Revised Terms of Reference [28/11/2000]

Heavily Modified Waters in Europe
Case Study on the Veluwerandmeren

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In association with

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PART I

1 Preface [to be drafted by project managers] (1 page)

[insert the standard preface - drafted by the project managers - briefly explaining the European project on heavily modified water bodies as the context for the individual case study. This should explain the context to readers of the case study, who may not be familiar with the European project.]

2 Summary Table (2 pages)

[insert the summary table on the case study already provided; "Annex IV" of the minutes of the kick-off meeting of the European project on heavily modified water bodies.]

	Item	Unit	Information
1.	Country	text	Netherlands
2.	Name of the case study (name of water body)	text	Veluwemeer
3.	Steering Committee member(s) responsible for the case study	text	RIVM / RIZA
4.	Institution funding the case study	text	RIVM
5.	Institution carrying out the case study	text	Witteveen+Bos
6.	Start of the work on the case study	Date	1 October 2001
7.	Description of pressures & impacts expected by	Date	December 2001
8.	Estimated date for final results	Date	December 2001
9.	Type of Water (river, lake, AWB, freshwater)	text	A series of connected freshwaterlakes: Velu
10.	Catchment area	km^2	850 km^2 (eastern part of Flevopolder and no
11.	Length/Size	km/ km^2	Nuldernauw: size is 6,64 km^2 and mean dep Wolderwijd: size is 18,25 km^2 and mean dep Veluwemeer: size is 30,22 km^2 and mean de Drontermeer is 4,76 km^2 and mean depth is
12.	Mean discharge/volume	m^3/s or m^3	Nuldernauw: volume is 13,7 $*10^6$ m^3 and re Wolderwijd: volume is 35,3 $*10^6$ m^3 and rete Veluwemeer: volume is 47,3 $*10^6$ m^3 and re Drontermeer: volume is 6,0 $*10^6$ m^3 and rete
13.	Population in catchment	number	± 250.000 inhabitants (Municipalities of Elbu Uddel/Elspeet, Nunspeet, Putten, Zeewolde
14.	Population density	Inh./km^2	250.000 / 850 km^2 = 295 Inh/ km^2
15.	Modifications: Physical Pressures / Agricultural influences	text	Direct physical alterations: – Reclamation of the Flevopolder in ±1950- Veluwerandmeren in their present form – Disruption of the ecological continuum be – Digging of a channel for shippery – Creation of islands in the lake to use the s – Bank reinforcement along roads and build – Extraction of sand – Reclamation of parts of the lake for indust Indirect physical alteration: – Construction of the Afsluitdike in the form lake IJssel
16.	Impacts?	text	The changes in hydrology are: – Change of an estuary with tidal movem unnatural water level fluctuations – Change of hydrology and water quality reclamation of the Flevopolder to creat to optimise agricultural use. Both altera period 1950-1960, because the supply agricultural pollution increased. The eu the lake with 50-100 million m3/year ca Flevopolder and 2) reduction of the nut The changes in morphology are: – Unnatural morphological form of the lak of the bank is asymmetric. This unnatu Flevopolder. Prior to the construction o border of the large lake IJssel/Zuiderze the border of a large lake changed into – Fortified banks along roads and built ar – Creation of holes of 5 and 8 m deep an bottom of the lake – Creation of islands in the lake – The ecological continuum is disrupted b management of the sluices aims at ena – Loss of lake area due to the reclamatio
17.	Problems?	text	Veluwerandmeren are presently mesotrophi is however still unstable, as future developm increasing mineral extraction) will probably i Additional restoration measures will be need

	Item	Unit	Information
18.	Environmental Pressures?	text	– Recreation – Agriculture – Households – Water management and flood protection – Fisheries – Mineral extraction – Shipping – Water supply – Industry
19.	What actions/alterations are planned?	text	For the period 2002-2010 a plan with 36 measures recreation function of the lake. Examples of the m Improvement of the sewage works at Harderwijk ir the waste water – Diverting a discharging stream to an adjacen – Partial ecological restoration of the banks alo
20.	Additional Information	text	The Veluwerandmeren have a history with a large changing from estuary into clear, mesotrophic fres and restored to clear lakes again. They are howev waterbody itself has a natural origin.
21.	What information / data is available?	text	Data on hydromorphology, water quality, algal con and fish
22.	What type of sub-group would you find helpful?	text	Multifunctional
23.	Additional Comments	text	The Veluwerandmeren is an protected area accor

3 Introduction (2 pages)

These Terms of Reference should guide the production of the case studies reports to be written in the framework of the European project on heavily modified water bodies. They are provided as a standard report format **which can simply be overwritten**. Please do not alter the formatting of paragraphs, headings etc. For tables and boxes within this case study, please make use of the following models:

Table 1 [model heading for a table]

Box 1 [model heading for a box or map]

You received two files of Terms of Reference for your case study. In general, you should only use file ‚HMWB TOR' consisting of Part I, II and III for producing your case study. Part I includes chapters 1-4 which give an introduction to the case study. In chapter 4, you should identify different water bodies within your case study area.

In Part II, the physical alterations, the ecological status, the identification and designation as heavily modified and the definition of maximum and good ecological potential (see chapters 5-9) should be described for the water bodies in the case study area. In general, it is expected that the different water bodies in your case study would be affected by similar pressures and physical alterations.

Part III is dedicated to highlight main findings during the identification and designation process and the lessons learned in the case study. Please try not to exceed a total of 50 pages (excluding maps and annexes). A number of pages is also indicated for each section next to the first level heading to guide the authors. They do not intend to be prescriptive.

In case your case study consists of water bodies affected by substantially different pressures and physical alterations, please try to group them (to a limited number of groups) by similar pressures and physical alterations (in chapter 4). If the impacts of these pressures are distinct it would be useful to report your Part II results separately. Use the separate file ‚HMWB extra Part II TOR' and complete it separately for each impact group. In total, please do not exceed a length of 80 pages (excluding maps and annexes), including all groups of water bodies.

3.1 Choice of Case Study

This case study is about a Dutch shallow freshwater lake; the Veluwerandmeren. There are two Dutch lakes in the HMW case study project; the Veluwerandmeren and Lake Loosdrecht. The lakes have been influenced drastically by hydromorphological changes. Both lakes have different water authorities: The Veluwerandmeren are managed by Rijkswaterstaat, acting on a national scale. Lake Loosdrecht is managed by the Water boards, acting on a regional scale.

The Veluwerandmeren have been selected as a case, because it is the product of the building of dikes and the reclamation of a polder. Therefore, the Veluwerandmeren are to a certain extent comparable to a number of relatively large Dutch shallow lakes (e.g. Lake IJssel, Markermeer). The lake is relatively young (±1955) and has a unnatural morphology as a result of the reclamation of the polder. The present lake has numerous human uses, and a history of large hydromorphological impacts. Due to this impacts it has no stable period of relatively undisturbed ecological functioning. This makes the Veluwerandmeren an interesting case.

Moreover, the Veluwerandmeren have been selected, because its functioning has been studied extensively. There are many data and studies available for this case study.

3.2 General Remarks

[Explain the location and nature of the water bodies within the case study area (map). Explain the place of the case study in the sub-group structure adopted by the European project on heavily modified water bodies.]

4 Description of Case Study Area (3 pages)

4.1 Geology, Topography and Hydrology

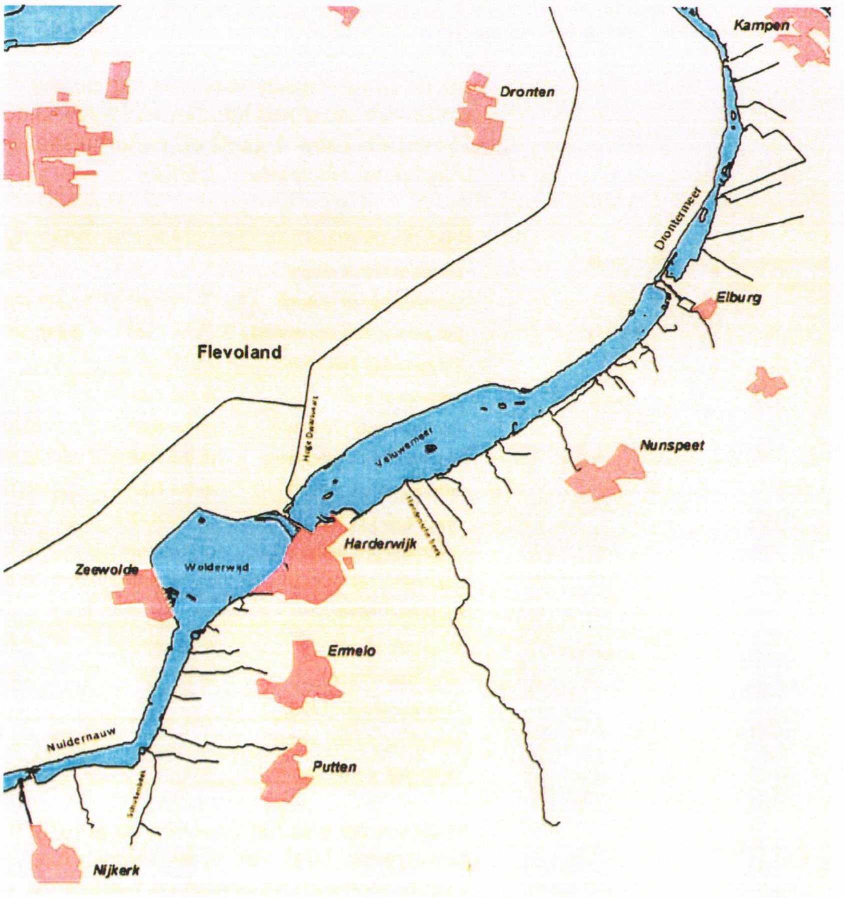
[Please briefly consider the geology, topography and hydrology of the catchment. Include information from summary table and provide further detail and explanations on: type of water; surface of the catchment in km²; length [in km] or surface size [in km²] of the water; mean discharge in [m³ per second] or total water volume [in m³]; altitude; depth; salinity and tidal range; describe seasonal and other variations in flow and any other important aspects of flow dynamics. Maps showing the river network, coastal length should be provided.]

The Veluwerandmeren are located in the middle of the Netherlands, at the south-eastern side of the Flevopolder. The northern side of the lake is bordered by the Flevopolder (polderside) and the southern side is bordered by the Veluwe (old land side). The lakes were created by the reclamation of the Flevopolder in the Lake IJssel: the lakes Veluwemeer and Drontermeer in 1957 and the lakes Wolderwijd and Nuldernauw in 1968. The lake IJssel was formerly an estuary, the Zuiderzee. It turned into a lake due to the construction of the Afsluitdike. In figure 4.1 a map is shown of the four connected lakes, the towns located near the lakes and the discharging streams and canals. In table 4.1 some hydromorphological characteristics of the Veluwerandmeren are described.

Table 4.1 Hydromorphological characteristics of the Veluwerandmeren (Meijer et al., 1999)

	Surface	**Average depth**	**Volume**	**Retention time**	**Summer water level**	**Winter water level**
	ha	**m**	**$*10^6$ m^3**	**year**	**m NAP**	**m NAP**
Nuldernauw	664	2,06	13,7	0,12	-0,10	-0,30
Wolderwijd	1825	1,94	35,3	0,32	-0,10	-0,30
Veluwemeer	3022	1,56	47,3	0,16	-0,05	-0,30
Drontermeer	476	1,26	6,0	0,05	-0,05	-0,30

Figure 4.1 Map of the Veluwerandmeren with the towns located near the lakes and the discharging streams and canals (source: BOVAR, 2001)



The Veluwerandmeren are bordered by two sluices; the Roggebotssluis in the north and the Nijkerkersluis in the south. At present Veluwemeer-Drontermeer and Wolderwijd-Nuldernauw are separated by a sluice. In 2003 the sluice will be removed and both lakes will be connected. The depth of the lakes is smaller at the old land side than at the polderside, because the old land side was the former bank of the Zuiderzee and the bank at the polderside was created by the reclamation of the polder. The soil type differs within the lake: at the old land side it consists mainly of sand, whereas at the polderside more silt and clay is found.

4.2 Socio-Economic Geography and Human Activities in the Catchment

[Please describe the case study area, including maps. Please consider the (socio-economic) geography of the catchment. Include information from summary table (chapter 2) and provide further detail and explanations on: population in the catchment [number] and population density [in persons per km²]; explain distribution of population and identify the most important centres of population; describe the most important economic activities and water uses in the catchment and their impacts on the water body and adjacent aquatic and terrestrial ecosystems (in quality, quantity and morphology).]

The main functions of the Veluwerandmeren are recreation, fisheries and nature. In addition to this the lakes have a shipping function (both commercial and recreation). In the year 2000 ±30.000 ships passed the sluices of the lakes, of which 80% was recreational shipping (RDIJ, 2001b). Furthermore, the lakes are used for the extraction of drinking water, irrigation water, industrial process water and minerals. Three towns are located at the border of the lakes, Harderwijk having 40.100 inhabitants, Elburg with 21.700 inhabitants and Zeewolde with 18.378 inhabitants. The main land use in the area bordering the lakes, the Flevopolder and the Veluwe, is recreation, agriculture and nature. The Veluwerandmeren have been designated as an protected area according to the Birds Directive

4.3 Identification of Water Bodies

[Refer to HMW paper 7 ver 2 and the WFD Annex II, 1.2 "Ecoregions and Surface Water Body Types" for detail; if possible provide information according to either system A or system B.

This section should identify the water bodies within the study area. The description of water bodies should define the extent of the impact of the physical modification (i.e. it should include the unaffected water body immediately upstream and downstream).

Depending upon the circumstances, the impacts of a pressure may affect one water body or a series of water bodies.

If necessary, please group the water bodies according to different pressures and physical alterations. Please identify each water body clearly and group the water bodies according to the types of pressures to which they are subject (see table 2).

The following Table 2 serves as an example for grouping water bodies and indicating which sections (Part II, Part IIa) they refer to. You could use it for grouping the water bodies of your case studies, if you think such a grouping is useful. Please note that the separation is optional and only useful where there are fundamentally different pressures and physical alterations that affect distinct water bodies in your case study area. It is to avoid having more than 2 (or max. 3) different groups (and accordingly Parts II).]

In this section the lakes have to be divided in waterbodies on the basis of:

- **Application of the typology system** as defined in Annex II. This will split rivers into units based upon system "A" or "B" which will define the type-specific hydromorphological and physicochemical conditions. According to system A, Annex II of the WFD, the Veluwerandmeren:
  - are situated in one ecoregion, the Central plains;
  - the altitude typology is lowland (<200 m);
  - the mean depth of the lakes is 1,26-2,06, thus the class is < 3 m;
  - the total size of four connected lakes is 60 km^2; the class is 10-100 km^2;
  - the geology is silicious.

  The application of the typology system does not lead to the identification of different waterbodies.
- **Definition of hydromorphological units** (e.g. major physical divisions - separate tributaries, main river stretches between large tributaries). The lake in this case study is a lowland shallow lake with a soil of sand and clay/silt. The four connected lakes have been created in the same time due to the reclamation of the Flevopolder. No different hydromorphological units can be identified.
- **Effective management unit,** taking into account the pressures and resultant impacts. The Veluwerandmeren are managed by the regional division of Rijkswaterstaat, which are water authorities acting on a national scale. The province Flevoland is responsible for this lake at the provincial level. The catchment of the lakes at the southern side, the Veluwe falls under the responsibility of the province Gelderland.
- **Type specific biological condition** (e.g. the degree to which the waterbody forms a consistent ecological type, in terms of ecosystem structure and function). It is difficult to define a specific biological condition, as the ecological condition of the Veluwerandmeren changed continuously since the creation of the lakes: There were no really, stable ecological phases over longer periods, as the clear period after creation lasted for only 8 years. Therefore, a theoretic reference condition will be selected for the Veluwerandmeren based on the theory of shallow lakes of Scheffer (1999): the condition of a mesotrophic, clear lake with macrophytes, natural banks and marshes and natural water level management. (see information in Box 1 on the different types of shallow lakes and Box 2 on the reference condition of the Veluwerandmeren).

For this case study we will distinguish one waterbody: the Veluwerandmeren. The Veluwerandmeren consist of a series connected lakes, which have comparable characteristics: The Veluwemeer, Drontermeer, Wolderwijd and Nuldernauw. At present Veluwemeer-Drontermeer and Wolderwijd-Nuldernauw are separated by a sluice. In 2003 the sluice will be removed and both lakes will be connected.

Table 4.2 Details on separate groups of water bodies

Name of the group	Main pressures of the group	Main physical alterations of the group	Water bodies of the group	Section referring to the group	page numbers
Group 1	Flood protection Recreation Mineral extraction Shipping	Unnatural water levels Sluices Artificial banks Extraction pits	Water body 1	Part II (included in the HMWB TOR file)	

[A map should be provided showing the water bodies relative to the modified characteristics. This section should include discussion of:

- the main issues which were considered important in identifying the water bodies;
- any problems experienced in identifying the water body;
- comments on the level of differentiation (minimum size of water body) which was considered appropriate.]

Box 1. Types of biological condition of shallow lakes

Shallow lakes can be distinguished in three biological types based on their nutrient richness:

- Oligotrophic shallow lakes having very low nutrient concentrations a low biological diversity and low biomass. An example of an oligotrophic lake were Lake Loosdrecht after its creation.
- Mesotrophic shallow lakes having moderately high nutrient concentrations and a moderately high biomass. These types of lakes have the highest biological diversity. Examples of these lakes are Lake Naardermeer and Lake Stichtse Ankeveen.
- Eutrophic shallow lakes having high nutrient concentrations, a high biomass and a low biological diversity. In the Netherlands a large number of lakes are presently this type of biological condition due to eutrophication. There are however lakes, which are eutrophic by nature, such as the Brasemermeer, called the bream lake because of its high biomass of bream.

4.4 Discussion and Conclusions

[Discuss lessons learned, any problems encountered and how they were overcome.]

Difference between artificial and heavily modified

Numerous lakes in the Netherlands are created due to large human influence. The difference between an artifical or a heavily modified water is therefore not always clear. The Veluwerandmeren were formerly the border of the estuarium Zuiderzee. The reclamation of the Flevopolder created the Veluwerandmeren in its present condition as freshwater lakes. We defined the difference between artificial and heavily modified in the following way:

- In case the water has been dug by humans, the waterbody is artificial (e.g. canals, pools for swimming, pools resulting from mineral extraction). The question remains then to hat extent the water body has to be dug (partially or completely).
- In case human activity has made the preconditions for creation , but the water body has not dug by humans, the waterbody is heavily modified.

In case the criterium of digging of the waterbody still does not lead to a clear difference, a second criterium could be applied: the existance of a natural reference condition on the basis of a comparable waterbody. If a natural reference condition applies to that water body, it is HMW. In case there exists no natural reference condition for that water body, as it differs too much from natural waters, the water is artificial. On the basis of these two criteria, the Veluwerandmeren are designated as heavily modified and not artificial.

We would appreciate if the future guidance will provide clear criteria for determining the difference between artificial and heavily modified.

Selection of the correct scale of waterbodies

The selection of the correct scale of waterbodies is unclear. In both case studies on Dutch lakes there are a number of connected or neighbouring lakes, which have a comparable hydrology and pressures and impacts, but the ecology is not completely identical in the different lakes. The question is: should the lakes be selected as different water bodies or as one water body?

PART II

5 Physical Alterations (5 pages)

5.1 Pressures and Uses

[This chapter should provide detailed information on significant pressures on the water bodies, i.e. the economic and social forces that create pressure on the water bodies. See HMW paper 5 ver 3, nr. 3 for the terminology concerning pressures.]

The pressures and uses of the lake and catchment are:

- Agriculture leading to:
  - diffuse pollution (BOVAR , 2001);
  - reclamation of the Flevopolder to create land for agriculture and drainage of the Veluwe area to optimise agricultural use. Both alterations have led to changes in the hydrology of the catchment and a reduction of seepage water supply into the lake from the streams in the Veluwe area.
- Urbanisation leading to:
  - diffuse and point source pollution from the surrounding households (BOVAR, 2001);
  - reclamation of the Flevopolder to create land for habitation. This alteration has led to changes in the hydrology of the catchment of the lakes and a reduction of seepage water supply into the lake.
- Industry leading to the reclamation of additional land of ±100 ha over the past ten years for industrial activity and public works.
- Watersupply: extraction of drinking water, irrigation water, and industrial process water. It is still unclear to what extent this function forms a pressure for the Veluwerandmeren.
- Flood protection and water management leading to:
  - unnatural water level fluctuations due to the water level management of the connected Lake IJssel: the waterlevel is high in the summer period and lower in the winter;
  - construction of three sluices (two sluices at the east- and westborder of the Veluwerandmeren and a third sluice between the Veluwemeer-Drontermeer and Wolderwijd-Nuldernauw. In 2003 the third sluice will be removed and both lakes will be connected;
  - building of dikes and the fixation of banks.

- Recreation, such as sailing, motorboating, angling, surfing, rowing (Stichting water recreatie, 1997). In table 5.1 some data on recreational facilities at the Veluwerandmeren are given. Recreation leads to the following pressures:
  - diffuse and point source pollution from the surrounding yacht-basins and beaches. This pressure is relatively unimportant;
  - small scale mowing of macrophytes and deepening of shallow areas;
  - disturbance of the fauna and flora of the lake by the sailing of yachts and recreational fisheries;
  - fixation of natural banks at yacht-basins and havens.
- Commercial fishery: There are two fishermen fishing in the Veluwerandmeren (Meijer et al., 1999). The exact amount of fish yield is not known, but estimations range between 10 to 40 kg/ha*year of bream (*Abramis brama*) catch (Lammens et al., in prep.). It is expected however that the catch of bream had a positive effect on the transparency of the water and the ecological condition.
- Mineral winning of the lake sediment (sand for construction). Mineral winning has led to sand winning pits of 5 and 8 m in the Veluwelake and the Wolderwijd. More mineral winning is planned for the period 2001-2010 (table 5.2) (RDIJ, 2001a).
- Shipping. In the lakes a channel for ships has been dug with a mean depth of 3,5-4,5m.

Table 5.1 Data on the recreational facilities in the Veluwerandmeren (Source: Stichting water recreatie, 1997)

	Veluwemeer	Drontermeer	Wolderwijd	Nuldernauw
# Yachting basins	15	6	3	5
# Camping sites	8	5	1	7
# Parking sites	8	11	4	12
# Landing stages	3	6	2	1

Table 5.2 Planned mineral extraction in the Veluwerandmeren in the period 2000-2010. The numbers represent the surface in hectares. The depth varies between 1,5 and 12 m (Source: RDIJ, 2001a)

	Veluwemeer	Drontermeer	Wolderwijd-Nuldernauw
Surface (ha)	548,1	131,7	319,4

5.2 Physical Alterations

[This section should refer to the physical alterations which result from the above pressures (See HMW paper 5 ver 3, nr. 4-9 for terminology on physical alterations). This should include reference to alterations to the water bed, banks and riparian zone. Photographs, maps, plans, graphs and tables should be produced as required. In particular, please discuss the types of physical alterations, which are considered to be relevant/appropriate. These may include:

- direct physical alterations upon river channel or bed such as river straightening;
- alterations resulting from pressures upon riparian zone such as flood defence ;
- indirect physical alterations such as drainage work on adjacent land;
- others...]

Direct physical alterations are:

- Reclamation of the Flevopolder in ±1950-60, a polder of 241.200 ha, leading to the Veluwerandmeren in their present form.
- Reclamation of additional land of ±100 ha over the past ten years for industrial activity and public works.
- Disruption of the ecological continuum because of the construction of three sluices (two sluices at the east- and westborder of the Veluwerandmeren and a third sluice between the Veluwemeer-Drontermeer and Wolderwijd-Nuldernauw. In 2003 the third sluice will be removed and both lakes will be connected.
- Digging of deep holes for sand extraction.
- Digging of a channel for shippery.
- Creation of islands in the lake to use the sand coming from the digging of the shippery channel.
- Bank reinforcement along roads and build area.

Indirect physical alterations are:

- Drainage of the Veluwe area to optimise agricultural use. The drainage led to a reduction of seepage water supply into the lake from the streams in the Veluwe area.

An indirect physical alteration, which occurred even before the creation of the Veluwerandmeren in their present form, is the construction of the Afsluitdike in the former Zuiderzee. Due to the construction of the dike the estuary Zuiderzee changed into the freshwater lake IJssel.

5.3 Changes in the Hydromorphological Characteristics of the Water Bodies and Assessment of Resulting Impacts

[Describe the hydromorphological changes, which result from the direct physical alterations. For example:

- change in flow regimes and the consequent impact upon downstream channel morphology (e.g. connected to interrupted sediment transport);
- lake water level regulation and the impact on lake basin morphology;
- artificial flow regime and the impact on riparian vegetation and bank morphology ;
- others...]

The changes in hydrology are:

- Creation of a freshwater lake with unnatural water level fluctuations out of an estuary with tidal movement and brackish water due to the Afsluitdike. The unnatural water level management leads to high levels in the summer period and low levels in winter (see table 4.1). This unnatural water management is linked to the water level management of the connected lake IJssel and aims to reduce the risk of floods.
- Change of hydrology and water quality of the freshwater lake after its creation, because of the reclamation of the Flevopolder to create land for agriculture and drainage of the Veluwe area to optimise agricultural use. Both alterations have led to an eutrophication of the lake in the period 1950-1980, because the supply of nutrient poor seepage water reduced and diffuse agricultural pollution increased. The eutrophication of the lake has been tackled by:
  1. reduction of the nutrient load from agriculture and sewage works;
  2. flushing the lake with 50-100 million m^3/year calcium rich and nutrient poor seepage water from the Flevopolder. The main effect of flushing is the reduction of the retention time of the water in the lake. Formerly, the seepage water reduced also the nutrient concentration in the lake. This restoration measure has been applied since 1979 in the Veluwemeer and in the period 1980-1983 and since 1989 in the Wolderwijd;
  3. reducing the nutrient load to the Veluwerandmeren by displacing the discharge of the stream Schuitenbeek away from the Veluwerandmeren.

The changes in morphology are:

- Unnatural morphological form of the lake and its banks; the lake is very undeep and the form of the bank is asymmetric. This unnatural form has been caused by the construction of the Flevopolder. Prior to the construction of the Flevopolder the Veluwerandmeren were the border of the large lake IJssel/Zuiderzee. Due to the creation of the polder in the Lake IJssel the border of a large lake changed into a separate lake.

- Fortified banks along roads and built area.
- Creation of holes of 5m and 8m deep and a channel of an average depth of 3,5-4,5 m in the bottom of the lake.
- Creation of islands in the lake.
- The ecological continuum is disrupted by the sluices, acting as migration barriers.

5.4 Discussion and Conclusions

[Discuss lessons learned, any problems encountered and how they were overcome.]

Numerous human uses have led to hydromorphological changes causing eutrophication problems. This eutrophication of the lakes has been tackled by restoration measures leading to hydromorphological changes, such as the flushing of the lakes and the displacement of a discharge of a lake. The restoration measures do not aim at a return of a former situation, but aim to reduce the eutrophication problems and are somewhat “artificial”. The hydromorphological changes can be classified in “negative” changes for the ecological condition of the lake and “positive” restoration measures.

6 Ecological Status (7 pages)

[In this chapter, please describe the current ecological status of the water body, following the structure of WFD Annex V, 1.1 "Quality Elements for the Classification of Ecological Status". Refer to HMW paper 6 ver 2.]

6.1 Biological Quality Elements

[Please describe briefly the current ecological condition of the water body (with more detail provided below). It will be important to discuss the following aspects:

- The range of biological measurements (phytoplankton, macrophytes, phtytobenthos, macroinvertebrates, fish fauna) used and the extent to which it is considered that they adequately reflect the pressures resulting from the physical modification upon the water body. Would additional measurements be needed in the future? Shortfalls in the information available should be highlighted here and proposals for additional measurements should be suggested.
- The extent to which the impacts upon biology are a consequence of the physical alterations. Both upstream and downstream impacts should be described. Are other pressures (such as pollution) important? How can such pressures be separated?]

Data on the following biological parameters are presented (Van den Berg et al., 2001):

- algal concentrations (figure 6.1, 6.2 and 6.3);
- the coverage with a number of macrophyte species (figure 6.4);
- the abundance of a number of macro-invertebrate species (table 6.1);
- the biomass of fish species (figure 6.5).

Figure 6.1. Development of the summer mean chlorophyll concentration in the period 1970-2000 in the Veluwe- and Drontermeer

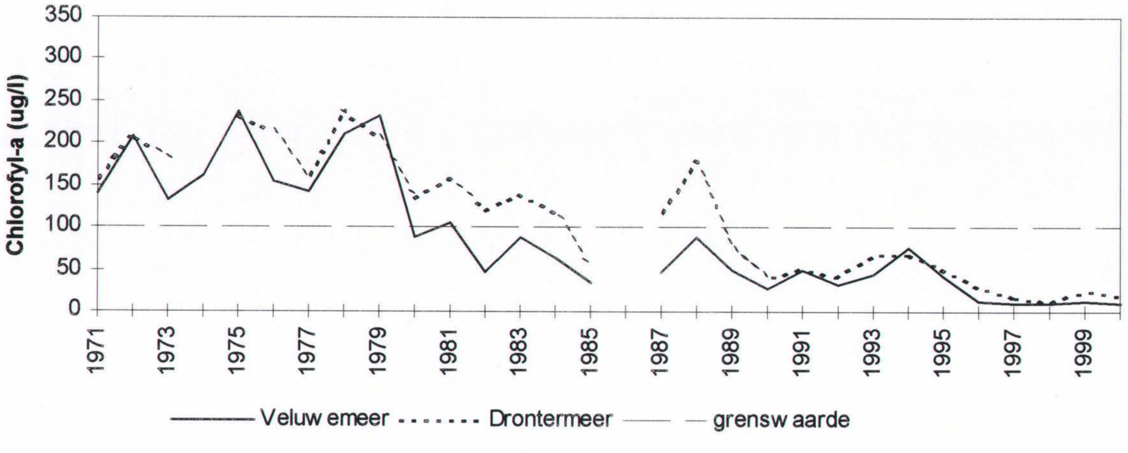


Figure 6.2. Development of the chlorophyll concentration in the period 1970-2000 in the Wolderwijd and Nuldernauw

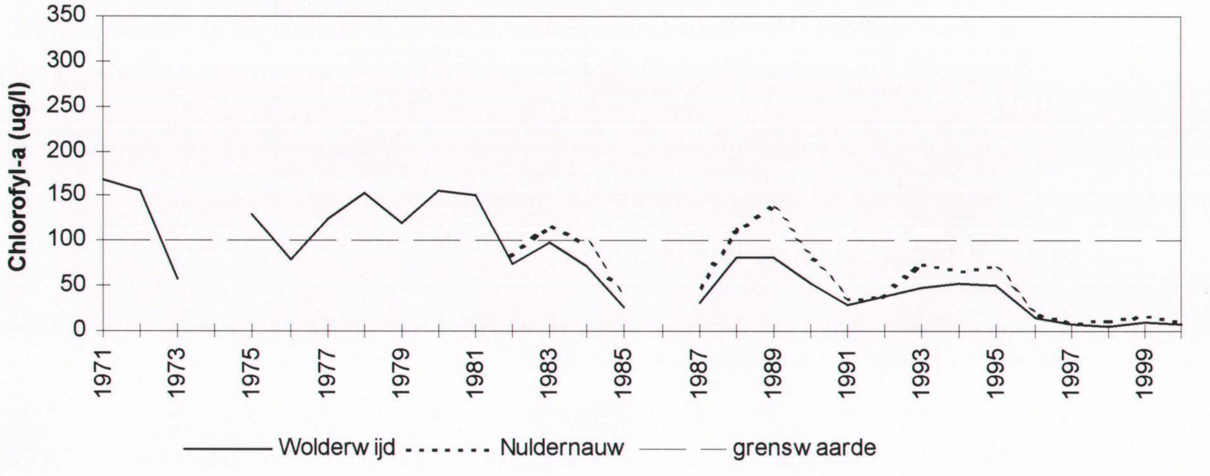


Figure 6.3 Seasonal development of algal concentrations in the years 1998, 1999 and 2000 in the four lakes

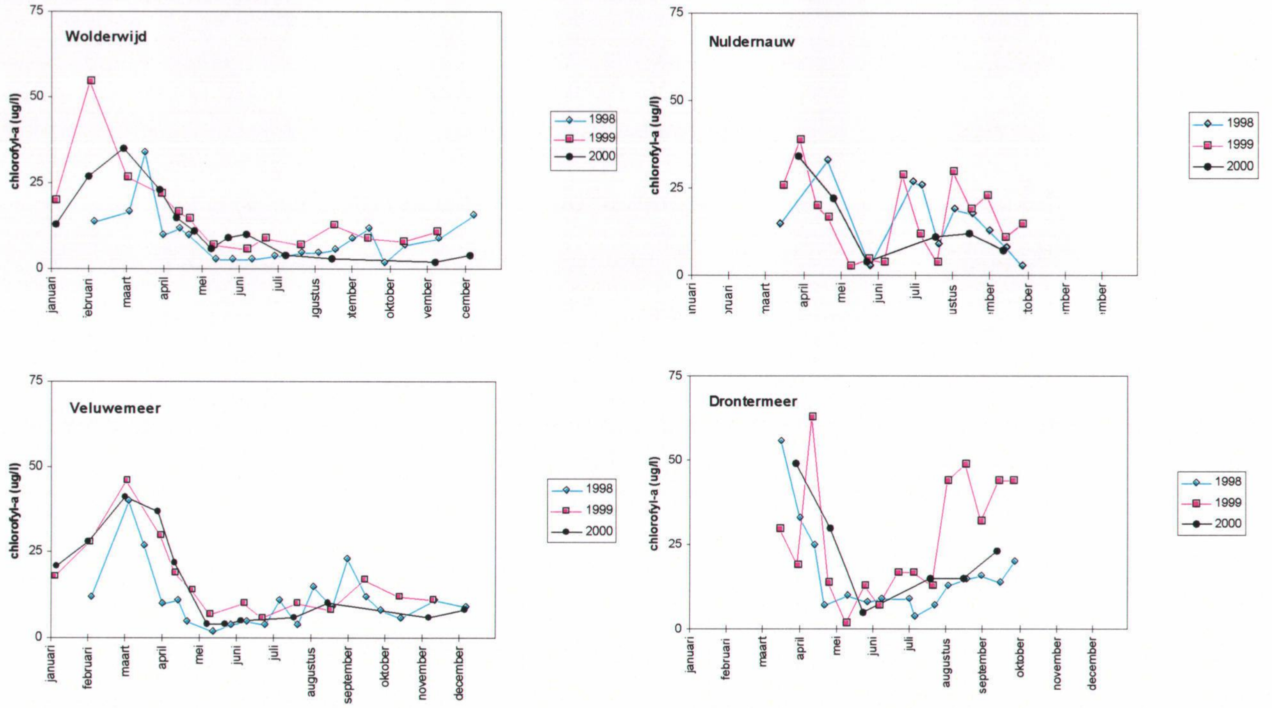


Figure 6.4 Coverage (as percentage of total area) of Veluwemeer and Wolderwijd/Nuldernauw with different macrophyte species in the period 1987-2000

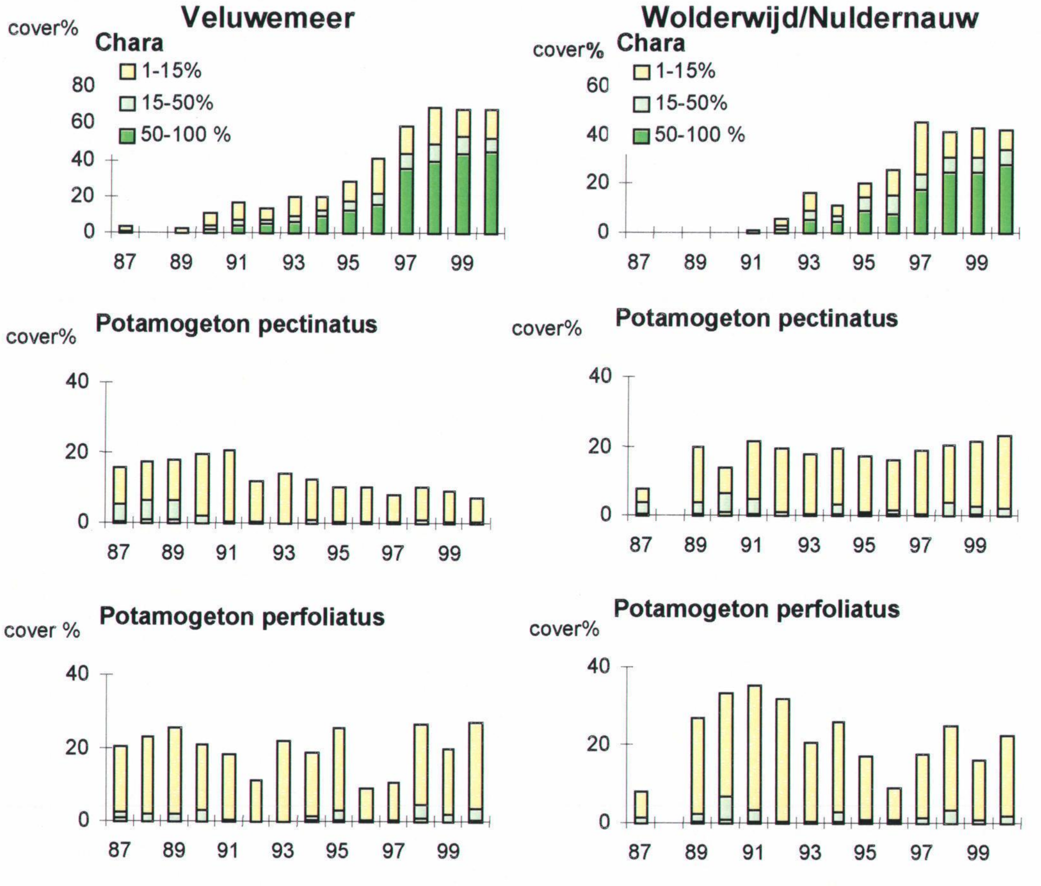
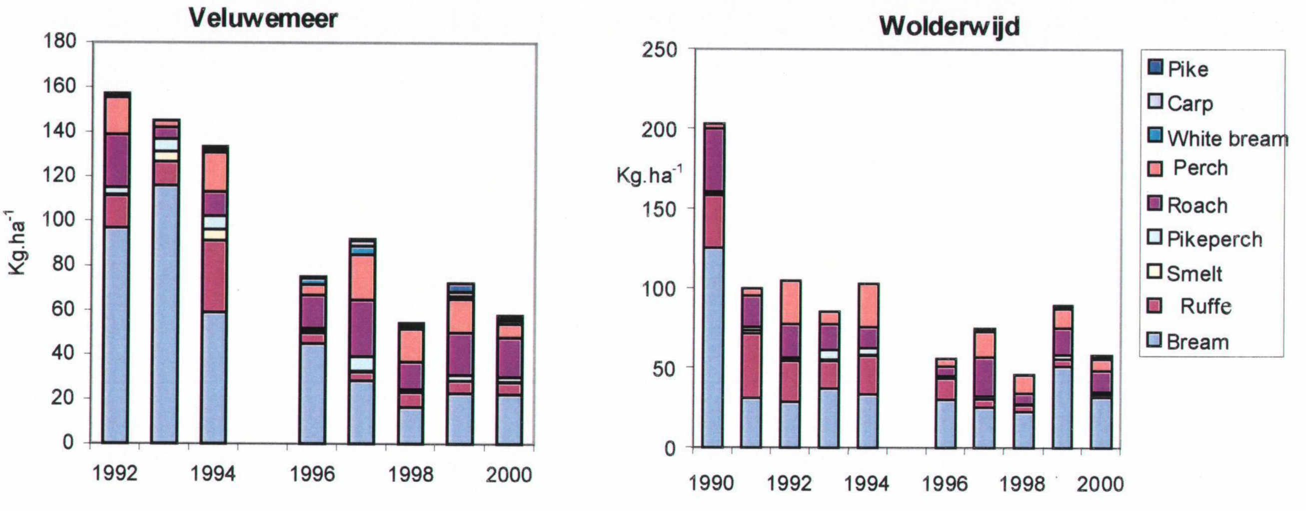


Table 6.1 Indication of the abundance of different macro-invertebrate species for the years 1994-2000. The value represents the total number of individuals on 5 average stones

Date	Drontermeer	Veluwemeer	Wolderwijd	Nuldernauw
Corophium curvispinum				
08-sep-94	0	0	0	0
07-sep-95	0	0	0	0
17-sep-96	150	0	0	0
22-sep-97	250	37	0	0
29-sep-98	28	8	500	120
28-sep-99	1200	1300	700	2000
16-nov-00	2400	550	440	1200
Gammarus tigrinus				
07-sep-95	200	120	75	150
17-sep-96	40	200	30	10
22-sep-97	38	40	75	0
29-sep-98	30	3	0	0
28-sep-99	145	8	18	0
16-nov-00	160	4	5	3
Dikerogammarus haemibavus				
08-sep-94	0	0	0	0
07-sep-95	0	0	0	0
17-sep-96	0	0	0	0
22-sep-97	109	199	1	5
29-sep-98	27	85	200	46
28-sep-99	39	114	20	55
16-nov-00	290	69	105	225
Asellus aquaticus (Asellidae sp.)				
08-sep-94	2	0	0	0
07-sep-95	1	0	0	0
17-sep-96	9	3	0	0
22-sep-97	0	0	0	4
29-sep-98	0	0	0	0
28-sep-99	0	0	0	0
16-nov-00	0	0	0	0
Dreissena polymorpha				
08-sep-94	11	28	95	11
07-sep-95	91	1113	225	18
17-sep-96	550	1500	124	15
22-sep-97	17	153	220	55
29-sep-98	69	175	250	158
28-sep-99	76	392	444	245
16-nov-00	215	190	437	520
Theodoxus fluviatilis				
08-sep-94	0	0	70	59
07-sep-95	0	0	250	90
17-sep-96	0	0	228	57
22-sep-97	0	0	159	17
29-sep-98	0	0	270	209
28-sep-99	23	0	472	0
16-nov-00	0	0	0	0

Figure 6.5 Biomass of different fish species in kg/ha in the Veluwemeer and Wolderwijd for the period 1990-2000



The biological parameters show that the ecological condition changed in the period 1980 to 2000: the algal concentrations decreased, the macrophyte coverage increased and the biomass of benthivorous fish decreased and the diversity of fish increased. This change indicates a reduction of the eutrophication of the lakes.

6.2 Physico-Chemical Elements

[Does the physical alteration have an impact upon the physico-chemical elements? Examples of such impacts are:

- low oxygen levels because of straightened and deepened channel;
- low temperature because of discharge of the dam, etc.

Describe the scale of the change in physico-chemical elements in the context of other pressures (e.g. pollution).]

The physico-chemical elements are described for the period 1980-2000 on the basis of the parameters transparency (figure 6.6) and nutrients values (total N, total P, PO_4, NH_4, NO_3) (figures 6.7 and 6.8).

Figure 6.6 Development of transparency (m) of lakes in the period 1980-2000

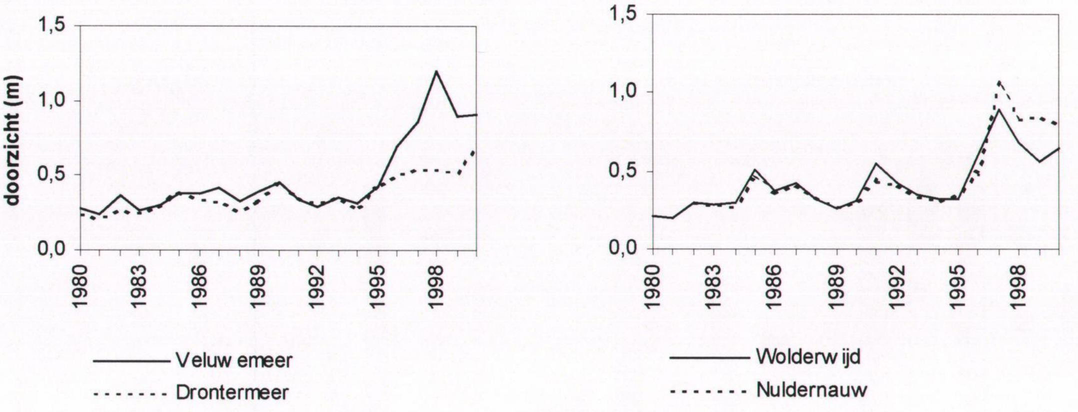


Figure 6.7 Development of summer average total P and total N concentrations of the Veluwemeer and Drontermeer in the period 1980-2000. The development of the values in for Wolderwijd and Nuldernauw is comparable

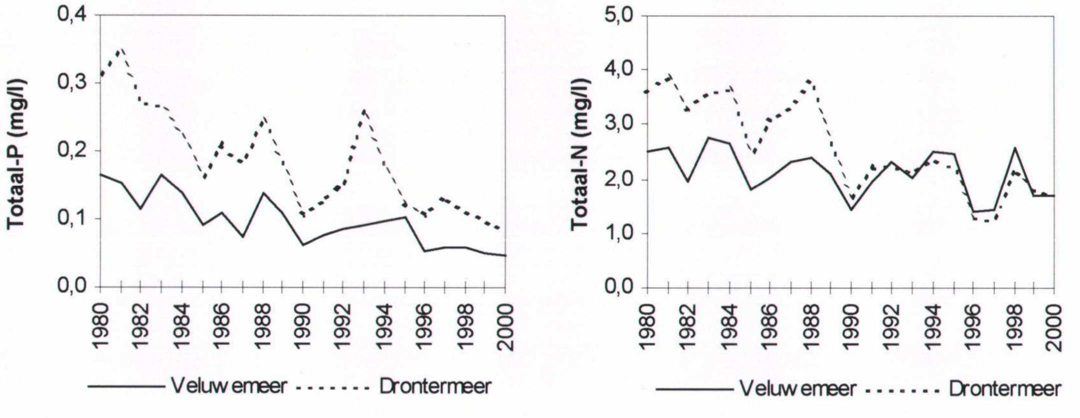
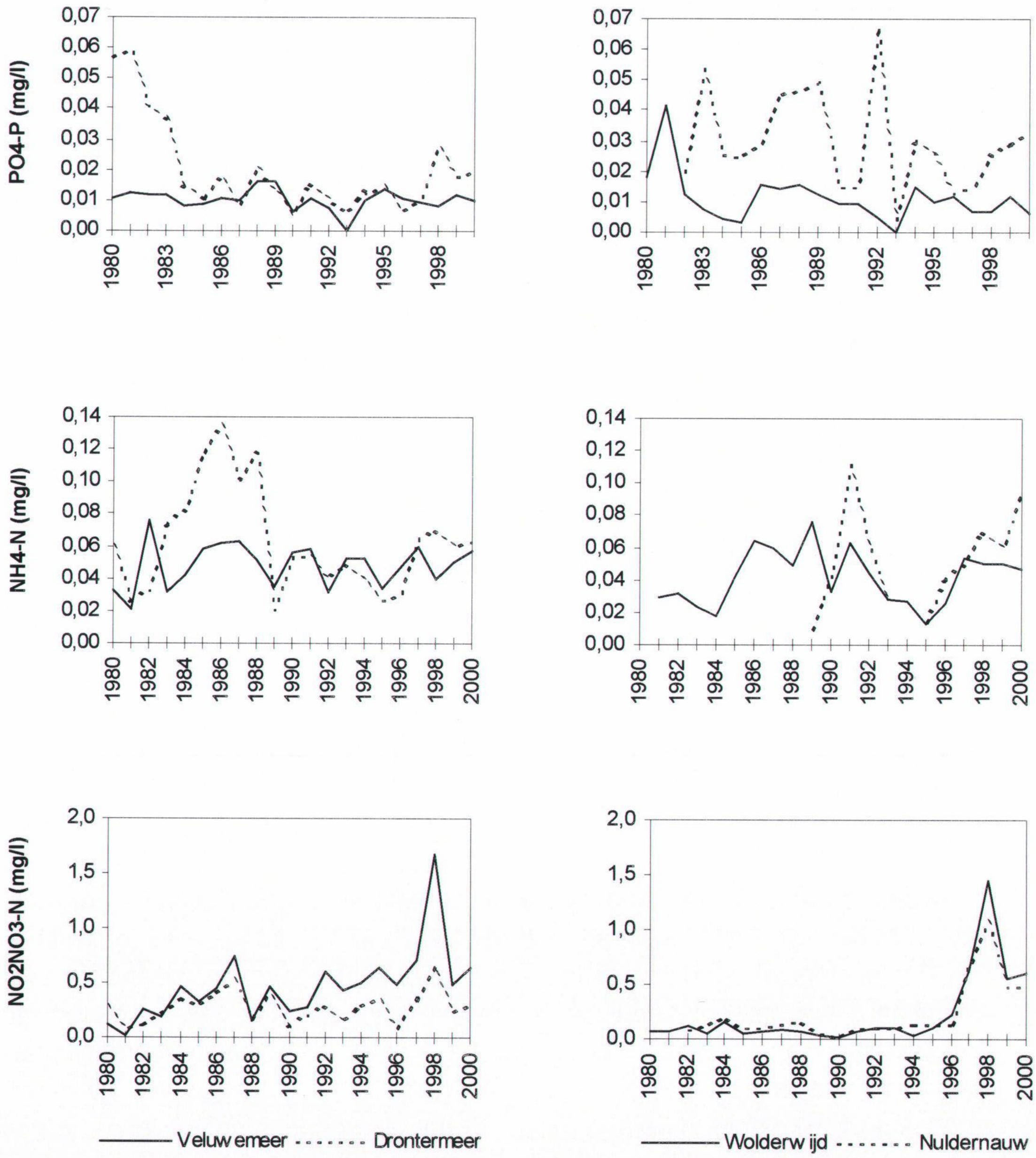


Figure 6.8 Summer average concentrations of PO_4, NH_4, and NO_3 in the lakes since 1980



The development of the transparency and nutrient values shows a reduction of the eutrophication as well. Transparency increases and total N and total P values decrease.

6.3 Definition of Current Ecological Status

[How have the physico-chemical and biological quality elements been brought together in order to define ecological status?

Has this been done using an existing classification or using expert judgement?

Is it considered a good approximation to the definition of good ecological status as defined by the directive, what are the weakness in the current definition?]

The physico-chemical and biological quality elements show a development from an eutrophic, turbid lake with no macrophytes and high biomasses of benthivorous preyfish to a mesotrophic, clear lake with macrophytes, less fish biomass and a higher fish diversity. This development is the result of the restoration measures, which have been taken in the beginning of 1980, namely the flushing of the eutrophic lakes with nutrient poor seepage water of the Flevopolder, reduction of the nutrient emissions from agriculture and sewage works and biomanipulation in lake Wolderwijd. The ecological quality of the banks at the Flevopolder side (new land) is low. No typical bank and marsh vegetation, such as reed, grows along the Veluwerandmeren, because of the fixation, the unnatural form of the banks (steep and 3 m deep) and the unnatural water level management. At the Veluwe side (old land) the banks are more in a slope and there exists some natural banks between the recreational facilities.

In order to define the current ecological status the present ecological condition has to be compared with the reference condition. The reference condition for the Veluwerandmeren will based on a theoretical reference of a shallow, clear mesotrophic lake with natural water levels and natural banks and marshes (see information in Box 2). The ecological condition of the water part of the lake approaches the reference condition. This present condition is however still unstable, as future developments (climate change, increase of population numbers) will probably increase the nutrient loads into the lakes till 2030. Additional restoration measures will be needed. The condition of the banks differs largely with the reference condition and the water level management is presently unnatural. On the basis of this analysis, we defined the current ecological status as moderate to good.

Box 2 Reference situation and history of the Veluwerandmeren

The history of the Veluwerandmeren is described by the following developments. The Veluwerandmeren were formerly part of the border of the estuary Zuiderzee. The construction of the Afsluitdike in 1932 changed the Zuiderzee into a large freshwater lake, the lake IJssel. The reclamation of the Flevopolder in the period 1950-1967 created the Veluwerandmeren in their present form as a series of connected shallow freshwater lakes. These lakes had and still have unnatural water level dynamics, which is linked to the water level management of the Lake IJssel and aims to reduce the risks of a flood. Directly after their creation, in the period 1958-1966, the lakes Veluwemeer and Drontermeer were in a mesotrophic condition with a high transparency and macrophytes growing. The lakes Nuldernauw and Wolderwijd were created in 1967 and had never a mesotrophic phase. In the period 1965-1980 the supply of nutrient poor seepage water decreased and diffuse agricultural pollution increased. The hydrology and water quality of the ground- and surface water in the catchment changed, because of the reclamation of the Flevopolder and drainage of the Veluwe area to optimise agricultural use. The lake eutrophicated and turned into a turbid lake without macophytes. The eutrophication of the lake has been tackled by a number of restoration measures (flushing the lake with calcium rich and nutrient poor seepage water, reduction of nutrient emissions, biomanipulation).

The reference condition of a lake should describe the undisturbed situation of the ecological type of the water category under consideration. The selection of a historical reference condition for the Veluwerandmeren is difficult, because:

- Different large hydromorphological changes have taken place leading to different water categories and ecological conditions. Depending of the selection of the condition long before the creation of the lakes (prior to the building of the Afsluitdike and Flevopolder), just before the creation (after the building of the Afsluitdike and before the reclamation of the Flevopolder) or just after the creation (after the building of the Afsluitdike and the reclamation of the Flevopolder) as reference condition, the reference can be an estuary or a freshwater lake. In this case study the freshwater lake has been selected as reference, as that was the condition just after creation of the Veluwerandmeren.
- The ecological condition changed continuously since the creation of the lakes: there were no really, stable ecological phases over longer periods (in contrast to the Loosdrecht lakes), as the clear period after creation lasted for only 8 years.
- The mesotrophic condition directly after the creation of the lakes was not undisturbed due to fortified banks and unnatural water level dynamics (in contrast to the oligotrophic (reference) phase after the creation of the Loosdrecht lakes).

Therefore, a theoretic reference condition will be selected for the Veluwerandmeren based on the theory of shallow lakes of Scheffer (1999): the condition of a mesotrophic, clear lake with macrophytes, natural banks and marshes and natural water level management.

6.4 Discussion and Conclusions

[Discuss lessons learned, any problems encountered and how they were overcome.]

Availability of assessment method

There is no adequate, quantitative assessment method based on 5 classes available for lakes, because too few clear and mesotrophic lakes exist at present in the Netherlands. Moreover, an assessment method, which meets all the requirements of the WFD, has not been developed yet. Therefore, the ecological status has been derived on the basis of expert-judgement and the difference between the present situation and the reference condition.

Selection of reference condition

The selection of the reference condition is a crucial step in the HMW designation, as it determines how much the present ecological status differs from the good ecological status. If this difference is very small, the water body should be designated natural.

The reference condition is defined as the undisturbed condition of an ecological type of a certain water category. This definition means that the reference condition should not be defined for an individual waterbody, but for an ecological type. Inside an ecoregion more water bodies of that ecological type should exist. In case former hydromorphological changes have led to a change of water category (change from estuary to fresh water lake due to building of dam), the reference condition should be based on the new water category (undisturbed freshwater lake). In that case the reference condition is not based on an undisturbed historical situation, but on a spatial or theoretical based reference.

However, if the present policy aims to "remove" the former hydromorphological changes and to restore the former water category, then the reference condition should be based on the former water category and the reference condition can be historically based (e.g. the reference condition of the present lake Haringvliet is an estuary, as it has already been decided that the Haringvliet dam will be opened in the future).

Application of this definition of the reference condition on lakes in the Netherlands leads to the observations that many lakes have different phases in history with a different level of hydromorphological impact and a different ecological condition of even a different water category. Therefore, it is not always very clear which phase is the undisturbed reference condition.

The selection of a certain phase as reference condition has consequences for the designation as natural or HMW. This is examplified by the Veluwerandmeren:

- Selection of condition prior to the creation of the Veluwerandmeren, namely the estuary Zuiderzee, as reference condition. However, the former hydromorphological change (building of the Afsluitdike) has led to a change in water category, namely the creation of a freshwater lake. Moreover, there are no present plans to remove the dam. Therefore, the reference condition will be based on an undisturbed freshwater lake and not on an undisturbed estuary.
- Selection of condition directly after the creation of the Veluwerandmeren as freshwater lakes as reference condition. However, the selection of a historical reference condition for the Veluwerandmeren is difficult, because:
  - the ecological condition changed continuously since the creation of the lakes: there were no really, stable ecological phases over longer periods (in contrast to the Loosdrecht lakes). The mesotrophic period with clear water lasted only ± 8 years;
  - the mesotrophic condition directly after the creation of the lakes was not undisturbed due to fortified banks and unnatural water level management (in contrast to the oligotrophic (reference) phase after the creation of Lake Loosdrecht).

Therefore, a theoretic reference condition has been selected for the Veluwerandmeren based on the theory of shallow lakes of Scheffer (1999): the condition of a mesotrophic, clear lake with macrophytes, natural banks and marshes and natural water level management.

7 Identification and Designation of Water Bodies as Heavily Modified (6 pages)

[Refer to HMW paper 7 ver 2].

7.1 Provisional identification of HMWB

On the basis of the physical alterations described in chapter 5 and the current ecological status described in chapter 6, the Veluwerandmeren are provisionally identified as Heavily Modified Waters.

7.2 Necessary Hydromorphological Changes to Achieve Good Ecological Status

[Here, the changes to the hydromorphological characteristics that would be (theoretically) necessary for achieving good ecological status should be assessed. Based on this, the effects these changes would have on the specified "Uses" shall be estimated and evaluated. [Article 4.3 (a). [1]

How have the required measures to achieve good ecological status been defined?

How has the impact of these measures on water uses been described?

How have "significant adverse effects" been defined (tools could range from simple descriptions of the consequences to economic analysis)? [2]

How have impacts upon the wider environment been assessed? This should include upstream/downstream effects, wider implications of mitigation measures - waste disposal or energy use.]

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[1] Article 4.3 (a) WFD. "*Member States may designate a body of surface water as artificial or heavily modified when: (a) the changes to the hydromorphological characteristics of that body which would be necessary for achieving good ecological status would have significant adverse effects on* [Uses]: *i) the wider environment, ii) navigation, including port facilities, or recreation, iii) activities for the purposes of which water is stored, such as drinking water supply, power generation, irrigation, iv) water regulation, flood protection, land drainage; or v) other equally important sustainable human development activities.*"

[2] Different methods for decision-making are:

- rule of thumb;
- expert assessment (incl. qualitative and quantitative data);
- direct consideration of "main" or dominant uses, involving political decision, public involvement and consensus among water users.

7.2.1 Required hydromorphological changes and required measures to achieve the Good Ecological Status

To achieve the good ecological status the present lake has to be changed into a mesotrophic, clear lake with macrophytes, natural banks and marshes and natural water level management. The following hydromorphological measures have to be taken:

- Changing the unnatural water level management into a natural water level management.
- Removal of the fortified banks and dikes and recreation beaches and creation of natural banks and marshes
- Restoration of the bottom of the lake by filling of the holes of 5 and 8m deep and the channel of an average depth of 3,5-4,5 m and stopping further mineral extraction.
- Replacing the artificial restoration measure of flushing seepage water through the lakes by nutrient poor seepage water from the stream in the Veluwe. Therefore, the drainage and diffuse agricultural pollution in the stream catchments of the Veluwe has to be reduced. This process of restoration of former ground- and surface water flows and –quality will probably take decades or even more time.

Next to hydromorphological changes the nutrient load has to be reduced to improve the water quality of the lake.

7.2.2 Impact on water uses and significant adverse effects

The required measures will have the following impact on water uses:

- Natural water level dynamics increase the risk of floods in the Flevopolder and the border of the Veluwe. This impacts the towns and the recreational facilities located at the border of the lakes.
- The change of the fixed banks into natural banks and marshes will negatively impact the recreation function of the Veluwerandmeren. Yachting basins, camping sites, landing stages and beaches will have to be removed to enable the creation of nature at the border of the lake.
- The filling of the shipping channel will negatively impact the transport function of the Veluwerandmeren. Shipping will be impossible in the shallow lake if the shipping channel is filled, which is a significant effect.
- Stopping mineral extraction has obviously significant effect on this water use.
- The reduction of the drainage and diffuse agricultural pollution in the stream catchments will impact the agricultural yield in these catchments, as the hydrology is less optimal for the agricultural function and the application of manure and fertilisers has to be reduced.

7.2.3 Impacts on the wider environment

In order to realize natural water levels in the Veluwerandmeren, the water level management of the Lake IJssel has to change to a natural water level management as well. This will lead to negative effects on related waterbodies, as the water quantity management of the whole of the northern part of the Netherlands depends on the water management of the Lake IJssel. Thus, 30% of the Netherlands will have to adapt their water management, as a consequence of restoration measures for the Veluwerandmeren and the Lake IJssel.

7.3 Assessment of Other Environmental Options

[This section should consist of two parts and the first part defines the scope of the second:

- The first part should refer to the identification and definition of the beneficial objectives served by the modified characteristics of the water body [see Art. 4.3 (b))] [3]
- The second part should consider other alternatives to the existing "water use"[again see Art. 4.3 (b)]. There are three aspects to the test of Art 4.3 (b). Alternatives to the existing "water use" must:
    - be technically feasible;
    - not be disproportionately costly;
    - reasonably achieve significantly better environmental option.

How have these issues been addressed?

How wide has the assessment of options been?]

7.3.1 Identification and definition of the beneficial objectives served by the modified characteristics of the water body

The beneficial objectives served by the modified characteristics of the water body are:

- Reduction of the risk of floods in the adjacent area and in the polder areas in the northern and western part of the Netherlands.
- Recreation.
- Shipping.
- Mineral extraction.
- Agriculture in the catchment.

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[3] Article 4.3 (b) WFD. *"Member States may designate [...] as heavily modified, when: (b) the beneficial objectives served by the [...] modified characteristics of the water body can not, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option."*

7.3.2 Alternatives to the existing "water use"

Alternatives can be distinguished at different levels:

- Displacement of a use from one waterbody or catchment to another. However, this alternative leads often to a displacement of the problem as the water uses, such as recreation, shippery, fishery, mineral extraction or agriculture, will cause negative impacts there. Thus, this is in many cases not really a good alternative.
- Performing use in an alternative way: drinking water can be extracted from surface water instead of ground water. Goods can be transported on the road or rail instead of on the water.
- Adaptation of uses: the use can be performed in an ecologically better way, such as biological farming for the agricultural function.

For the impacted uses we bring up the following alternatives and discuss their technical feasibility and costs.

1. Significant impact: increased risk of floods

Natural water dynamics in lake IJssel and the Veluwerandmeren will lead to an increased risk of floods in the adjacent land and the northern part of the Netherlands. A study called WIN (Water management in the wet heart (MinVenW, 2000)) has been carried out on the necessary adaptations to the water management in the Netherlands to reduce the risk of floods as a result of climate change and lowering of the soil. One of the alternatives in this study is the realization of (more) natural water levels. This study describes the economic and ecological effects of more natural water levels. Presently, a continuing study is realized (TWIJG, Toekomstig waterpeil IJsselmeergebied), which aims to come to a decision with regard to the future water level management.

2. Significant impact: recreation

For the creation of natural banks and marshes yacht basins, beaches, camping sites, landing stages and parking sites will have to be removed. Recreation is an important economic function in the region: at present there are 29 yacht-basins and 21 camping sites. Removal of recreational facilities will cause loss of labour and income leading to disproportinate costs. Moreover, the displacement of the yacht-bassins and yachts to another lake is not a real alternative, as the yacht-bassins will have the same negative effect on the other lakes as in the Veluwerandmeren.

Another argument against the removal of the recreation function for large scale nature development at the border is the present artifical morphology of the Veluwerandmeren. At the Flevopolder side the banks are steep and 3 m deep due to the reclamation of the polder inside the Lake IJssel. It is probably very expensive and therefore not effective to restore the banks at that side of the lake. However, at the Veluwe side the banks are more in a slope and development of more natural banks and marshes is more feasible. The water authorities and parties concerned (present water users) have developed together an integrated plan IVR (Inrichtingsplan Veluwerandmeren, IIVR, 2001) for the period 2002-2010 with 36 measures to improve the nature and recreation function of the lake. A characteristic of the realisation of IVR is the open plan process and the participation of all interested parties. This process took a long time, but the public support is high. Within the framework of this plan nature development is planned in the coming years at a number of locations along the lakes (see paragraph 9.2). One of the measures is to remove recreation for nature development. In the near future natural banks will be realized near Elburg, over 5 km at the Veluwe side of the lakes. Therefore, 95 owners of the present small recreational sites will have to be bought out. The costs of this measure have been estimated to be €5.800.000,--.

A possible alternative is the adaptation of recreation. For example, landing sites and yacht-basins can be adapted to enable more natural banks. Recreation can be limited at certain locations and at certain times. These alternatives, their feasibility and costs have not yet been studied. However, as recreation is an important function in the Veluwerandmeren, the costs could be high.

3. Significant impact: shipping

An alternative for the shipping of goods over the Veluwerandmeren is:

- The transport of goods on the road or rail. Transport of goods by ships is presently stimulated as an environmentally friendly alternative to transport on the road. Moreover, the roads in large parts of the Netherlands are distressed by traffic jams. Stopping transport by ships will even increase the transport intensity on the roads.
- The use of an another shipping route, for example the route in the neighbouring Lake IJssel. This alternative shipping route has negative impacts on the local industry in the Veluwerandmeren, as they can only use the shipping route in this lake. Another negative impact is the higher wind force in the Lake IJssel compared to the Veluwerandmeren. Due to this higher wind force the ships can not sail for a number of days in the year. The costs for the two negative impacts of the alternative shipping routes are not known (yet).

4. Significant impact: Mineral extraction

The need for minerals in the Netherlands increases the coming decades. The national government decided to extract a larger part of the minerals needed from the sediment of large fresh water bodies and the North Sea instead of extraction of minerals on the land. Till 2008 27 million tonnes of sand will have to be extracted in all the national waters (e.g. Rijkswateren: Veluwerandmeren, Lake IJssel, Haringvliet, Rhine, Meuse) (RDIJ, 2001a). For the period 2008-2025 it is estimated, that 2,5 million tonnes of sand/year is needed.

The reasons for the decision to extract more minerals from water than from land were:

- The resistance to extract minerals on the land increases because of the NIMBY effect (Not in my backyard).
- A number of longterm concessions have been made to the extraction industry in the past. Due to these concessions it is not technically feasible to stop the extraction of sand.
- An environmental impact assessment with regard to the location of the sand extraction has given the following priority with regard to environmental impacts: 1. North Sea 2. IJssellake area 3. On land.

The decision on extraction at different alternative locations has not been based on a cost study.

The hectares planned for mineral extraction in the Veluwerandmeren in the period 2000-2010 are described in table 5.2. With regard to the realization of the mineral extraction in the Veluwerandmeren it is tried to reduce the the environmental impact as much as possible. Therefore, the sand will be extracted in and near the shipping channel. The shipping channel will be broaden from 100m to 250m. This will however lead to a loss of area of macrophytes. For the parts in the lakes where mineral extraction has a significant impact on the ecology, the lost nature will be compensated as a consequence of the Bird and Habitat directive.

5. Significant impact: Agriculture

To restore the discharge of nutrient poor and clean water by the streams in the catchment of the Veluwe, the impact of agricultural drainage and pollution has to be reduced. Reduction of this impact can be realised by:

- Reduction of agriculture in the catchment or concentration of the agricultural function at locations which lead to lesser impact.
- Adaptation of the agricultural practice, for example by biological farming.

In the catchment of the Veluwe (and in all other higher level, sandy areas) a large scale spatial reconstruction is planned, in which the different functions in a catchment can be displaced. This reconstruction aims to reduce the negative impact on nature (e.g. restoration of hydrology, stream rehabilitation, reduction of desiccation problems) and to improve the agricultural viability (e.g. enlargement of economic viability, reduction of risks of infectious cattle diseases). This process of spatial reconstruction is under way and will take place over a long period. The economic and environmental costs and benefits of this process in the Veluwecatchment are not yet known.

7.4 Designation of Heavily Modified Water Bodies

[Describe how the designation process has been applied (include maps of designated water bodies). See HMW paper 3 ver 3, paper 7 ver 2.

What issues have determined the scope of the designation - compare different approaches (see HMW paper 7 ver 2). It is recommended that both designation options described in paper 7 ver 2 fig.7 & 8 are applied. This involves

1) the case where only the morphology of the water body is altered and it affects the ecological status or

2) the case where the hydromorphology is altered and it affects the ecological status.

The preferred options should then be identified.]

On the basis of the information described in paragraph 7.2 and 7.3 the Veluwerandmeren are designated as Heavily Modified Waters. There were no alternatives for the serious impacts or the costs of the alternatives were too high. With regard to the two approaches, which have to be applied, it is concluded that in the Veluwerandmeren both the morphology and the hydrology have been altered, leading to the status of HMW.

7.5 Discussion and Conclusions

[Discuss lessons learned, any problems encountered and how they were overcome.]

Definition of a natural water body

This discussion point relates to the question if a water body is designated as natural based on the condition of the biological parameters or based on a natural hydrological, morphological and ecological functioning. This question is relevant as many Dutch lakes have suffered from eutrophication. Oligotrophication of eutrophicated shallow lakes leads to a hysteresis effect, meaning that there are different threshold nutrient loadings for transitions between the clear and turbid equilibrium state (see explanation in Box 3). The nutrient loading has to be lower, if the lake is in a turbid, eutrophic state and has to switch to a clear, mesotrophic state than the nutrient loading, which causes the switch from clear to turbid. The hysteresis effect implies for the watermanagement that the nutrient concentrations have to be lower than the concentrations in a clear state prior to the switch to a turbid state. This is for many lakes an objective, which is difficult to achieve, as population densities and agricultural use in the catchment have multiplied since the 19th century. In order to reach a clear, mesotrophic lake numerous restoration measures have been taken, such as flushing with nutrient-poor seepage water, biomanipulation, digging of a silt catch in the bottom of the lake, dephosporization of the inlet water. These measures have been applied with different degrees of succes in the Netherlands, which shows that the equilibrium of most clear lakes is still unstable and depends on a number of artificial and sophisticated measures. Moreover, the hydromorphology of these lakes has often been changed drastically. For example, the Veluwerandmeren have achieved a moderate to good condition due to the flushing of the lakes with 50-100 million m^3/year calcium rich and nutrient poor seepage water from the Flevopolder. The question is if such systems can really be called natural waters, even if the biological and physico-chemical parameters have reached the good ecological status (as stated by the designation scheme of in the Terms of Reference). We recommend that a natural hydromorphological functioning should also be a criterium to designate a water as natural.

Alternatives for water uses

The question is what type of alternative should be described and at what scale should the alternatives be derived? We distinguish the following types:

- Displacement of uses from one lake to another: if uses, such as recreation, shippery, fishery, mineral extraction or agriculture, are moved to another lake or catchment this will lead to negative impacts there. Thus, this is in many cases not really a good alternative.
- Performing use in an alternative way: drinking water can be extracted from surface water instead of ground water. Goods can be transported on the road or rail instead of on the water. This type of alternative can be reasonable for many uses.
- Adaptation of uses: agriculture can be performed in an ecologically better way (biological farming), recreational yachts can be adapted by having an undeeper underside. Landing sites and yacht-basins can be adapted to more natural water levels. Recreation can be limited at certain locations and at certain times. This type of alternative can be reasonable for many uses.

We think that determining the costs for all negative impacts on uses of all water bodies in the Netherlands will be an enormous task. The question if it is necessary to describe all possible alternatives (and their costs and feasibility) in case one alternative has been identified, which is not technically feasible.

In this case study, many data are costs of alternatives are not available, as no studies have been performed yet. This complicates the designation of a water body as Heavily modified. In the Netherlands, an environmental impact assessment is obligatory for certain new activities. However, the EIA assesses the most environmental friendly way of performing or realizing the activity, but not so much the need for that activity as such (balancing the economic and environmental costs and benefits of the activity).

8 Definition of Maximum Ecological Potential (6 pages)

[Please discuss, to the extent possible at this stage, the maximum ecological potential (MEP) of the water body that is achievable (see WFD Annex II, 1.3 "Establishment of Type-Specific Reference Conditions for Surface Water Body Types", with reference to WFD Annex V, Table 1.2.5 "Definitions for Maximum, Good and Moderate Ecological Potential for Heavily Modified or Artificial Water Bodies" giving the normative definitions of ecological potential). Identify any areas requiring further clarification.]

8.1 Determining Maximum Ecological Potential

The MEP will be based on:

1. Theoretic knowledge: ecological functioning of a clear, mesotrophic and a turbid eutrophic lake (Scheffer 1999).
2. Historic data on the condition in 1957-1966 (shortly after the enclosure of the Veluwerandmeren) (Meijer et al., 1999).
3. Research on the development of the Veluwerandmeren from the past till now and the expected developments in the future (Meijer et al., 1999).

Ad 1. The theoretic knowledge on the ecological functioning of a clear, mesotrophic and a turbid eutrophic lake is explained in Box 3.

Box 3 The theory on eutrophication of shallow lakes (Scheffer, 1999)

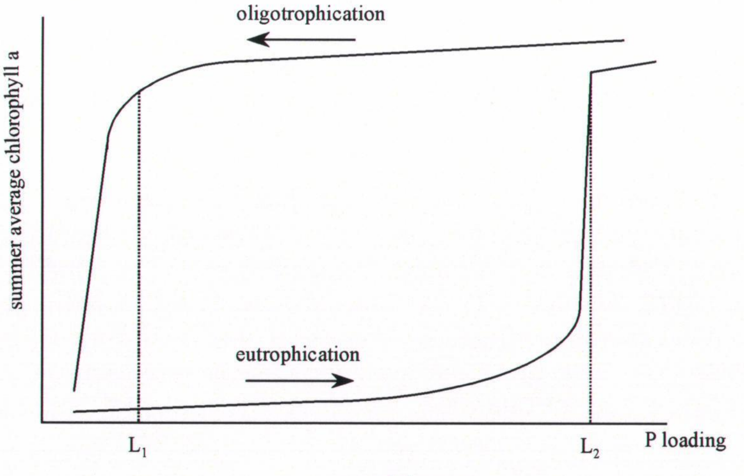
This section summarises the ecological theory of eutrophication of shallow lakes. The predominant effect of increased nutrient loads into lakes is eutrophication, which involves a cascade of direct and indirect effects (Janse & Van Liere, 1995, Klinge et al., 1995, Hosper 1997, Scheffer 1998). This cascade of effects can lead one of the two equilibrium states of shallow lakes ; a turbid, phytoplankton dominated lake in a meso- or eutrophic state. The other equilibrium state is a clear and macrophyte dominated lake, which is in a meso- or oligotrophic state. The balance between these two states depends on two forces (Klinge et al., 1995):
- A bottom up force determined by producers, such as algae, zooplankton and plankti- and benthivorous fish. The potential biomass at different trophic levels, including the production of preyfish, is determined by the nutrient richness of the system.
- A top down force determined by consumers, such as predatory fish. The actual biomass and community structure are considered to depend mainly on consumer-control.

In shallow lakes (mean depth 1-4 m) high nutrient levels can lead to increased primary production of phytoplankton. The higher algal biomass increases the turbidity of the water and increases oxygen demand of the sediment due to decomposing algae. The turbidity can lead to a decline of submerged macrophytes. Macrophytes have clearing effects on the water, because they 1) provide refuge to grazing zooplankton; 2) protect the sediment from resuspension and 3) provide a habitat and hiding place for predatory fish, feeding on plankti- and benthivore fish.

Turbid lakes devoid of vegetation have few predatory fish and have a high abundance of plankti- and benthivorous fish. Abundant planktivore fish control the zooplankton, resulting in low grazing of algae. Benthivore fish cause resuspension of sediment, increasing both turbidity and phosphate release from the sediment.
The biomass of predatory fish depends heavily on the morphometric conditions of the lake. These morphometric conditions determine the availability of suitable habitat for the predatory fish, such as submerged vegetation and emergent plants. The area of suitable habitat determines the maximum biomass of predatory fish and thereby the top down force of preyfish consumption. This area of suitable habitat has declined in the Netherlands due to a number of causes. Next to eutrophication, leading to turbidity and the disappearance of macrophytes, the application of artificial (high in summer and low in winter) or stable waterlevels, embankment of natural banks and floodplains have lead to a reduction of submerged and emergent vegetation.

The transition between these states is characterised by a so-called hysteresis effect (figure 8.1). The hysteresis effect implies that there are different threshold nutrient loadings for transitions between the two equilibrium states, namely the critical nutrient loading for transition is lower, if the lake is in an eutrophic state than in a meso or oligotrophic state. This is illustrated by L1 and L2 in figure 3. Hysteresis is caused by a number of physico-chemical (e.g. nutrient release from sediment, wind-induced resuspension of sediment in plant free lake) and ecological processes (e.g. increase of turbidity and nutrient release due to sediment perturbation by benthivore fish, dominance of non-consumable blue green algae at high turbidity) (Scheffer 1998, Hosper 1997). These processes cause a certain resistance to change with increasing and decreasing nutrient loading untill the loading is high or low enough to cause a switch to another equilibrium state (Hosper 1997). The difference in threshold nutrient loading between oligotrophication and eutrophication depends on lake characteristics and the application of restoration measures. Lake characteristics are the depth of the lake, its retention time and sediment characteristics. Restoration measures can change the lake characteristics (e.g. flushing of lakes, lowering water level) or suppress the hysteresis effect (e.g. removing white fish and introducing predatory fish, dredging sediment).

Figure 8.1. A graphic representation of the hysteresis phenomenon in a lake, in which the eutrophication process has a different relationship of chlorophyll versus phosphate loading compared to the oligotrophication process (Figure adapted from Janse & Van Liere, 1995, Hosper 1997, Scheffer 1998)



Ad 2. Historic data on the mesotrophic, clear condition in the period 1957-1966 (shortly after the enclosure of the Veluwerandmeren).

There are only few data available about this period. They are described in table 8.1.

Table 8.1 Historic data on the mesotrophic, clear condition in the period 1957-1966. (Source: Meijer et al, 1999)

Data	Tot P (mgP/l)	Cover with Chara
1957	0,13	
1965	0,14-0,17	
1967	0,17	
1958-1966		45%

Ad 3. Research on the development of the Veluwerandmeren from the past till now and the expected developments in the future-

On the basis of research on the development of water quality and ecology of the Veluwerandmeren since their creation the preconditions for realisation of the target situation has been described (Meijer et al., 1999). This target situation is a mesotrophic, shallow freshwater lake with clear water and macrophytes. These preconditions describe the MEP and are listed in table 8.2. Next to the characteristics of the water itself, the banks and water levels dynamics should have a more natural character.

Table 8.2 Preconditions for the MEP: a mesotrophic, shallow freshwater lake with clear water and macrophytes with natural banks and natural water levels (based on Meijer et al., 1999). As a comparison the values of the undesired, turbid situation are also given

Parameter	**Target situation summer period: mesotrophic and clear**	**Undesired situation summer period: eutrophic and turbid**
Total P (mgP/l)	0,04-0,06	>0,1
Total N (mgN/l)	<1,35	> 2,2
Chlorophyll a (µg/l)	5-10	> 50
Transparancy (m)	> 1,0	< 0,4
Algal species	No dominance of Planktothrix	Dominance of Planktothrix
Zooplankton	Potential grazing pressure during summer > 0,4	Potential grazing pressure < 0,4
Macro-invertebrates	> 300 Dreissena mussel individuals/m^2 on the Chara free parts of the sediment and presence of macro-invertebrates associated to macrophytes on the parts with Chara	Absence of population on the sediment
Macrophytes in water	> 60% cover of Chara	No Chara
Macrophytes on the border of the Veluweside	Natural banks and marshes with typical vegetation (e.g. Reed)	Absent
Fish	Piscivorous fish/planktivorous fish = 1 No dominance of bream	Dominance of bream
Birds	Maximum capacity of system (50 birds/ha with macrophytes)	No herbivorous birds

8.2 Measures for Achieving MEP

[Description of measures that would theoretically have to be undertaken in order to allow comparison with the closest comparable water body.

How has the appropriate level of mitigation been defined?]

The MEP is a mesotrophic, shallow freshwater lake with clear water with macrophytes bordered by natural banks and marshes. The Veluwerandmeren are presently mesotrophic, clear lakes dominated by Characeae. But the ecological quality of the banks is low.

The clear water equilibrium is however still unstable, as future developments (climate change, increase of population numbers) will probably increase the nutrient loads (P loading + 20%, N loading – 13 %) and the retention time (-13%) of the lakes till 2030.

Additional restoration measures will be needed to stabilise the present condition of the water, such as the improvement of the sewage works at Elburg and Harderwijk in order to reduce the nutrient load coming from the waste water

In addition the banks of the Veluweside of the lakes should have a higher ecological value by creating natural banks and marshes. Measures needed are the removal of bank fixations, the planning and maintenance of the natural banks and marshes.

8.3 Comparison with Comparable Water Body

[Describe how a comparable water body was identified - what selection strategy was defined based upon typological (physico-chemical and hydromorphological) parameters. Was biological data used as part of the selection process?

Was the ecological condition of the water body comparable to the HMWB?]

There is no spatially based comparable water body, because the Veluwerandmeren are too specific due to their creation by the reclamation of the Flevopolder.

8.4 Discussion and Conclusions

[Discuss lessons learned, any problems encountered and how they were overcome.]

There is a risk that the measures needed to reach the objectives of the WFD will conflict with designation of the Veluwerandmeren to the Bird directive. Certain unnatural characteristics of the lake stimulate the presence of birds. The unnatural water levels of the Veluwerandmeren, especially the low water levels in winter, lead to a higher density of birds, as they can more easily forage in undeep water. Secondly, eutrophication leads to a high biomass of fish, which is an important source of food for the birds. So, reduction of the nutrient load and the realisation of more natural water level dynamics to reach the objectives of the WFD will probably lead to a decrease of the diversity and abundance of birds, which is not allowed according to the Bird Directive. We would like to have more clarity on which of the two directives should be leading in this case.

9 Definition of Good Ecological Potential (6 pages)

9.1 Determination of Good Ecological Potential

[Describe the ecological potential to be achieved in the medium and long term. Refer to paper 3 ver 3, nr.3.

How has slight deviation from the MEP been defined?

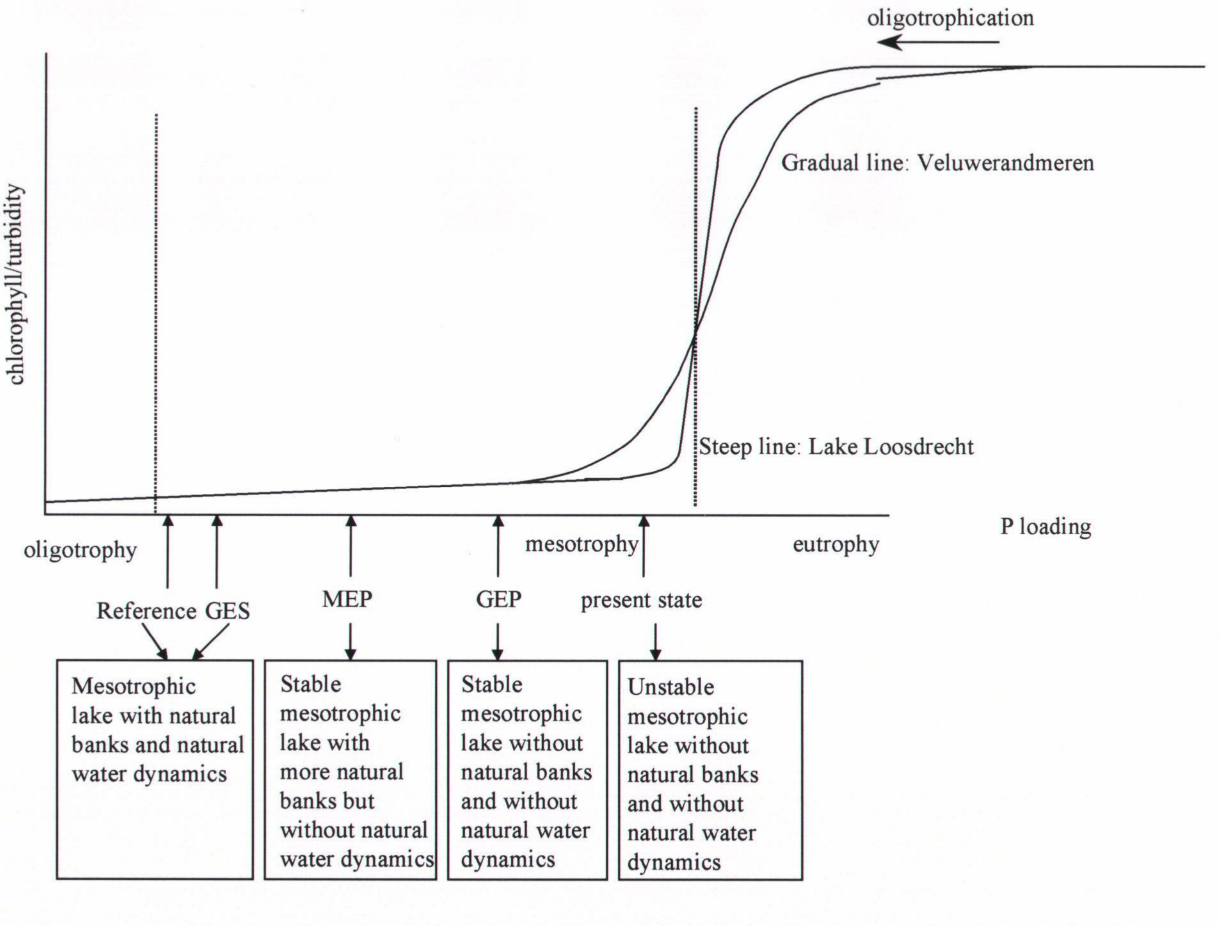
Has the definition of good ecological potential been influenced by the practicability of the mitigation measures?]

According to its definition the GEP should deviate slightly from the MEP, which means that the values of the biological, hydromorphological and physico-chemical parameters of the GEP are somewhat lower (or higher) than the values of the MEP. This is however difficult to implement to shallow lakes. The relation between abiotic parameters and ecological functioning of shallow lakes is not linear, but shows two equilibrium states (clear and turbid), which can switch depending on the nutrient loading, restoration measures, the area of macrophytes and helophytes etc. The MEP, described in table 8.1, leads to a clear equilibrium in the Veluwerandmeren. Abiotic values, which are somewhat higher or lower than the MEP could however lead to a turbid state of the lake, in which the biological parameters deviate largely from the MEP. The acceptable difference between MEP and GEP depends per lake and has to be studied more in detail (see explanation in Box 4). Therefore, it is decided to define the same values of the biological, hydromorphological and physico-chemical parameters for the MEP and the GEP. The only difference between MEP and GEP will be the state of the banks. The MEP includes the development of natural banks and marshes. In the GEP the banks remain fixed as in the present state. This definition has been influenced by the practicability of the mitigation measures: the removal of natural banks has a negative impact on the recreation function, which is the main use of the lake.

Box 4. The equilibrium between meso- and eutrophic

As explained in Box 3 the difference in threshold nutrient loading between a clear, mesotrophic and a turbid, eutrophic lake depends on the lake characteristics and the application of restoration measures. Also the form of the switch from turbid to clear and the related nutrient loading differs per lake and depends for example on the existence of seed banks. A seed bank allows a quicker restoration of the macrophyte growth and a quicker switch from turbid to clear in case the threshold nutrient loading has been reached. In other words, the steepness of the line, representing the switch of equilibrium can be higher or lower. The steepness of the line defines the acceptable difference in nutrient loading between the GEP and MEP. If the steepness is lower, the relation between turbidity and nutrient loading has a more linear character and the difference between GEP and MEP can be higher than with a very steep line. In figure 9.1 below the "switch lines" are represented for Lake Loosdrecht and the Veluwerandmeren. The steepness of the switch line of Lake Loosdrecht is higher than the Veluwerandmeren, because Lake Loosdrecht has still the seed bank of the mesotrophic phase, whereas the Veluwerandmeren had no seed bank due to its origin as estuary.

Figure 9.1 Relation between nutrient loading and turbidity/chlorophyll. The reference condition, GES, GEP and MEP of the Veluwerandmeren are also represented



9.2 Identification of Measures for Protecting and Enhancing the Ecological Quality

[In this chapter, please describe the options for measures designed to protect and if necessary enhance the ecological quality of the water body. WFD Article 11 requires the establishment of a programme of measures, distinguishing between basic and supplementary measures.]

Future measures and actions for the Veluwerandmeren are based on the IVR plan (Inrichtingsplan Veluwemeren, 2001). The IVR is an integrated plan made by the authorities and parties concerned (present water users) in an open plan process. For the period 2002-2010 a total of 36 measures are listed to improve the nature and recreation function of the lake. The following measures aim at an improvement of the ecological function of the lake:

- Realisation of a research on natural water level dynamics and the economic and ecological costs and benefits.
- Improvement of the sewage works at Elburg and Harderwijk in order to reduce the nutrient load coming from the waste water.
- Creation of collection point for waste water from yachts.
- Development of reed area near the town Elburg as habitat for birds, amphibians and fish in the Drontermeer.
- Limitation of recreation activities in important breeding area for birds in the Veluwemeer.
- Marsh development in Nuldernauw to improve the migration possibilities of fish, amphibians and mammals.
- Construction of fish passage for eels at the Roggebotssluice to improve migration into the Veluwemeer.
- Marsh development in Wolderwijd (southern of Harderwijk).
- Realization of 5 km natural banks near Elburg by displacement of recreational activities and houses.

9.2.1 Basic Measures

[See Art. 11.3, which also refers to Art.10 and part A of Annex VI.

How has the link between the good ecological potential and any possible measures been determined?]

9.2.2 Supplementary Measures

[See Art. 11.4 and part B of Annex VI.

Can supplementary measures contribute to delivering environmental improvement?]

9.3 Discussion and Conclusions

[Discuss lessons learned, any problems encountered and how they were overcome.]

The abovementioned measures have not been distinguished as basic and supplementary measures, as the difference between the two types of measures is unclear. Comparison of the definition of both type of measures in the Water Framework Directive in article 11, part 3 and 4, revealed no clear difference, as:

- they both aim to achieve the ecological objectives described in article 4;
- the definition of the basic measure (article 11, part 3) focuses on the objective of a measure. The definition of the supplementary measure (article 11, part 4) describes the instruments to be used in a non-exclusive list of supplementary measures in Annex VI, part B. As all possible types of instruments (legislative, economic etc.) are listed, all possible measures will fall under one of the instruments.

PART III

10 Conclusions, Options and Recommendations (5 pages)

10.1 Conclusions

[Highlight the "lessons learned" concerning the treatment of heavily modified water bodies in the Water Framework Directive. Discuss applicability of results in other river basins in the same ecoregion (of your country).]

10.2 Options and Recommendations

[Recommendations should be of general nature and pertain to the objectives of the European project on heavily modified water bodies. In particular, items for consideration in the harmonised and consistent implementation of the Water Framework Directive should be discussed. Highlight any clarifications of Annexes or guidelines that may be needed or helpful.]

10.3 Discussion points of the Dutch HMW case Veluwerandmeren

The lessons learned and the recommendations have been combined in a number of discussion points. Some of these points do not relate only to the lake in this case study the Veluwerandmeren, but apply also to the other Dutch cases on Lake Loosdrecht or on shallow lakes in the Netherlands in general.

1. Difference between artificial and heavily modified

Numerous lakes in the Netherlands are created due to large human influence. The difference between an artifical or a heavily modified water is therefore not always clear. The Veluwerandmeren were formerly the border of the estuarium Zuiderzee. The reclamation of the Flevopolder created the Veluwerandmeren in its present condition as freshwater lakes. We defined the difference between artificial and heavily modified in the following way:

- In case the water has been dug by humans, the waterbody is artificial (e.g. canals, pools for swimming, pools resulting from mineral extraction). The question remains then to hat extent the water body has to be dug (partially or completely).
- In case human activity has made the preconditions for creation , but the water body has not dug by humans, the waterbody is heavily modified.

In case the criterium of digging of the waterbody still does not lead to a clear difference, a second criterium could be applied: the existance of a natural reference condition on the basis of a comparable waterbody. If a natural reference condition applies to that water body, it is HMW. In case there exists no natural reference condition for that water body, as it differs too much from natural waters, the water is artificial. On the basis of these two criteria, the Veluwerandmeren are designated as heavily modified and not artificial.

We would appreciate if the future guidance will provide clear criteria for determining the difference between artificial and heavily modified.

2. Selection of reference condition

The selection of the reference condition is a crucial step in the HMW designation, as it determines how much the present ecological status differs from the good ecological status. If this difference is very small, the water body should be designated natural.

The reference condition is defined as the undisturbed condition of an ecological type of a certain water category. This definition means that the reference condition should not be defined for an individual waterbody, but for an ecological type. Inside an ecoregion more water bodies of that ecological type should exist. In case former hydromorphological changes have led to a change of water category (change from estuary to fresh water lake due to building of dam), the reference condition should be based on the new water category (undisturbed freshwater lake). This means that the reference condition is not based on an undisturbed historical situation, but on a spatial or theoretical based reference.

However, if the present policy aims to "remove" the former hydromorphological changes and to restore the former water category, then the reference condition should be based on the former water category and the reference condition can be historically based (e.g. the reference condition of the present lake Haringvliet is an estuary, as it has already been decided that the Haringvliet dam will be opened in the future).

Application of this definition of the reference condition on lakes in the Netherlands leads to the observations that many lakes have different phases in history with a different level of hydromorphological impact and a different ecological condition of even a different water category. Therefore, it is not always very clear which phase is the undisturbed reference condition. The selection of a certain phase as reference condition has consequences for the designation as natural or HMW. This is examplified by the Veluwerandmeren:

- Selection of condition prior to the creation of the Veluwerandmeren, namely the estuary Zuiderzee, as reference condition. However, the former hydromorphological change (building of the Afsluitdike) has led to a change in water category, namely the creation of a freshwater lake. Moreover, there are no present plans to remove the dam. Therefore, the reference condition will be based on an undisturbed freshwater lake and not on an undisturbed estuary.
- Selection of condition directly after the creation of the Veluwerandmeren as freshwater lakes as reference condition. However, the selection of a historical reference condition for the Veluwerandmeren is difficult, because:
    - the ecological condition changed continuously since the creation of the lakes: there were no really, stable ecological phases over longer periods (in contrast to the Loosdrecht lakes). The mesotrophic period with clear water lasted only ± 8 years;

- the mesotrophic condition directly after the creation of the lakes was not undisturbed due to fortified banks and unnatural water level management (in contrast to the oligotrophic (reference) phase after the creation of Lake Loosdrecht).

Therefore, a theoretic reference condition will be selected for the Veluwerandmeren based on the theory of shallow lakes of Scheffer (1999): the condition of a mesotrophic, clear lake with macrophytes, natural banks and marshes and natural water level management.

3. Effect of designation as HMW or natural on the present uses of the waterbody

The Veluwerandmeren are important for recreation and have a number of additional uses, such as fishery and mineral extraction. The societal acceptance of limitations to these uses is low, as these functions provide employment and income in the region. The question is to what extent the designation as natural or HMW affects present uses of the waterbodies? The WFD states that a deterioration of the ecological status is not allowed and the MEP should represent the maximum ecological potential of the water. Uses can only profit from the designation in case the uses take advantage from the hydromorphological changes leading to the designation. Certain uses, such as fishery, have no or do not profit from the hydromorphological impacts. The designation as HMW or natural should make no difference for that use. Other uses, such as recreation, profit from fixed banks and take advantage from the designation as HMW.

4. Selection of the correct scale of waterbodies

The selection of the correct scale of waterbodies is unclear. In both case studies on Dutch lakes there are a number of connected or neighboring lakes, which have a comparable hydrology and pressures and impacts, but the ecology is not completely identical in the different lakes. The question is: should the lakes be selected as different water bodies or as one water body?

5. Definition of a natural water body

This discussion point relates to the question if a water body is designated as natural based on the state of the biological parameters or based on a natural hydrological, morphological and ecological functioning. This question is relevant as many Dutch lakes have suffered from eutrophication. Oligotrophication of eutrophicated shallow lakes leads to a hysteresis effect, meaning that there are different threshold nutrient loadings for transitions between the clear and turbid equilibrium state: the nutrient loading has to be lower, if the lake is in an turbid, eutrophic state and has to switch to a clear, mesotrophic state than the nutrient loading, which causes the switch from clear to turbid. The hysteresis effect implies for the watermanagement that the nutrient concentrations have to be lower than the concentrations in a clear state prior to the switch to a turbid state. This is for many lakes a difficult task, as population densities and agricultural use in the catchment have multiplied since the 19th century. In order to reach a clear, mesotrophic lake numerous restoration measures have been taken, such as flushing with nutrient-poor seepage water, biomanipulation, digging of a silt catch in the bottom of the lake, dephosporization of the inlet water. These measures have been applied with different degrees of succes in the Netherlands, which shows that the equilibrium of most clear lakes is still unstable and depends on a number of artificial and sophisticated measures. Moreover, the hydromorphology of these lakes has often been changed drastically. For example, the Veluwerandmeren have achieved a moderate to good condition due to the flushing of the lakes with 50-100 million m^3/year calcium rich and nutrient poor seepage water from the Flevopolder. The question is if such systems can really be called natural waters, even if the biological and physico-chemical parameters have reached the good ecological status (as stated by the designation scheme of in the Terms of Reference). We recommend that a natural hydromorphological functioning should also be a criterium to designate a water as natural.

6. Application of time derogation for lakes

The ecological effect of restoration measures in lakes takes often a long time. The reason can be the high retention time of certain lakes or the hysteresis effect due to the internal loading of the lakes from the sediment. Possibly the time derogation will be needed (Article 4, part 4) stating that deadlines may be extended, because the natural conditions do not allow a timely improvement in the status of the water body.

7. Effect of ground water hydrology on ecology lakes

Both cases on lakes show that the ecological condition of the lakes has changed due to changes in the groundwater hydrology leading to different patterns of seepage and infiltration. These changes in groundwater hydrology can be caused by alterations outside the catchment. For example, the reclamation of the Flevopolder, lying outside the catchment of Lake Loosdrecht, has affected the seepage stream into Lake Loosdrecht and the Veluwelakes. This observation has the following consequences:

- The measures needed to restore the former groundwater hydrology pattern have to be taken outside the catchment of the river basin management plan (borders are based on surface water hydrology). The water managers of the lake have present in most cases no authority to take measures in the area outside the catchment. However, the WFD states that measures in a catchment may not have a negative impact on other catchments.
- Groundwater measures should not only to be assessed on their impact on the groundwater quantity and quality, but also on their impact on the surface water bodies.
- Certain historic changes are irreparable, as original groundwater flows have been changed and can not come back in their original form.

8. Alternatives for water uses

The question is what type of alternative should be described and at what scale should the alternatives be derived? We distinguish the following types:

- Displacement of uses from one lake to another: if uses, such as recreation, shippery, fishery, mineral extraction or agriculture, are moved to another lake or catchment this will lead to negative impacts there. Thus, this is in many cases not really a good alternative.
- Performing use in an alternative way: drinking water can be extracted from surface water instead of ground water. Goods can be transported on the road or rail instead of on the water. This type of alternative can be reasonable for many uses.
- Adaptation of uses: agriculture can be performed in an ecologically better way (biological farming), recreational yachts can be adapted by having an undeeper underside. Landing sites and yacht-basins can be adapted to more natural water levels. Recreation can be limited at certain locations and at certain times. This type of alternative can be reasonable for many uses.

We think that determining the costs for all negative impacts on uses of all water bodies in the Netherlands will be an enormous task. In the case study many data are costs of alternatives are not available, as no relevant studies have been performed. In the Netherlands, an environmental impact assessment is obligatory for certain new activities. However, the EIA assesses the most environmental friendly way of performing or realising the activity, but not so much the need for that activity as such (balancing the economic and environmental costs and benefits of the activity).

9. Water Framework Directive versus Birds Directive

There is a risk that the measures needed to reach the objectives of the WFD will conflict with designation of the Veluwerandmeren to the Bird directive. Certain unnatural characteristics of the lake stimulate the presence of birds. The unnatural water levels of the Veluwerandmeren, especially the low water levels in winter, lead to a higher density of birds, as they can more easily forage in undeep water. Secondly, eutrophication leads to a high biomass of fish, which is an important source of food for the birds. So, reduction of the nutrient load and the realisation of more natural water level dynamics to reach the objectives of the WFD will probably lead to a decrease of the diversity and abundance of birds, which is not allowed according to the Bird Directive. We would like to have more clarity on which of the two directives should be leading in this case.

10. Definition of GEP on the basis of MEP

According to its definition the GEP should deviate slightly from the MEP, which means that the values of the biological, hydromorphological and physico-chemical parameters of the GEP are somewhat lower (or higher) than the values of the MEP. This is however difficult to implement to shallow lakes.

The relation between abiotic parameters and ecological functioning of shallow lakes is not linear, but shows two equilibrium states (clear and turbid), which can switch depending on the nutrient loading, restoration measures, the area of macrophytes and helophytes etc. The MEP leads to a clear equilibrium in the Veluwerandmeren. Abiotic values, which are somewhat higher or lower than the MEP could however lead to a turbid state of the lake, in which the biological parameters deviate largely from the MEP. Therefore, it has been decided for both cases on Dutch lakes to define for the GEP the same values as for the MEP of the parameters applying to the water body. The difference between MEP and GEP is the ecological condition of the banks; in the MEP the banks are natural, whereas in the GEP they remain fixed.

11. Difference between basic and supplementary measures

The measures to achieve the GEP have not been distinguished as basic and supplementary measures, as the difference between the two types of measures is unclear. Comparison of the definition of both type of measures in the Water Framework Directive in article 11, part 3 and 4, revealed no clear difference, as:

- They both aim to achieve the ecological objectives described in article 4.
- The definition of the basic measure (article 11, part 3) focuses on the objective of a measure. The definition of the supplementary measure (article 11, part 4) describes the instruments to be used in a non-exclusive list of supplementary measures in Annex VI, part B. As all possible type of instruments (legislative, economic etc.) are listed, all possible measures will fall under one of the instruments.

We recommend providing clearer definitions and criteria for both type of measures.

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