Report on Workshop setting nutrient standards

International workshop, Zandvoort 11-12 October 2007

Centre for Water Management

2 November 2007
Final Report
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HASKONING NEDERLAND B.V.
SPATIAL DEVELOPMENT

Boschveldweg 21
P.O. Box 525
's-Hertogenbosch 5201 AM
The Netherlands
+31 (0)73 687 41 11 Telephone
+31 (0)73 612 07 76 Fax
info@den-bosch.royalhaskoning.com E-mail
www.royalhaskoning.com Internet
Arnhem 09122561 CoC

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1 INTRODUCTION

On October the 11th and 12th an international workshop on the subject of determining the standards for nutrient levels for the Water Framework Directive (WFD) was organized in Zandvoort, the Netherlands. 60 participants from 13 EU member states discussed the practice of deriving nutrient standard for the WFD. On the first day there were 3 separate sessions with presentations and discussion:

- coastal waters;
- rivers;
- lakes.

The second day started with a summary of the discussion and conclusions per session. This was followed by a broader discussion on the deriving of nutrient standards. After the discussion 4 presentations gave more insight in upstream-downstream relations, defining measures (including cost-effectiveness) and setting nutrient standards in heavily modified and artificial water bodies.

This report gives a summary of the discussion and conclusions for each session and ends with the general remarks and conclusions from day 2. The programme of the workshop is presented in annex 1. The participants are presented in annex 2.
All presentations can be found at:
http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/standards_zandvoort

2 COASTAL WATERS SESSION

By Theo Prins (Centre for Water Management, the Netherlands)

The session on coastal waters had participants from 6 countries (England, Portugal, France, Belgium, Netherlands and Germany). The session started with a short introduction by Theo Prins on the background of the workshop and the objectives of the meeting. Uwe Brockmann (University of Hamburg, Germany) presented the results of studies to derive natural background concentrations of nutrients that are used in Germany to establish reference conditions and thresholds. Hanneke Baretta-Bekker (Centre for Water Management, The Netherlands) presented the results of an OSPAR workshop on models for the North Sea and some work on transboundary nutrient transport. Priscila Goela (Institute of Marine research, Portugal) gave an overview of work on nutrients in coastal lagoons in Portugal. Gert van Hoey (Marine Environment Service, Belgium) showed the results of the work on development of nutrient standards for Belgian coastal waters. Anne Daniel (Ifremer, France) gave an introduction on the approach how France is developing nutrient standards. Finally Theo Prins (Centre for Water Management, The Netherlands) presented the methods and results of the work to set nutrient standards in the Netherlands.

The afternoon session started with a summary of the state of progress. While 3 countries are finalizing the work on nutrient standards (Belgium, Netherlands and Germany), the work is still in progress in many other countries. There are many differences between countries in the way nutrient standards are derived. Some are based on dose-effect relations derived from field data, others are using models, in some cases the OSPAR approach of deriving standards from natural background concentrations is used. Which nutrients and in what form are addressed also differs (DIN, DIP, total-N, total-P). Some of the differences are a logical consequence of different ecological conditions (e.g. Mediterranean region vs Atlantic region), but some are the result of different approaches and assumptions.

In the discussion several points were raised.

Relation between nutrients and good ecological status
Coastal and transitional waters are complex systems, with many abiotic and biological factors that influence the biological quality elements. In addition, there are many other human pressures besides eutrophication. There may be interactions between biological quality elements (e.g. phytoplankton and macrophytes, macrobenthos and phytoplankton) that affect the relation between nutrients and the quality elements. Responses in transitional waters may differ from coastal waters, for example due to turbidity, residence times etc. As a consequence, there is uncertainty in the cause-effect relationship between nutrients and the value of the biological quality elements. Harmonization in the way to deal with this uncertainty when setting standards for physico-chemical elements would be welcome.

Comparison of WFD with other policies
WFD only deals with a small part of the marine environment. In the future EMS will cover the major part of marine waters, so a consistency in policies is necessary. The OSPAR approach is different from the WFD, in the sense that OSPAR thresholds are derived from natural background values. These threshold values are not necessarily the same as the Good/Moderate boundaries in WFD.

Exchange of results
The group felt the exchange of ideas, approaches and results would be helpful and should be promoted. International comparison and transparency was considered important.

What nutrients?
Most countries use inorganic nutrient concentrations. It was felt that more attention for total nutrient concentrations might be necessary, especially to establish the link with (upstream) freshwater systems. There are however some methodological problems with the use of total nutrient concentrations (e.g. influence of SPM concentrations). For comparative purposes, it would be beneficial if all countries used similar parameters.

River basin wide consistency in standards
Several countries are exploring the consequences of coastal water quality objectives for the upstream water systems (rivers), to account for transboundary effects. Standards for nitrogen levels for rivers may not be necessary to ensure good ecological status in the rivers, but are necessary to reach objectives in coastal waters. More interactions between groups working on rivers and coastal waters may be necessary to come to a consistent set of nutrient standards. Also, for some coastal waters the relation with groundwater is important.

Finally, knowledge gaps and relevant research questions were discussed. Climate change may be an important factor in the future, changing relations between nutrients and biological quality elements. Other issues are the relation between eutrophication and harmful algal blooms, and secondary impacts like changes in zoobenthos and oxygen deficiencies.

3 RIVER SESSION

By Piet Verdonschot (Alterra, the Netherlands)

The session on rivers had participants from different countries. During the session the participants discussed different aspects of setting nutrient standards for European rivers. In fourteen lectures the playing field between science and policy was introduced. In addition the way different countries tackled the issues was shown. Based on these presentations six main questions came forward and were discussed.

Are nutrients in rivers important?
This question was easy to answer for the river group. They unanimously concluded that nutrients are important in river ecosystems.

Are we able to set nutrient standards for rivers?
The group noticed several problems in the process of deriving nutrient standards. Rivers are complex ecosystems with multiple interactions, especially the large influences of the large land-water connection. Thereby, rivers are mostly subject to multiple stresses and nutrient effects may not always be directly visible, but they are there and can be important. An example is that after restoration eutrophication 'still' can pop up and become the visible problem although it was there also before.

Nutrient standards are a mean to communicate with managers and the group concluded that the existing standard values are currently evaluated and have become stricter. Furthermore, nutrient standards in rivers have a diagnostic value.

About the standards themselves the group concluded that one should always consider the objectives for setting standards and keep in mind that standards are targets to strive for, not holy grails. In general, the primary objective of the WFD is good ecological status and river assessment thus can not do without ecology and always needs the ecologist's knowledge to interpret results.

The process of standard setting is mostly based on existing monitoring data. Thus, the current standards were derived with classifications based towards degraded rather than reference states. Because the data series started between a few to about 30 years ago for the biological elements and maybe about 50 years for the physico-chemical parameters. At that time the rivers in Europe already suffered more or less degradation. What we call reference is not necessarily in line with the former pristine condition, as for that data lack. On the other hand concerning the definitions of the WFD there are rivers in high status as the WFD allows minor anthropogenic alterations.

Which parameters should be included?
There are quite some differences between the parameters selected as standard in the different countries. The reasons are that (i) sometimes parameters listed are the consequence of foregoing monitoring programs and thus need not necessarily be the best ones, but also (ii) sometimes the relation to ecology is proven, or they were selected (iii) because the respective parameter could be measured with a more reliable method (like t-P), and in some cases (iv) the parameters used also depended on the organism group one wanted to looked at or was correlated with. A quite realistic (v) argument is that there is always a need for a large amount of data in order to derive robust standards.

For the near future the group also recommended to keep an open mind for the ecological relevant parameters and suggested also to look outside the water column, like sediment parameters, sulphate concentrations (also in the sediment), N:P ratio in plants, etcetera.

Should standards be linked to direct effects only?
Though many standard were derived based on macroinvertebrates the group concluded that direct effects were most relevant and that yes, the primary producers are most important. It became clear that when standards were derived from primary producers the standards were stricter. This is in line with the one out all out principle and argues in favor of the most vulnerable organism group. The primary producers are, except some rooting macrophytes, less influenced by hydromorphology.

This raised the reality that most data are available for macroinvertebrates. Whilst macroinvertebrates are good saprobic pollution indicators, they are not necessarily the best organism group for setting nutrient standards. Nonetheless, they may reflect changes via trophic cascades so they may still be helpful for setting nutrient standards. At the same time we must realize that primary producers do not provide a complete ecosystem picture. Thus, setting standards differs from identifying problems at ecosystem level.

The group stated that there is a need for more sophisticated, diagnostic, stressor specific indicators and suggested to let each organism tell what it tells best.

Is the GEP stricter then the GES?
This somewhat provocative question was bases on the facts that a regulated river is like a lake and thus needs stricter standards. This may make sense from an ecological point of view. However, according to the Guidance on Artificial and Heavily Modified Water Bodies, hydromorphological alterations may result in changed conditions for nutrients (e.g. irreversible loss of nutrient absorbing wetlands). This may result in changed boundary conditions for the maximum biological potential. Next, a good biological potential should be derived on the basis of ‘slight changes’ of the biological parameters. Finally, nutrient conditions can be derived ensuring that this status will be accomplished.

Should we incorporate downstream effects in standards?
The answer should be yes as this is necessary for downstream protection. It was noted that automatically this will bring in the need to include small rivers (< 10km2) as well, independent from a need to report to the EU. On the contrary, incorporating downstream effects, especially in GEP’s, would result in site specific standards. It was suggested to address the downstream effects in upstream measures not in standards. Hereby, it is also necessary to find cost-effective measures by looking at the catchment.

In general, it became clear for the group that setting standards or selection of multi-measures needs not only innovations in monitoring but also needs much more clearly focused explanatory research to tackle in practice the causes that most effective can and must be tackled. Such focused research is cheaper then the wide spread frequent monitoring programs and will brings us ahead much faster and be really cost-effective.

4 LAKE SESSION

By Rob Portielje (Centre for Water Management, the Netherlands)

The main topic in the lake session was the comparison of the methods and assumptions, which the different countries used for deriving the nutrient standards. The following questions were addressed:

- How did Member States deal with the concept of 'to ensure'?
- Which biological quality (sub)element was used?
- Were standards derived for phosphorus, nitrogen or for both?
- What methodology was used: empirical/modelling/expert judgement/palaeolimnology?
- Which values were derived so far for the reference, the high/good boundary and the good/moderate boundary for different lake types?

The answers to the questions for different member states are presented beneath.

United Kingdom

- Linear regression (which implies a 50% risk of not meeting the biological standard) of the most sensitive element (usually either chlorophyll-a or macrophytes species composition); hysteresis effects for very shallow lakes were not included.
- Only standards for P are derived.
- UK used MEI models for lake specific reference situation, empirical data for G/M boundary, and some palaeolimnological data. A lake specific approach resulted in a range of the standards within the various lake types.

The Netherlands

- NL used the 90th percentile of the Chlorophyll-a:P ratio. For the very shallow lakes effects of hysteresis were included, the clear water state (transparency > 90 cm) was used. For the shallow lakes (>3m) the overall 90th percentile was used.
- As the sensitive element chlorophyll-a was used, where standards for chlorophyll-a were based on secondary effects on macrophytes, as derived within the Central Baltic GIG.
- Standards are derived for both N and P.
- The method for deriving the standards is based on empirical data.

Belgium

- How to deal with the concept of 'to ensure' has not been decided yet.
- Preliminary results on epiphytic diatoms, the most sensitive element will be added later on, based on actual status.
- Standards are derived for both N and P.
- Empirical & palaeolimnological data were used for deriving the standards.

Norwegian

Data from Norway will be added later on.

Germany

- Concept of 'to ensure' was not yet implemented; probably a range will be given.
- Current standards are based on chlorophyll-a, data on diatoms and macrophytes will be added later on (depending which will turn out as the most sensitive element).
- Only standards for P are derived.

- The method for deriving the standards is based on empirical data.

France

- 'To ensure' has not been worked out yet, approach will probably be based on river work.
- No standards have been derived yet.
- A correlation between chlorophyll-a and P has been attempted for LCB3 and alpine type lakes.
- The method for this attempt was based on empirical data.

Czech Republic

- Heavily modified water bodies (HMWB's) only: reservoirs and fish ponds.
- GEP Standards for nutrients (P) were derived as follows: The P concentration in reservoirs were derived from the P concentration in discharging river; GES P standards for streams were used as the P concentration in the discharging river and sedimentation was used to compute the resulting P concentration near the dam; mitigation measures not clear; for fish ponds nutrient GEP's also derived from discharge.
- P GES standard for streams was set at 150 ug/l P (median), resulting in 150 ug/l as the 95th percentile for the reservoir and ca. 80 ug/l as the median P concentration in the reservoir.
- The approach is based on empirical models on P retention in reservoirs.

The following values were derived so far (P standards in ug/l, N standards in mg/l).

Very shallow lakes (LCB2)

Member state	Ref	H/G	G/M	Nutrient
NL		40	90	P
NL		1.0	1.3	N
BE	30	40	70	P
UK-C	18-45	23-55	33-75	P
UK-N	12-30	15-35	21-50	P

GE will be added later on

Shallow lakes (LCB1)

Member state	Ref	H/G	G/M	Nutrient
NL		20	30	P
NL		0.8	0.9	N
BE	20	35	55	P
UK-C	12-28	16-34	22-46	P
UK-N	8-17	10-22	14-30	P

Shallow, very shallow lakes with low or moderate alkalinity

Member state	Alkalinity	Depth	Ref	H/G	G/M	Nutrient
Be	Moderate alkalinity (<1.3 meq/l)	< 3m	20	30	40	P
BE	Low alkalinity (<0.4 meq/l)	< 3m	15	20	30	P
UK-N	Moderate (0.2-1.0 meq/l)	3-15m	5-11	7-15	10-21	P
UK-N	Moderate (0.2-1.0 meq/l)	< 3m	8-19	10-25	15-36	P
UK-N	Low alkalinity	3-15m	2-10	3-13	4-20	P
UK-N	Low alkalinity	< 3m	3-17	4-23	6-34	P

Deep lakes > 15m

Member state	Type	Ref	H/G	G/M	Nutrient
UK-N	Moderate alkalinity	3-8	5-11	7-16	P
UK-N	Low alkalinity	2-7	2-9	3-15	P
GE	Alpine		6-8		P
GE	Pre-alpine		6-19		P
GE	Lowland (small catchment)*		8-30		P
GE	Lowland (large catchment)		30-45		P
NL	Deep lakes (LCB1)		20	30	P
NL	Deep lakes (LCB1)		0.8	0.9	N

* Catchment/lake volume <0.5

General remarks

- Different regions may become different values for percentiles of chl:P ratio's, this depends on concentration range in the data set.
- HMWB's: generally GES applies, except for some cases where hydromorphology affects nutrient loading itself. It can also work other way around: deepened lakes can have more stringent standards than they had originally. See also approach by Czech Republic for reservoirs.
- How to deal with naturally eutrophic lakes (UK)? It was felt that these lakes should be a separate category with its own (eutrophic) reference.

The following statement was discussed:

- The nutrient standard for good status of a natural lake should determine the nutrient standard for good status of a natural river discharging into it.
- The nutrient standard of high status for a natural river should determine the nutrient standard of high status for a natural or artificial lake downstream.

5 FROM STANDARDS TO MEASURES

The second day of the workshop started with the summary of the discussion and conclusions of the sessions on lakes, rivers and coastal waters on the previous day in order to inform all participants of the interesting findings of the various sessions. Summary presentations can be found at the website.

After the review of the first day, various presentations were given on issues one encounters when making the step from nutrient standards towards measures to combat eutrophication:

- Heide Jekel (Germany) presented experience in Germany and in various international river commissions on **upstream-downstream relations** and how to organize coordination and tuning within a catchment between countries, federal states and between freshwaters and marine waters. Upstream-downstream relations are an issue for most of the participants when setting nutrient standards in rivers.
- Joost Icke (the Netherlands) showed a **tool for selecting cost effective and appropriate measures** in a catchment: the WFD-explorer. A lot of interest was shown to share also at an international level information on measures and how to select them.
- Michael Payne (UK) presented an overview of costs and effectiveness of **measures for agriculture** in the UK. In many countries, agriculture is a major source for nutrient inputs to the aquatic environment. The presentation showed that a lot of money is involved when applying measures that result in a visible improvement of the water quality with regard to nutrients.
- The last presentation of the workshop - by Roel Knoben (the Netherlands) - dealt with a specific typical water body in The Netherlands, namely ditches as an example of **artificial waters**. For such waters he presented an example for deriving nutrient standards in artificial waters (‘a road to GEP’).

6 GENERAL CONCLUSIONS

After a lengthy and lively discussion on all the material that had been presented, the following conclusions were drawn and issues for further work were identified. Where a need is identified for further work at European level, this could be brought to the attention of the EU steering group for an EU guidance on eutrophication.

Deriving nutrient standards

- A lot of information on how countries set nutrient standards has become available the last years and has been shared at the workshop. Setting nutrient standards is considered to be important in all water types! (lakes, coastal and transitional waters and rivers)
- Many differences exist in derived standards and used methodologies/assumptions to derive standards. As many countries share catchments and marine areas, there is a need for harmonization of methods and assumptions at European level, possibly in the same way as is done for ecological standards within the context of the WFD. Standards will not be necessarily the same in the different Member states because it depends on the functioning of the ecosystems but the methods to derive them should be harmonized.
- Lack of knowledge exists especially on background levels in large rivers, as there are not many good reference sites. This hampers the deriving of nutrient standards in large rivers.
- Nutrient standards should be derived and used as management tools for indicating ecological problems in the ecosystem; standards are aspirational values, not holy grails. According to the WFD, the physico-chemical elements are supporting the biological quality. So, they should primarily be used to explain bad results for the biological elements and to set the programmes of measures.
- The relation between nutrient standards and ecological quality status within the WFD context is an issue that needs further attention. What if a mismatch exists between nutrient standards and biological quality? How to interpret and harmonize the multi interpretable term “to ensure ecological status” from the WFD? In this case, some Member states propose to take into account the biological elements to assess the ecological status and, if necessary, to apply the checking procedure as described in the CIS European guidance on the classification of the ecological status and ecological potential. This checking procedure needs further clarification for use in this context.
- Coordination between all working groups is important as well, since the problem of the nutrients is obviously responding to catchment logic: the same nutrient concentration has not the same effect, and the effects are not yielded by the same elements, according to the water body types (e.g. small rivers vs. lakes, freshwaters vs. coastal waters).
- Discussion point was how to take into account Natura 2000 objectives. The general view is not to confuse it with GES; there may be overlap, but they are not necessarily the same; most stringent objective would apply; conflicting situations may exist, but generally they WFD and Natura 2000 objectives are complementary.

Upstream-downstream

- The management of nutrients in upstream areas should take into account problems with nutrients downstream, for example in lakes/reservoirs connected to a river and rivers that are entering into transitional an coastal/marine waters. Coordination is needed at catchment level.

- The question is how to take into account downstream problems: should the needs of a downstream area be reflected in the standards upstream, or in the measures or in both? There is a strong wish to further exchange information on ways to address the upstream-downstream relations. It is recommended to share information on methodologies to address upstream-downstream relations.

Measures and MEP/GEP

- Countries are busy with the implementation of the Nitrates and Urban Waste Water Directives and with development of the WFD river basin management programmes, including the identification of the appropriate measures to achieve the goals. There is a strong interest to share tools and methods to identify all possible measures, including information on costs and effectiveness.
- Various situations exist where there are clear differences in the (methodology to derive) ecological goals for natural water bodies (good ecological status) and artificial water bodies (good ecological potential), for example the differences in flow (e.g. a reservoir in a river).

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Annex 1
Programme workshop 'Setting nutrient standards for the water framework directive'

Programme day 1: Thursday the 11th of October

Welcome and opening by Paul Boers
From 9:15 on: Parallel Sessions:

Rivers session

Nutrient standards in European Rivers: policy introduction	J. Elbersen (The Netherlands)
Nutrients in running waters: an introduction	N. Friberg (United Kingdom)
Towards an integrated good physico-chemical status in Spanish streams (Northern Spain and the Balearic islands): different views from biological indicators	I. Pardo (Spain)
Deriving nutrient standards for heavily modified and artificial waters in the catchment Rhine-East (Netherlands)	M. Limbeek & G. Duursema (The Netherlands)
First and future steps towards chemical indicators for Good Ecological Potential in the Dutch Meuse District	V. van den Berg (The Netherlands)
Setting nutrient standards for rivers in Belgium	A. Schneiders (Belgium)
Type specific assessment of nutrients in Austria	K. Deutsch (Austria)
Nutrient levels and a nutrient classification for Greek rivers	N. Skoulikidis (Greece)
A rationale for defining 'good ecological status' in UK and Irish rivers	M. Kelly (United Kingdom)
LAWA-background and benchmark values for surface waters: nutrients and some other primary physico-chemical quality elements	F. Vietoris (Germany)
Phytoplankton based strategy for setting German nutrient standards for rivers and consequence for necessary nutrient reduction in catchment planning (example river Elbe)	U. Mischke & H. Behrendt (Germany)
Scale issues for setting nutrient standards in Latvian small rivers	V. Jansons (Latvia)
Reflections on the nutrient status of French rivers: methodological limits and risks	C. Chauvin (France)
Setting nutrient standards for rivers in Europe	P. Verdonschot (The Netherlands)
Discussion	P. Verdonschot (The Netherlands)

Coastal waters session

Introduction, objectives of the workshop	T. Prins (The Netherlands)
Background values for nutrients in the German Bight	U. Brockmann (Germany)
Results from OSPAR workshop on nutrients in the North Sea	H. Baretta-Bekker (The Netherlands)
Nutrient standards for Belgian coastal waters	G. van Hoey (Belgium)
Nutrient standards for Dutch coastal waters	T. Prins (The Netherlands)
Discussion on the derivation of nutrient standards	All
Conclusions	All

Lakes session

Introduction, objectives of the workshop	R. Portielje (The Netherlands)
Nutrient standards for lakes in the UK (preliminary title)	G. Phillips (United Kingdom)
Nutrient standards for Belgian lakes (preliminary title)	L. Denys (Belgium)
Abiotic nutrient conditions required by submerged macrophyte vegetations.	G. Arts (The Netherlands)
Setting nutrient standards for Dutch lakes	R. Portielje (The Netherlands)
Derivation of nutrient standards - approaches by various Member States	Various
General discussion and statements	All
Conclusions and synthesis	All

Programme day 2: Friday the 12th of October

Chair: Mrs. Jeannette Plokker

Welcome	J. Plokker (The Netherlands)
Presentations of the main findings from the three sessions on day 1	R. Portielje, P. Verdonschot & T. Prins (The Netherlands)
Reactions from the audience and discussion	All
Upstream- Downstream relations	H. Jekel (Germany)
Introduction to measures. The WFD-explorer as example.	J. Icke (The Netherlands)
Costs and effectiveness of measures for agriculture – progress in the UK	M. Payne (United Kingdom)
Discussion on Measures	All
The road to GEP	R. Knoben (The Netherlands)
Discussion	All
Summary and conclusions	J. Plokker (The Netherlands)

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Annex 2
Participants workshop

Name	Surname	Institute	Country
Gertie	Arts	Alterra	The Netherlands
Hanneke	Baretta-Bekker	Centre for Water Management	The Netherlands
Marcel	Van den Berg	Centre for Water Management	The Netherlands
Victor	Van den Berg	Waterboard Brabantse Delta	The Netherlands
Carla	Bierma	Centre for Water Management	The Netherlands
Paul	Boers	Centre for Water Management	The Netherlands
Hakon	Borch	Bioforsk Soil and Environment	Norway
Bert	Brinkman	IMARES	The Netherlands
Uwe	Brockmann	Inst. For Biogeochemistry and Marine Chemestry, Hamburg University	Germany
Josep Pablo	Canaves	University of Balearic Islands, Serveis Cientificotecnics, Universitat de les Illes Balears	Spain
Christian	Chauvin	Cemagref	France
Anne	Daniel	IFREMER	France
Luc	Denys	Instituut voor Natuur- en Bosonderzoek	Belgium
Karin	Deutsch	Federal Ministry of Agricultural, Forestry, Environment and Water Management	Austria
Ronald	Van Dokkum	Centre for Water Management	The Netherlands
Jindrich	Duras	Povodi Vltavy state interprise	Czech Republic
Gerhard	Duursema	Waterboard Velt en Vecht	
Janine	Elbersen	Ministerie van LNV, directie kennis	The Netherlands
Niels	Evers	Royal Haskoning	The Netherlands
Priscilla Raquel	Fernandes Costa Goela	IMAR Institute of Marine Research	Portugal
Nicolai	Friberg	Macaulay Institute, Catchment Management Group	United Kingdom
Ulrike	Frotscher-Hoof	MUNLV NRW	Germany
Maria Jesus	Fuente Alvaro	Ministry of Environment	Spain
Esther	Grinten	RIVM	The Netherlands
Gert	Hoey	Federale Overheidsdienst Volkgezondheid, Veiligheid van de Voedselketen en DG Leefmilieu, Dienst Marien Milieu	Belgium
Kor	Hoof	VMM (Flemish Environment Agency	Belgium
Behrendt	Horst	Institute of freshwater Ecology and Inland Fisheries	Germany
Joost	Icke	WL Delft Hydraulics	The Netherlands
Klaus	Isermann	Bureau for Sustainable Nutrition, Land Use and Culture (BSNLC)	Germany
Viesturs	Jansons	Latvia University of Agriculture, Dep. Of Environmental Engeneering and Water Management	Latvia
Heide	Jekel	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	Germany
Martyn	Kelly	Bowburn Consultancy	United Kingdom
Jeroen	De Klein	Wageningen University - Alterra	The Netherlands
Roel	Knoben	Haskoning Nederland BV	The Netherlands

Name	Surname	Institute	Country
Szymon	Kobus	Department of Land reclamations and Environment Management, University of Warmia and Mazury in Olsztyn	Poland
Chrisophe	Laplace-Treyture	Cemagref	France
Marga	Limbeek	Waterschap Rijn en Ijssel	
Henk	Maeckelberghe	Vlaamse Milieumaatschappij	Belgium
Mathilde	Merlo	Ministry of Ecology and Sustainable Development - French Water Department	France
Ute	Mischke	Leibniz-Institute of Freshwater Ecology and Inland Fiheries	Germany
Diederik	Van der Molen	Centre for Water Management	The Netherlands
Marianne	Mul	Unie van Waterschappen	The Netherlands
Gert-Jan	Noij	Alterra	The Netherlands
Fernando	Orozco Conti	General Direction of Hydric Resources - Balearic Islands Government	Spain
Mireille	Panjer	Centre for Water Management	The netherlands
Isabel	Pardo	University of Vigo, Department of Ecology and Animal Biology	Spain
Michael	Payne	Environmental Consultant, representing the National Farmers Union of England and Wales	United Kingdom
Geoff	Phillips	Environment Agency	United Kingdom
Jeanette	Plokker	Centre for Water Management	The Netherlands
Rob	Portielje	Centre for Water Management	The Netherlands
Olaf	Prawitt	Environmental Protection Agency, Federal State of Rhineland-Palatinate	Germany
Theo	Prins	Centre for Water Management	The Netherlands
Jorge	Rodriguez Romero	European Commission, DG Environment	Belgium
Anik	Schneiders	Research Institute for Nature and Forest	Belgium
Peter	Schweigert	Ing. Buro Dr. Schweigert	Germany
Marcin	Sidoruk	Department of Land reclamations and Environment Management, University of Warmia and Mazury in Olsztyn	Poland
Nikolaos	Skoulikidis	Hellenic Centre for Marine Research, Institute of Inland Waters	Greece
Bettina	Thiel	Ministerium fur Umwelt, Forsten und Verbrauchersschutz des Landes Rheinland-Pfaltz	Germany
Piet	Verdonschot	Alterra	The Netherlands
Friederike	Vietoris	Bezirksregierung Munster	Germany
Guido	Waajen	Waterboard Brabantse Delta	The Netherlands
Marie-Claude	Ximenes	Ministere de l'ecologie du developpement et de l'amenagement durables	France