through the Odense Pilot River Basin project and the other pilot projects are disseminated to water management authorities regionally, nationally and internationally, as well as to the EU Commission.

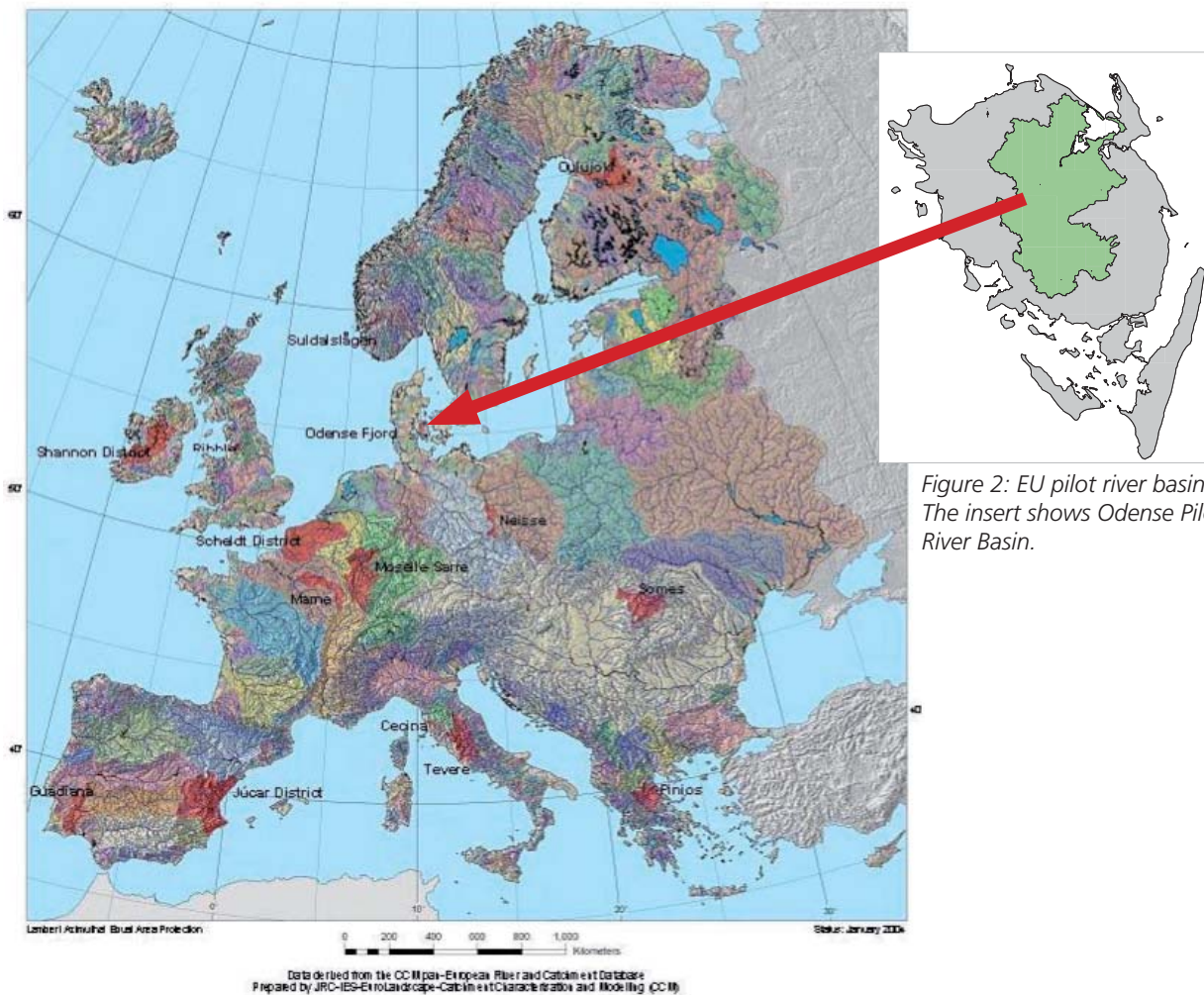


Figure 2: EU pilot river basins. The insert shows Odense Pilot River Basin.

A river basin management plan

The path to ensuring achievement of the environmental objectives established for the watercourses, lakes, coastal waters and groundwater is via a so-called “river basin management plan”. The Environmental Objectives Act requires four river basin management plans to be drawn up in Denmark, one for each of the four river basin districts. Within each river basin district there are several naturally defined river basins. On Funen, for example, there are four river basins for which a separate sub-plan has to be drawn up. The Danish river basin districts and river basins are indicated in Figure 3.

The river basin management plans are prepared by the seven Environment Centres under the Danish Ministry of the Environment. The first Danish river basin management plans have to be completed and adopted by 22 December 2009. The river basin management plans apply for a period of six years, whereafter a new plan for the subsequent six-year period enters into force. The required contents of a river basin management plan as specified in the Environmental Objectives Act are summarized in Box 2.

The Municipalities are required to ensure implementation of the river basin management plans. They do so by drawing up a municipal action plan describing how the Municipality intends to implement the river basin management plan and the associated programme of measures within the boundaries of the municipality. The municipal action plan can contain measures pertaining to several river basins. For example, Odense

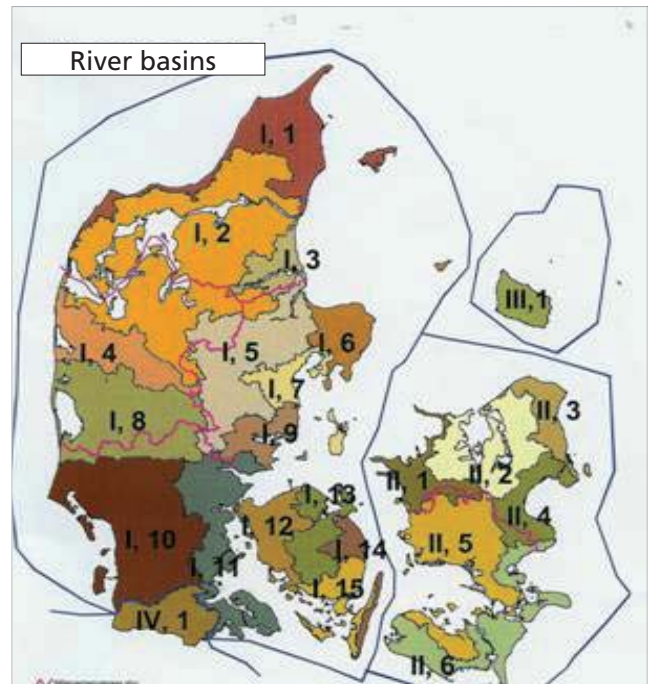


Figure 3: Danish river basin districts and river basins for which river basin management plans are to be prepared.

Municipality will have to draw up an action plan that implements parts of three river basin management plans on Funen. The municipal action plans have to have been adopted by the end of 2010.

Box 2: Required contents of a river basin management plan as specified in the Environmental Objectives Act.

- A summary of the Article 5 Analysis (characterization of all water bodies and pressures) and an assessment of the risk that water bodies will fail to achieve their environmental objectives.
- Information on the location of the protected areas.
- Subdivision of the river basin into “Particularly valuable water abstraction areas”, “Valuable water abstraction areas” and “Less valuable water abstraction areas”.
- Map indicating the monitoring station network.
- Map showing the status of the surface waters (ecological and chemical), groundwater (chemical and quantitative) and protected areas.
- Environmental objectives for surface waters, groundwater and protected areas.
- A programme of measures stipulating how the environmental objectives are to be achieved, including an economic analysis.
- A summary of the measures taken with regard to public information and consultation, the results obtained and any ensuing changes to the plan.

Odense River Basin

Odense Fjord, including the inner fjord Seden Strand, is a shallow fjord with a water surface of 65 km². Since 1780 the area of water surface has been reduced by approximately one third, primarily due to land reclamation for agricultural purposes. Water exchange between the fjord and the sea takes place through a narrow opening called Gabet bordering onto the northern Belt Sea.

Odense River Basin covers an area of approx. 1,050 km², corresponding to one third of Funen. There are just over 1,000 km of watercourse in the river basin, including the largest river on Funen, the River Odense, which is about 60 km long and drains a catchment of 625 km². There are approx. 2,600 lakes larger than 100 m² included in the river basin management plan.

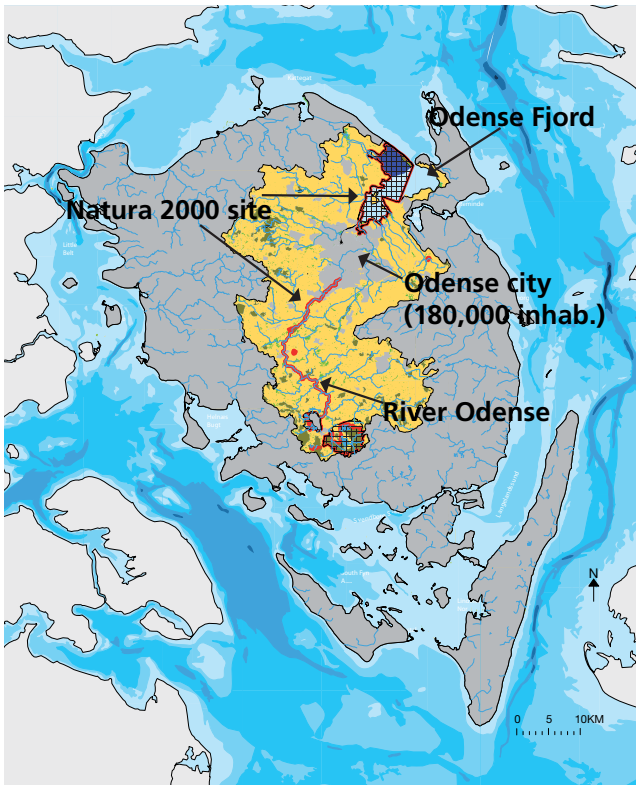


Figure 4: Odense River Basin

These lakes cover a total area of 1,106 ha, corresponding to approx. 1% of the river basin. By far the majority of the lakes are small, over 1,500 of them being smaller than 1,000 m² and only 21 being larger than 3 ha (30,000 m²).

Just as in the remainder of Denmark, land use in Odense River Basin is dominated by agricultural exploitation of the soil. Many of the watercourses in the river basin are presently culverted, and a large proportion of the remaining open watercourses are physically regulated through channelization and watercourse maintenance, etc. It is estimated that drainage has been established on at least 55% of the arable land in Odense River Basin over the past 50–100 years. Moreover, 13 large lakes and approx. 30% of Odense Fjord have been drained and converted to farmland. Around 68% of the river basin is used for agricultural purposes, corresponding to the average for Denmark as a whole (Table 1).

Key figures for Odense River Basin and Denmark		
	Odense River Basin	DK
Catchment area (km²)	1,050	42,800
Population		
Total (1,000 inhabitants)	246	5,300
Density (inhabitants/km ²)	234	124
Land use (%)		
Built-up areas	16	12
Farmland	68	70
Woodland	10	11
Natural/seminatural countryside	4	5
Wetlands	2	2
Climate		
Precipitation (mm)	825	830
Temperature (°C)	8.4	7.9

Table 1: Key figures for Odense River Basin.

Sea trout angling in Odense Fjord in the spring. Photo: Bjarne Andresen.



Pressures on water bodies in Odense River Basin



Types of pressure around the outlet of the River Odense into Odense Fjord.

The water bodies in Odense River Basin are affected by both natural factors and man's activities. The pressures to which they are subject include the input of pollutants such as nutrients and hazardous substances, and various physical pressures.

Pollutants reach the water bodies via both water and the air. The sources from which they derive are classified as either diffuse sources or point sources. Examples of diffuse sources are the loss of nutrients from arable land due to leaching or to soil erosion. Examples of point sources are the discharge of wastewater from households via wastewater treatment plants, direct discharges from industry, atmospheric emissions from industry and agriculture and leaching from former landfills.

Many water bodies are subject to physical pressures of varying degree. Examples are the reclamation of shallow coastal water bodies and shallow lakes through dyking and draining, damming, channelization and maintenance of watercourses, water abstraction and shipping.



Watercourse that has been straightened to facilitate effective exploitation of the soil for agricultural production. Photo: Jan Kofod Winther.

All these types of pressure influence the quality of the water bodies and hence their ability to achieve "Good status".

Provisional environmental objectives for the water bodies in Odense

The Water Framework Directive requires that all water bodies achieve “Good status” by 2015 at the latest.

In order to be able to establish a qualitative and quantitative definition of “Good status” for the individual water bodies and assess their present status it is necessary to decide what quality elements and associated criteria are to be used to assess their status. Reference conditions (undisturbed conditions) are determined using historical data for the selected quality elements, by modelling and in certain cases by expert judgement.

Efforts are currently being made at EU level to establish common guidelines for environmental objectives in order to ensure a uniform understanding of what is meant by “Good status” for the various types of water body. As this work has not yet been completed, however, the present project is based on the provisional criteria for “Good status” applicable to the various water bodies.

The quality elements employed in the Odense Pilot River Basin project are as follows: Lakes: phosphorus concentration; Watercourses: a physical index and a fauna class index; Odense Fjord: the depth distribution of eelgrass.

The advantage of using eelgrass is that good historical data are available on its distribution in Danish marine waters that can be employed to establish reference conditions (Figure 7).

The distribution of eelgrass – and hence also the depth at which the eelgrass is able to grow – is affected by the concentration of nitrogen in the water. The lower the water concentration of nitrogen, the

lower the abundance of planktonic algae. The lower the abundance of planktonic algae, the clearer the water and hence the greater the depth at which eelgrass is able to grow. Given a knowledge of eelgrass biology and its present distribution, a predetermined reference condition and the present level of nitrogen loading of Odense Fjord, it is possible to calculate the maximum annual level of nitrogen loading of the fjord that is compatible with the achievement of “Good status” (Figure 8). The criterion for “Good status” applied in the present project is that the depth distribution of eelgrass must not deviate more than 25% from the reference condition (Figure 8).

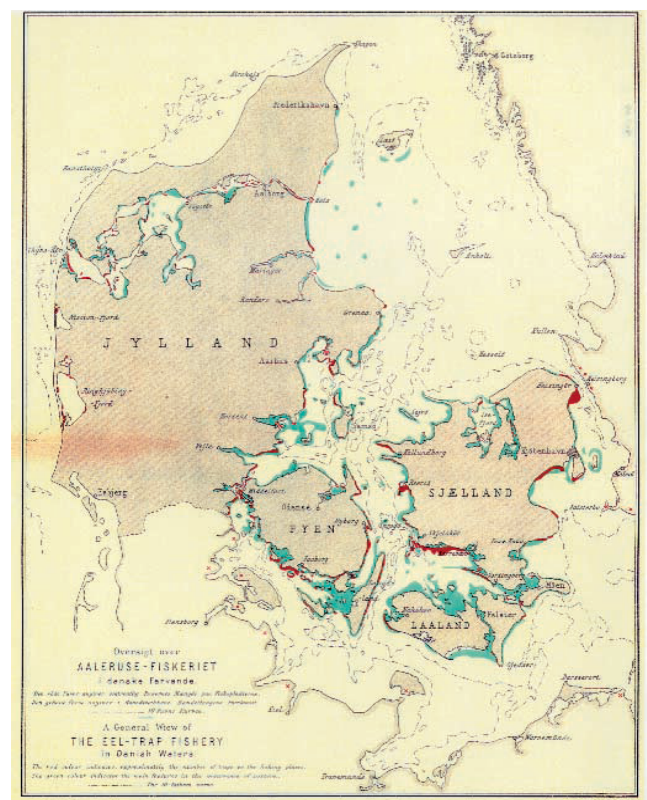


Figure 7: Distribution of eelgrass in Danish marine waters in 1900.

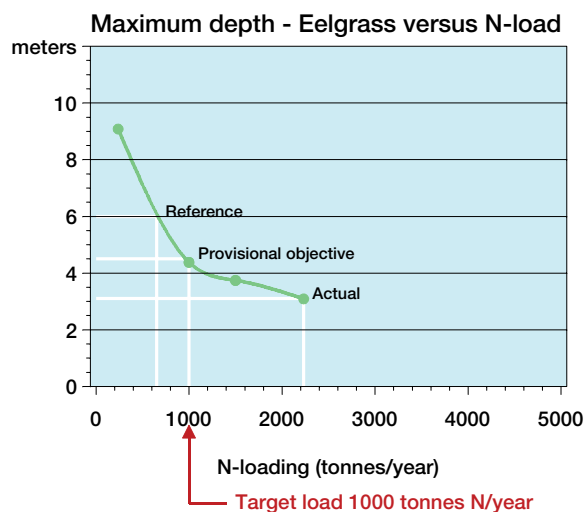


Figure 8: Graph of depth distribution of eelgrass versus nitrogen loading of Odense Fjord (N = nitrogen)



Eelgrass. Photo: Nanna Rask.

Risk assessment – Odense River Basin

The baseline characterization of the river basin includes an assessment of the risk that the individual surface water bodies and groundwater bodies will fail to achieve “Good status” by the year 2015 with the environmental measures already adopted.

The risk assessment takes into account the expected effects of the measures already adopted but not yet fully implemented pursuant to national and regional aquatic environment plans and EU directives. As is apparent from Table 2, the risk assessment for Odense River Basin reveals that given the assumptions made regarding the above-mentioned measures,

a very large proportion of all water bodies in the river basin are at risk of failing to fulfil the Water Framework Directive environmental objective of “Good status” by 2015.

It will therefore be necessary to implement further measures to ensure that all bodies of surface water and groundwater in Odense River Basin achieve “Good status” by 2015. These supplementary measures are to be specified in a programme of measures, which is a key part of the river basin management plan.

Table 2: Baseline assessment of the risk that the individual surface water bodies and groundwater bodies in Odense River Basin will fail to achieve “Good status” by the year 2015 together with the reasons for failure to meet the objective.

Water body type	Water bodies at risk (% of number)	Reason for lack of compliance with objectives Pressures that should be reduced/prevented
Watercourses	>90%	Physical pressures (regulation and culverting of watercourses, watercourse maintenance and drainage of river valleys for agricultural purposes, obstructions to the free passage of fauna Wastewater discharges (stormwater outfalls, sparsely built-up areas)
Lakes	88%	Nutrient loading, especially from agriculture Nutrient release from nutrients accumulated in lake sediment
Coastal waters	100%	Nutrient loading, especially from agriculture Wastewater discharges, especially from sparsely built-up areas and stormwater outfalls Hazardous substances from households, industry and shipping, etc. Physical pressures, for example from dredging of shipping fairways, raw materials extraction, fishery and marine dumping of harbour sediments
Groundwater	92%	Nitrate loading from agriculture Hazardous substances that leach from former industrial sites, etc. or in connection with pesticide use Pressure from overexploitation of the water resource (reduced water flow in watercourses and through lakes, drying-out of wetlands and intrusion of salt water, etc.)
Wetlands	(% of area)	Reduced area, fragmentation of terrestrial ecosystems and drying-out (lowering of the groundwater table) of wetlands due to draining, land reclamation and water abstraction
Coastal meadows	30–70%	Nutrient loading, especially from agriculture, in particular atmospheric deposition of ammonia nitrogen
Freshwater meadows	>50%	Pesticide loading
Mires	>75%	Overgrowth of habitats due to the lack of natural grazers

Programme of measures for Odense River Basin

The risk assessment shows that in order to fulfil the environmental objectives for the water bodies and terrestrial ecosystems in Odense River Basin it is necessary to implement a programme of measures to reduce the pressures responsible for the lack of compliance with the environmental objectives.

A programme of measures has therefore been drawn up for Odense River Basin containing a balanced combination of different types of measure that will together ensure that the water bodies and terrestrial ecosystems comply with their environmental objectives. In the project the programme of measures for the water bodies has been integrated with Natura 2000 planning such that the programme of measures for the water bodies to some extent also includes measures that will concomitantly contribute to ensuring fulfilment of the Habitats Directive objective of

“Favourable conservation status”.

Some of the measures in the programme of measures aim to reduce a specific type of pressure. An example is the group of measures “Environmental optimization of crop production” (Table 3), which reduce diffuse nutrient loading of water bodies from agriculture.

Other measures are multifunctional, for example the group of measures “Set-aside of farmland under crop rotation – lowland/river valleys” (Table 3). In this case the set-aside of land to form new wetlands will concomitantly reduce nutrient loading of surface waters, reduce physical pressure on the watercourses and re-create new terrestrial ecosystems. The new terrestrial ecosystems will eventually help ensure the necessary dispersal corridors in the cultural landscape and halt the decline in biodiversity.

Table 3: Groups of cost-effective measures to achieve the environmental objectives in Odense River Basin.

Groups of measures to reduce pressure on water bodies and terrestrial ecosystems	Water bodies and terrestrial ecosystems affected by the measure				
	Coastal waters	Lakes	Water-courses	Ground-water	Terrestrial ecosystems
Reduction of diffuse nutrient and pesticide loading – agriculture					
- Environmental optimization of crop production – upland	+	+		++ (N)	
- Environmental optimization of crop production – lowland /river valleys	++	++			
- Set-aside of farmland under crop rotation – upland	+	+		++(N)	++
- Set-aside of farmland under crop rotation – lowland/river valleys	++	++	++		++
- Special groundwater protection measures	+(N)	+(N)		++	++
Reduction of physical pressure – watercourses	+(N, P)	+(N, P)	++		+
Reduction of pressure from point sources	+	+	+	++	
Creation of new terrestrial ecosystems and management of existing terrestrial ecosystems	+	+	+	(+)	++



Birds around a sand spit in the Natura 2000 site in Odense Fjord. Photo: Michael Hansen.

Economics of the programme of measures for Odense River Basin

An economic analysis of various scenarios of measures that can be used to ensure achievement of the provisional environmental objectives for the individual water bodies has identified the most cost-effective programme of measures for the river basin. The annual economic cost of this programme of measures is summarized in Table 4. Implementation of all the groups of measures specified in the table will thus ensure that the environmental objective "Good status" is achieved by all water bodies in the river basin, including groundwater bodies, in the cheapest way.

The calculated economic cost of the programme of measures for ensuring full achievement of the environmental objectives is approx. DKK 94 million per year. A large proportion of the cost is accounted for by measures directed at point sources (43%), while the remainder (56%) is accounted for by agriculture-related measures and nature restoration. Given that the present total expenses for water use in Odense River Basin amount to DKK 612 million compared with a total income and production value of DKK 116,600 million, the programme cost thus corresponds to an increase in the total expenses for water from 0.5% to 0.6% of the total income and production value. The corresponding budget cost amounts to DKK 65 million.

The programme of measures entails the set-aside of 12,479 ha of farmland – corresponding to 19% of the farmland in the river basin. Of this, 2% is set aside as woodland, 8% as wetlands and 9% as permanent grassland. The area of farmland in the river basin will thereby be reduced from 68% of the river basin to 56% of the river basin in 2015. However, it will remain possible to utilize approx. 3/4 of the land that has been set aside for extensive agricultural production (grazing).

The project has not included any political assessment of whether the overall costs of the programme of measures are disproportionately expensive for society, and the river basin management plan does not consider how the programme of measures is to be financed, including whether the programme should be paid by water consumers, enterprises or in some other way. Moreover, the river basin management plan does not take into account to what extent the legislation necessary to ensure implementation of the programme is presently in force.



The River Ryds. Photo: Bjarne Andresen.

Groups of measures	Economic cost DKK 1,000
Reduction of diffuse nutrient and pesticide loading – agriculture	
- Environmental optimization of crop production – upland	3,990
- Environmental optimization of crop production – lowland /river valleys	2,471
- Set-aside of farmland under crop rotation – upland	7,068
- Set-aside of farmland under crop rotation – lowland/river valleys	15,362
- Special groundwater protection measures	14,832
Reduction of physical pressure – watercourses	10,338
Reduction of pressure from point sources	39,904
Creation of new terrestrial ecosystems and management of existing terrestrial ecosystems	-
Total cost	93,965
Set-aside of farmland	
Area of farmland under crop rotation that is to be set aside (ha)	12,479
Percentage of the total area of farmland in Odense River Basin (67,142 ha)	19%

Table 4: Summary of the results of the economic analysis. The subdivision of the table follows the groups of measures in Table 3. However, the cost of the measure "Creation of new terrestrial ecosystems and management of existing terrestrial ecosystems" is included in the other groups of measures as these measures are multifunctional.

Public participation in the Odense Pilot River Basin project

Stakeholders				
Representation level	Key actors	Other authorities	Business organizations, research, etc.	NGOs and associations
Local and regional	Environment Centre Odense/Fyn County	Municipalities	Local industry, agro-industrial companies	Danish Sports Fisher Association
			Representatives of private consultancy firms	Danish Hunters Association
			Danish Agriculture and 3 local farming associations: Funen Family Farmers' Association, Funen Farming Unions, Patriotisk Selskab	
			Fyntour (Funen tourism organization)	
			Association of private waterworks on Funen	
National	Danish Forest and Nature Agency		The Confederation of Danish Industries, Danish Agriculture	Birdlife Denmark
	Danish Environmental Protection Agency	Ministry of Food, Agriculture and Fisheries	Danish Water and Waste Water Association	Danish Society for Nature Conservation
	Danish Ministry of the Environment	Danish Regions	Danish Horticulture	Danish Forestry Extension
		Institute of Food and Resource Economics	Universities and research institutions	Danish Outdoor Council

Table 5: Stakeholders invited to participate in the Odense Pilot River Basin project.

Public information and consultation are important aspects of the implementation of the Water Framework Directive. The Environmental Objectives Act describes the work and planning process that has to be followed in Denmark to ensure that the Water Framework Directive environmental objective of "Good status" is achieved in all surface water bodies and groundwater bodies, including requirements as to public participation.

The participation of stakeholders has primarily been achieved through the establishment of various advisory boards and expert groups:

- A national scientific advisory board
- A regional political advisory board
- An external technical expert group
- An environmental economics expert group

All the important elements in the preparation of the provisional river basin management plan, including the baseline characterization of the river basin, the risk assessment and the development of a cost-effective programme of measures and the river basin management plan itself, have been presented to and discussed with the advisory boards and expert groups. Various types of comment have been put forward that have subsequently been taken into account when drawing up the river basin management plan. The comments received can be grouped as follows:

- Technical comments

- Comments concerning the definition of provisional environmental objectives and reference conditions
- Political comments
- Comments on the planning process.

In the present pilot project it has not been possible – and in any case would not have been meaningful – to invite the public to participate in and contribute to the process as laid down in the Environmental Objectives Act. In the pilot project it was therefore decided to involve the public by inviting the various stakeholders in the river basin management plan to a series of meetings organized by the water management authority.



Pond surrounded by grazed meadow and dry grassland. Photo: Birgit Bjerre-Laursen.