SOCOPSE

SOURCE CONTROL OF PRIORITY SUBSTANCES IN EUROPE

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SOCOPSE
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SOURCE CONTROL OF PRIORITY SUBSTANCES IN EUROPE

SOCOPSE

TNO report

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Socopse Meuse Case

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Summary

This report presents the results obtained in the Socopse Meuse case (work package 5). The approach followed differed from that of the other river basin cases in Socopse. The activities were not primarily aimed at testing the Decision Support System (DSS), but were taken to a higher level of abstraction. A number of key persons involved in the implementation of the WFD (Water Framework Directive) for the Dutch Meuse river basin were interviewed and asked to fill out a questionnaire dealing about the way the problem of reaching the WFD targets in the Meuse river basin is discussed in the river basin management plan (RBMP) and how the experiences and insights obtained thus far should work out in the next generations RBMP.

The reasons for the specific procedure followed in the Meuse case, are that the solution of problems related to priority (hazardous) substances (P(H)S) cannot be found in technological measures at a local level (e.g. aimed at reduction of point sources). Because diffuse sources of P(H)S and historical pollution are more important than (remaining) point sources, measures should be identified that can tackle these emissions. This requires a broader set of measures (more policy development oriented) than included in the present DSS. Furthermore, because of the limited size of the P(H)S problem compared to other benefits to be gained from measures that can be taken, water managers do not regard P(H)S as their first priority. Therefore, testing the DSS in its present form was not deemed opportune and it was decided to focus on the current obstacles for policy makers to handle P(H)S in the Dutch WFD implementation process and to include these policy makers in the target group of our investigation, consisting of a number of interviews and an inquiry in writing (questionnaire).

Conclusions gathered from the interviews and the questionnaire are:
- Reduction of industrial point sources are not expected to result in significantly lower P(H)S concentration, as these sources are already strictly regulated by the IPPC guideline.
- Particularly the planned municipal water treatment plants in the Walloon Region are promising for the improvement of water quality in the Meuse river, not only for ‘classical’ contamination (BOD, nutrients, etc.), but also for contamination with P(H)S.
- P(H)S emissions can be further reduced by tackling the diffuse sources. Measures to reduce diffuse sources should be addressed on a European level.
- For specific substances (e.g. PAH), a good chemical status for the international Meuse River basin will not be reached in 2015 and chemical objectives are postponed to 2027.
- On a local level, concrete measures on reduction of diffuse pollution get too little attention. More research on effectiveness and costs of measures is necessary.
- International co-operation in the Meuse (Meuse treaties, International Meuse commission) have already led to very positive developments, but much can and should be improved in the composition of the next generations RBMPs.
- Problem translocation (in time, space, …) is an important issue in sustainable river basin management and much attention should be paid to this at all policy levels or scales within the river basin.
- Finally, based on the results of the interviews and enquiries a number of recommendations for the Socopse DSS are presented, to enhance the DSS flexibility, to increase user-friendliness, to handle uncertainties and to extend the information on measures contained in the DSS.

For a better connection to the other Socopse river basin cases, an annex has been added in which the Meuse case is discussed in line with the DSS steps. Besides the approach followed for the Dutch Meuse case, as indicated above, a separate chapter has been devoted to the French Meuse river basin. This part describes the outcomes of interviews and meetings with French water agencies and modeling results obtained with a surface water quality model.

Contents

Glossary

BAT	Best Available Techniques
BKMW	Decree on Quality Demands Monitoring Water
BOD(5)	Biological Oxygen Demand (in French: 'BDO5')
BREF documents	BAT Reference documents
CEA	Cost Effectiveness Analysis
CIW	Coordination committee Integrated Water management
CIS	Common Implementation Strategy for the WFD
COD	Chemical Oxygen Demand
CSN	Coordination office for River Basins in The Netherlands
DG	Directorate-General (part of Dutch Ministry)
DGRNE	Direction Générale des Ressources Naturelles et de l'Environnement (Directorate-General for Natural Resources and the Environment within the MRW)
DGARNE (former DGRNE)	Direction Générale Opérationnelle de l'Agriculture, des Ressources Naturelles et de l'Environnement de la Région Wallonne
DGW	Directorate General Water (part of V&W)
DIREN	(French) Regional Direction of the Environment
DSS	Decision Support System
ELV	Emission Limit Values
EQS	Environmental Quality Standard
GIS	Geographical Information System
IMC	International Meuse Commission
IPPC	Integrated Pollution Prevention and Control (Directive 2008/1/EC)
LBOW	National Administrative Consultation Group Water
MAF	Maximum Acceptable Fluxes
MCA	Multi-Criteria Analysis
NGO	Non-Governmental Organization
NH_4	Nitrogen present as ammonium
N_{Kj},	'Kjeldahl' nitrogen
$N\text{-}NO_2$	Nitrogen present as nitrite
$N\text{-}NO_3$	Nitrogen present as nitrate
PCB	Polychlorinated biphenyls
P_{tot}	Total phosphorus (sum of organic and inorganic phosphorus)
P(H)S	Priority (Hazardous) Substance
PNRSDE	(French) National Programme on the Reduction of Hazardous Substances in Water
POTW	Publicly Owned Treatment Work (also see WWTP)
PRIBEL	Pesticide Risk Indicator for BELgium
PRPB	(Belgian) Programme for Reduction of Pesticides and Biocides
RBMP	River Basin Management Plan
RBO Maas	Regional Administrative Consultation Group for the Dutch Meuse river
REACH	Registration, Evaluation, Authorization and Restriction of Chemical substances (Directive 2006/1907/EC)
RIWA Maas	(Dutch) Association of Meuse River Water Companies

RIZA	(Former) Dutch Institute for Inland Water Management and Waste Water treatment
RWS	Rijkswaterstaat (under responsibility of V&W)
SCBA	Societal Cost Benefit Analysis
SDAGE	(French) Water Arrangement and Management Scheme
TBT	Tributyl tin
VEWIN	Association of Water Companies in the Netherlands
VMM	Flemish Environment Agency (under responsibility of the Flemish Minister of Environment, Nature and Energy)
VROM	Dutch Ministry of Housing, Spatial Planning and Environment
V&W	Dutch Ministry of Transportation and Water management
WFD	Water Framework Directive (Directive 2000/60/EC)
WWTP	Wastewater Treatment Plant

1 Introduction

The Meuse case is part of the Socopse work package 5, in which a number of European river basins are taken as cases for application of the DSS (Decision Support System) that has been developed in the Socopse work package 4. Four case study areas in Europe have been selected:

- West - the Meuse catchment in the Netherlands and France
- North - the Baltic Sea catchment of the Vantaa river in Finland and the Klodnica river in Poland
- Central - the Danube catchment
- South - the Ter/Llobregat catchments in Spain

At the start of the activities in the Meuse (for the Dutch part of the Meuse river basin) it turned out that a different approach for this case was appropriate. This implies that for the Dutch part of the Meuse case not a direct application of the DSS was tested, but that the approach was taken to a higher level of abstraction. The reasons for this procedure are explained in chapter 2.

As part of the procedure the key institutions involved in the implementation of the WFD (Water Framework Directive) for the Dutch Meuse river basin were interviewed. The results of these interviews are summarized in chapter 3. Subsequently, this chapter presents the results of an inquiry that was organized to obtain the comments from a number of stakeholders in the Meuse basin on the results and conclusions drawn from the interviews.

The results for the French part of the Meuse are presented in chapter 4. These consist of interviews and meetings with French water agencies and modeling results obtained with a surface water quality model. Chapters 4 and 5.3 (dealing about the French Meuse river basin) have been composed under responsibility of INERIS. In chapter 5 an overview is given of RBMPs (River Basin Management Plans) and other policy documents for the WFD implementation in the Dutch and French Meuse river basin. Also a short description of the Belgian (Flemish and Walloon) RBMPs for the Meuse with respect to P(H)S (Priority (Hazardous) Substances) is included in this chapter.

Chapter 6 summarizes the main conclusions from this report and the recommendations for the Socopse DSS. The consequence of the higher level of abstraction adopted in the Meuse case is that also these recommendations start from this higher level.
For reasons of connection to the other WP 5 cases, an annex (Annex 1) has been added in which the Meuse case is discussed in line with the DSS steps.

2 Approach followed for the Meuse case

Initially, the Socopse DSS was intended to support water authorities to make plans and make decisions for the control of P(H)S at the European, the national, or the river basin level. The composers of water management plans at water boards were the target group of the DSS. One of the goals of the Meuse case was to get feedback on the DSS from those plan composers, or in a broader sense form district water board representatives.

2.1 DSS set-up

The DSS focuses on the chemical status of river basins and not on the ecological status, although the chemical status can have impact on the ecological status. For support of RBMP composers with a focus on ecological status other DSS-like approaches and models are available, such as the WFD Explorer (www.krwverkenner.nl) in the Netherlands.
The DSS provides information on measures to treat problems with point sources and diffuse sources. In general, the measures (management options) can be classified in measures for polluters and policy instruments for government:

- Measures for polluters:
  - Process-oriented options: Available source control options in processes (both production of substances and use in other processes), including product recovery, process modification (e.g. use cleaner fuels, or cleaner raw materials, better maintenance), new processes, closed-circuit operation, use of other components.
  - End-of-pipe techniques: Techniques that can be used to remove the selected priority substances from process water and wastewater from industrial sites and wastewater from municipal WWTPs (wastewater treatment plants).
- Policy instruments for government:
  - Substitution of products (phase out): Stimulate use of alternative products that can be used in products, in applications by consumers, farmers, etc.).
  - Options for other (diffuse) sources (Community level options): Management options focussed on measures that could be taken at the community level, for example sewage sludge treatment, waste disposal, sediment or soil removal and treatment, etc.

DSS structure
The basic structure of Socopse DSS contains seven sequential steps (see Figure 1).
In the preliminary Step 0, the system boundaries are set and the geographical, physical, chemical, biological and societal characteristics of the system are described. The system definition is the background for all further assessments and therefore, as detailed information as possible is desired. The system definition is a general requirement for an RBMP.
In step 1, the problem around P(H)S and WFD are envisaged through an inventory of P(H)S concentrations (e.g. from monitoring data) in the area. P(H)S concentrations may not exceed the EQS (Environmental Quality Standards) and may not increase in time. If so, it will not be defined as a problem.
In step 2, we try to trace back the sources of the problem concentrations in the areas where the EQS is exceeded. Here, area specific information (e.g. from permits, emission registration data) and the EU wide inventory of possible sources can be used. This step results in a list of actual areas where P(H)S concentrations constitute a problem, together with their possible sources.

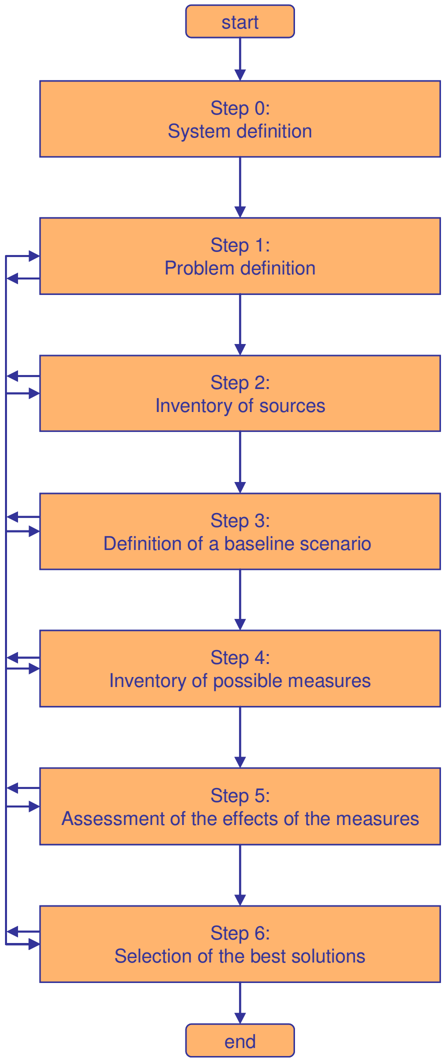

Figure 1: Overview of the decision support system

In step 3, a baseline scenario for the future is defined. This step checks if the present situation with respect to the water quality will change in the future and if so, to what extent additional measures are necessary to improve the water quality.
Step 4 creates an inventory of possible management options for the problem areas. These management options include e.g. process-oriented options, end-of-pipe techniques, product substitution (phase out) and other options, e.g. at the community level. Step 4 also checks the possibility to apply measures for more than one substance.
In step 5, an assessment of the effects of the possible measures takes place. Hence the categories of effects that need to be taken in account are determined. The assessment of the effects is at least a calculation/estimation of the costs of compliance and of the environmental performance of the measure: primarily the reduction in P(H)S concentration, but also the effect on other substances can be regarded.
In step 6, the selection of the best solution (sets of measures) takes place. In dialogue with the main stakeholder groups (pointed out in step 0; System definition) the most applicable selection method is chosen, based on the expected effects of the measure (sets): e.g. a Cost Effectiveness Analysis (CEA) if only costs and concentration

reduction are relevant, or either a Societal Cost Benefit Analysis (SCBA), or a Multi-criteria Analysis (MCA), when other effects should be regarded as well. From the result of these analyses, the best solutions are selected in dialogue with, or advice from the main stakeholder groups.

2.2 Observations from first few interviews

Interviews with local and national water managers were conducted to gain information about the P(H)S situation in the Dutch part of the Meuse and to introduce the DSS. From the first few interviews we learned that the water managers (water boards as well as Rijkswaterstaat) do not regard point sources of P(H)S as causing a serious problem to meet the WFD obligations.
Among other reasons, this is due to the less strict EQSs in the WFD compared to former Dutch standards. Diffuse sources and historical pollution are regarded as the most significant problems.

In addition, the interviewees revealed that at local scale hydrology and/or ecology related measures are more within the scope of the water boards. Hydrological measures are more in the picture than technical source reduction measures, and it is much easier to raise interest from various stakeholders for this type of measures. It should be noted that these measures often also have an effect on P(H)S concentrations. Furthermore, local water boards are waiting for the national policy level to come up with regulations for the implementation or prescription of (technical) measures to improve the chemical status. At the local water board level one is not that eager to implement technical measures themselves, as long as those measures are not made compulsory at the national level.

2.3 Change of case approach

The first interviews led to the conclusion that applying the DSS in the way it was meant to, would not lead to new insights in the Meuse case, because of the lack of point source related problems and/or the lack of focus on the chemical status of river basins. Furthermore, tackling diffuse emissions of P(H)S requires a broader set of measures (more policy development oriented) than included in the present DSS. Therefore, we decided to change the approach of the Dutch part of the Meuse case by focussing on the current obstacles for policy makers to handle P(H)S in the Dutch WFD implementation process. Hence, the case target group was shifted from the practical level (i.e. plan composers) to the policy level. The new aim for the Dutch part of the Meuse case became to get feedback from policy makers in order to make the DSS contribute more to policy development.

Specific points of interest were:
- Course of the WFD implementation process.
- Uncertainties: dealing with a variety of (often non-technical) uncertainties appears to be an important concern for the local and national water management level.
- Information need: which information is available and needed for decision making?
- Transboundary co-operation: for achieving the WFD targets, the Netherlands are dependent on the efforts of upstream countries or regions. International co-operation takes place in the International Meuse Commission (IMC), but bilateral agreements on emission reduction is still laborious.

- Translocation of P(H)S concentration problems in time, space and function.
- Flexibility: Is the DSS able, or should it be, to deal with new P(H)Ss (in the future), emerging substances, and nutrients?

Procedure:
Additional interviews were conducted with people and organisations in the Dutch Meuse WFD process (see chapter 3.1). After evaluation of the results of the interviews an inquiry (see chapter 3.2 and Annex 2) was sent to the interviewees. With this inquiry we gained opinions about P(H)S relevant passages in the Meuse RBMP, the WFD process and institutional aspects.
The first steps of the DSS could be filled-in (see Annex 1), mainly using information from the Meuse RBMP [RBMP Dutch Meuse, 2008; IMC, 2008].

3 Results for the Dutch part of the Meuse river basin

3.1 Interview results

An overview of the interviews conducted in the Dutch Meuse river basin is given in Table 1. Next to the organizations and the persons involved, also their roles within the WFD process are presented. Detailed reports of the interviews have been prepared (in Dutch); the main results are summarized in this report.

From the interviews very relevant and substantial information has been obtained. They yielded a number of new points of view regarding the WFD implementation, the approach of the P(H)S issue and the composition of the Socopse DSS. The main results are discussed below for four aspects: (1) WFD implementations processes, (2) complying to P(H)S standards, (3) the Socopse DSS and (4) dealing with uncertainties.

Table 1 Interviews conducted in the Dutch Meuse river basin

Organization	Persons	Role within the FWD process
VROM (Dutch Ministry of Housing, Spatial Planning and Environment)	J. Appelman	National Environment policy, e.g. Action programme diffuse sources.
Coordination office river basins in the Netherlands (CSN)	W. Mak	Composition of RBMPs, pivot function between regional and national WFD implementation institutions.
WFD Project Office Meuse	J. Bovendeur, P. Omvlee and W. van der Pennen	Facilitating ‘area processes’ in the Meuse river basin. Lay down the results in a master document (used by CSN for the Meuse RBMP)
RIWA Maas	J. Verheijden and A. Bannink	International lobby activities for companies that depend on the Meuse for production of drinking water.
Rijkswaterstaat / Centre for water management	F. Wagemaker and G. Niebeek	Composition of the management plan for national waterways (including the Meuse river), tuning activities with nature reserve interests, EU policy relating to P(H)S, CIS working Group E (deriving standards, revision of P(H)S list)
Water boards (‘de Dommel’ and ‘Brabantse Delta’)	Arjen Kolkman and Leo Santbergen	Pursuing WFD targets in regional water bodies within the area of control

3.1.1 *The WFD implementation process*

In the Netherlands, the WFD implementation – including the composition of the RBMPs – has been organized in a bottom-up process. The responsibility for the final plan lies with the secretary-general of the Ministry of Transportation and Water management (V&W). The detailed plan of measures for the State waters (including the water quality of the Meuse main stream) is composed by Rijkswaterstaat. The regional plans (including the water quality of the various tributaries) are composed by the water boards. The foundation for the identification and selection of WFD measures has been laid down by regional partners within the so-called 'area processes'. In these area processes for each water body the actions have been identified that are necessary to comply with the WFD targets. The national government did impose a number of boundary conditions, though. Important criteria for the selection of measures are the demands of feasibility and affordability. Furthermore, it is regarded as undesirable to do (or promise) more than is demanded by the EU. In the area processes the stakeholders directly affected by the selected measures have been invited to participate in the process.

The Project Office Meuse had a facilitating and harmonising task in the area processes. The final product, the Basic document Meuse [Project Office Meuse, 2008], has been agreed upon by all water managers within the Meuse river basin. The different stakeholders have been kept informed about the area processes by means of a participation platform and were stimulated to think along in the whole process. Composing the RBMP is a task of CSN, the Coordination Office for river basins in the Netherlands. This task has been commissioned by the Ministry of Transportation and Water management / DGW (Directorate-General Water). The Basic document and its background documents are used as starting point in this task.

During the WFD implementation process a lack of consultations has been noticed about the introduction of contaminants from abroad through surface water or groundwater transport. Water managers within the Meuse river basin have indicated they do not have an adequate international network at their disposal. This is probably partly caused by a lack of parity of authority levels, which makes it difficult to find the right organizations and their representatives at the other side of the border. Furthermore, time restraints and deadlines have promoted that the elaboration of the WFD obligations has been focused primarily at the national obligations. In the next planning stage (2^{nd} generation RBMP, due in 2015), this will probably be less pronounced.

3.1.2 *Complying to P(H)S standards*

The water managers (water boards as well as Rijkswaterstaat) interviewed do not regard point sources of P(H)S as causing a serious problem to meet the WFD obligations. The less strict test procedure in the WFD compared to former Dutch regulations contributes to this observation. Some concern has been ventilated about the public participation involved in the RBMP process. There is a danger that plans will have to be modified a number of times and will have to enter the procedure again and again.

For the drinking water production sector the lack of internationally co-ordinated measures and policy agreements is regarded as a serious problem. A substantial part of the water quality issues is caused by upstream supply of contaminants. RIWA Maas also missed attuning between Dutch water managers in the process. As a consequence of the strong directedness to meeting with ones own obligations, too little attention has been paid to translocation of problems to other river sections. Regional water managers are not sufficiently aware of the contribution regional waters can make to the pollution of downstream water intake locations for drinking water production.

The drinking water production sector also has a problem with the European standardization of priority substances. The standards are based on ecological risks and are not attuned to the river's drinking water function. Consequently, a number of standards are not sufficiently strict for the production of drinking water from surface water. Solutions can be found in temporary intake shut-down, or in the case of structural standard transgressions, in enhancing the purification efforts. RIWA Maas points to the fact that in article 7.3 the WFD demands that in the long term the purification efforts should decrease.

The National government has recognized that some problems can only be addressed on a European level. Therefore, the Ministry of Housing, Spatial planning and Environment (VROM) has put the Dutch problems related to cadmium, copper, zinc and PAH on the agenda in Brussels. This has resulted in the set up of an 'ad-hoc activity on emissions' within the CIS working group E. This 'ad-hoc activity' will be directed to the following questions:

i. For which compounds are actions deemed necessary?
ii. Which are the possible effects of these measures?
iii. Who (which authority) is responsible for the execution of these measures?

Suggestions (from various interviewees) to improve the WFD implementation process:

- Promote international consultations, expand international networks and opportunities to make agreements, also to avoid legal procedures;
- Avoid translocation of problems to other river sections, enhance managers' awareness of the needs experienced from downstream water functions;
- Make concrete agreements on a European level to tackle the problems of contaminants that are transported across (international) borders.

3.1.3 The Socopse Decision Support System (DSS)

The Socopse DSS was briefly introduced to all interviewees. In general the response was positive: the DSS was considered to be useful as an information source for identifying emission sources and suitable measures / techniques. For the present set of RBMPs the DSS is late, because the programs of measures have already been selected, but for the next set of plans it may be a good instrument. All parties have put forward that besides supplying technical information the DSS should include statements about the implementation feasibility of the various measures. A technically effective measure may not have sufficient legal, political, or societal support, rendering implementation difficult, or even impossible.

Suggested improvements for the DSS are:

- For the evaluation of measures, add a number of criteria, such as:

    - Who are involved in the execution of the measure? For instance, for the assignment of spray-free zones, the water boards and the farmers.
    - Does the measure meet sufficient support (both mental and financial) from the people involved? This support is necessary for a good chance of success!
    - What is the time of implementation, how long does it take for the measure to become effective?
    - Which instruments are available? Think e.g. of authorisation / licensing, subsidisation.
    - Does the measure connect to (inter)national policy decisions?
    - Are there other sectors or policy fields that take advantage from the measure?
    - Give preference to source reduction measures over end-of-pipe technology.
- The DSS should offer insight into the effects of a measure, or combination of measures, on the water quality, expressed in the extent to which the goals are achieved.
- Do not only indicate technological measures, but also measures that act upon people's behaviour. For example the influence upon consumption behaviour in favour of the use of non-polluting textile, or biologically produced food.
- Mention all relevant sources of contamination with P(H)S, including historical contamination (for instance the Kempen area in the Meuse river basin). Other sectors (extraction of groundwater and nature reserve management) may benefit from remediation of this type of contamination.
- Apply integral weighting in the DSS: Indicate the various functions (such as drinking water supply, or other WFD targets) of the water system, also when these functions are situated downstream.
- Supply a brief manual
- Keep the DSS 'up to date'

3.1.4 Handling uncertainties

The WFD is regarded as the most ambitious and important directive for the future of the water quality policy in Europe. For the measures in the RBMPs an obligation to achieve the targets ('do what you say') is valid. Nevertheless, the composers of the plans have to deal with a variety of uncertainties. Within the WFD process there is no method available that prescribes how to deal with these uncertainties. From the interviews the following uncertainties have come forward:

- Regarding the water system: Uncertainties about the effects of natural processes, such as climate change, and the consequences of these processes for the feasibility of achieving the WFD targets;
- Regarding emission sources: Uncertainties in qualitative and quantitative data referring to these sources. Especially the identification and quantification of diffuse emission sources is a hard job.
- Regarding standardization: Adaptation of standards to new scientific views influences the standards and targets, viz. for metals and emerging substances, such as endocrine disruptors. Establishment of new standards, or sharpening existing ones, may cause problems to achieve the target values. On the other hand, repealing or relaxing existing standards may mitigate such problems.
- Regarding effects of measures: A large portion of the measures in an RBMP has not yet been detailed or implemented. Hence, it is yet unknown to what extent they will contribute towards achieving the WFD targets. The relation between a specific measure and water quality is often ambiguous or not very clear, especially when the measure involves reduction of diffuse sources. Depending on the trends in water quality observed in the (near) future, additional (EU or national) policy measures may have to be considered in the

field of e.g. manure, diffuse sources, restoration and redevelopment of water systems, etc. after 2015. If it turns out that targets cannot be met, lowering of targets may come into the picture, but it is uncertain if or when this will happen.
- Regarding the obligation to comply with the targets set in the RBMPs versus the obligation to take fair measures directed to achieving the targets: The drinking water companies hold the view that the EQS for drinking water should be seen as obligatory targets. The more so, because the EU directive 75/440 (in which this was distinctly stated) has been abrogated and replaced by the WFD. According to Dutch policy makers the obligation to comply with the targets refers to the implementation of the measures that have been announced in the RBMPs. At present there is no jurisprudence on this subject yet, so it will take time to obtain more certainty.
- Regarding participation: The implementation of the WFD is mainly in the hands of managers and civil servants. Stakeholders can take part in the discussions and the thinking process in participation platforms acting as a 'sounding-board'. The participants in these groups experience uncertainty with respect to the extent to which their interests are given adequate attention and the way this is realized.
- Regarding societal developments: These uncertainties relate to setting priorities within a region, nation, or river basin district. This is strongly influenced by economic developments, the occurrence of natural disasters or extreme events (e.g. floods, droughts), industrial accidents (e.g. emission of toxic substances), etc.
- Regarding innovation: Technology development takes place in many sectors, resulting in improvement of techniques and enhanced options for measures to reduce emissions of P(H)S, nutrients, etc. (e.g. new generations of wastewater treatment plants, agricultural practice, substitution of products, alternative industrial processes, etc.). These developments can show a sudden acceleration, or in other cases an unexpected slow-down.

A systematic uncertainty analysis has been performed for the WFD implementation in the Scheldt river basin [Oosterwijk, 2008]. The study shows that the analyses produced a complete and objective picture of quantitative and qualitative uncertainties. The identified uncertainties in this study for the Meuse were also identified for the Scheldt.

Concepts and guidelines for handling uncertainty in adaptive water management are well described in Brugnach *et al.* (2009), one of the results of the NeWater project. The next paragraphs give a summary from this guidelines document.

Identification of uncertainties
In the guidelines document three types of uncertainty are identified: unpredictability, incomplete knowledge, and multiple knowledge frames:
- Unpredictability refers to unpredictable aspects of the system due to inherent natural variability or complex system behaviour.
- Incomplete knowledge refers to situations where the knowledge is incomplete, for example due to a lack of information or data, to a lack of theoretical understanding, or to ignorance.
- Multiple knowledge frames refers to different, sometimes conflicting, views about the best way to understand the system. Ways of understanding the system can differ in terms of opinions where to place the boundaries of the system, or what to place in the focus of attention. This kind of uncertainty can be called ambiguity and results from the presence of multiple ways of understanding or

interpreting the system, which can originate from differences in professional backgrounds, scientific disciplines, value systems, societal positions etc.

In most water management problems, all three of these types of uncertainty are present.

To facilitate the process of uncertainty identification NeWater considers the river basin system to be composed of three sub-systems: the natural system, the technological system and the social system. The natural system covers water quantity, water quality, climate and the ecosystem. The technical system includes technical elements/artefacts that are used to intervene in the natural system, with infrastructure and technologies (dams, irrigation systems, etc.). The social system includes the economical, cultural, legal, political, administrative and organizational aspects.

Combining the three types of uncertainty with the three sub-system types a comprehensive view of existent uncertainty can be obtained (Table 2).

Table 2 (A comprehensive view of existent uncertainty (from Brugnach *et al* (2009))

	Unpredictability	**Incomplete knowledge**	**Multiple knowledge frames**
Natural system - climate impacts - water quantity - water quality - ecosystem - …	Unpredictable behaviour of the natural system. E.g., what will be the highest water level next year?	Incomplete knowledge about the natural system. E.g. erroneous /unreliable water level measurements	Multiple knowledge frames about the natural system. E.g., is the main problem in this basin the water quantity or ecosystem status?
Technical system - infrastructure - technologies - innovations - …	Unpredictable behaviour of the technical system. E.g., what will be the side effects of using newly developed pesticides on human health?	Incomplete knowledge about the technical system. E.g., to what water level will this dike resist?	Multiple knowledge frames about the technical system. E.g., should we raise dikes or create flood plains?
Social system - organizational context - stakeholders - economical aspects - political aspects	Unpredictable behaviour of the social system. E.g. how strong will the reaction of stakeholders be at the next flood?	Incomplete knowledge about the social system. E.g., what are the economical impacts of a flood for the different stakeholders?	Multiple knowledge frames about the social system. E.g., do we need to impose insurance against floods, or adapt the legal regulations about spatial planning?

Approaches for dealing with uncertainty

Uncertainties may arise at different stages in the decision-making process. New management strategies (adaptation) must be continuously formulated through learning from previously implemented strategies. This can be achieved by iteratively comparing new adaptation strategies with existing policies or practices under alternative scenarios.

NeWater suggests a general approach for dealing with uncertainty: create solutions that are flexible and easy to adapt to changing conditions and unexpected developments. The type of uncertainty determines the strategies needed for dealing with it. For example, at a general level it can be stated that coping with unpredictability requires "accepting not knowing (better)"; dealing with incomplete knowledge requires "improving factual knowledge" and coping with multiple frames requires "learning to deal with differences" (Figure).

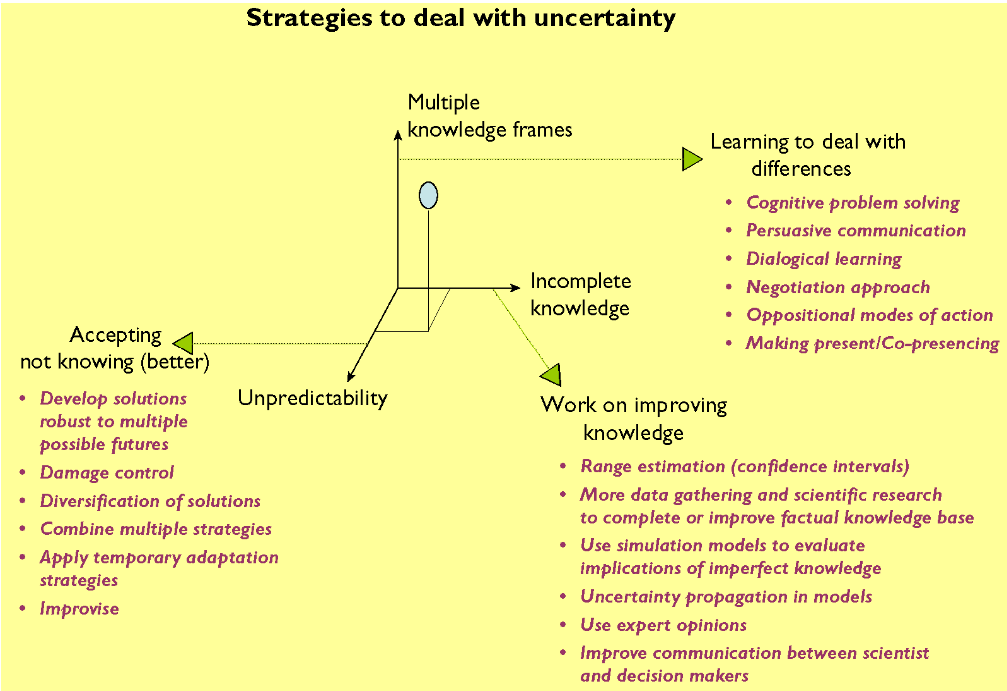

Figure 2: Strategies to deal with uncertainty (from Brugnach *et al.* (2009)

Strategies to support "Accepting not knowing (better)"
When a (partially) unpredictable and (partially) uncontrollable incident with potential negative effects occurs, there are several relevant strategies:

- To develop robust solutions that are suitable under different possible future scenarios.
- To diversify the measures and solutions applied, making sure that at least one measure is effective under each of the possible scenarios, even when some of the measures could fail (e.g., using dykes and floodplains).
- To consider temporary adaptation strategies applicable within the timeframe of an unfolding event (e.g., a storm surge barrier that is closed only under extreme weather conditions).

Strategies to support "Work on improving knowledge"
When a situation involves lack of knowledge, uncertainty could be reduced or even eliminated by carrying out more research, collecting more or better data, or assessing how lack of knowledge can affect the description or understanding of a situation. Amongst relevant strategies are:

- To estimate uncertainty ranges (e.g., confidence intervals)
- To collect more data or to carry out scientific research to improve factual knowledge.

Strategies to support "Learning to deal with differences"
Learning how to deal with differences is essential for coping with multiple and sometimes incompatible perspectives about a problem, and ultimately for dealing with the problem as a whole. The sources of these differences are for example, the existence of different scientific backgrounds, differences between context-specific experiential knowledge and general expert knowledge, and different societal positions or ideological backgrounds. Relevant strategies for coping with this type of uncertain situation are for instance:

- Cognitive problem solving
- Persuasive communication
- Dialogical learning

3.2 Follow-up (additional inquiry)

3.2.1 Set up

At first it was planned to organize a workshop in which water managers and other stakeholders from the Netherlands as well as upstream Meuse river basin countries were invited to respond to the results and conclusions drawn from the interviews, with an emphasis on the importance of an international approach, in view of the next generation RBMPs due in 2015.
All interviewees have been asked if they would be willing to contribute to such a workshop. A number of positive responses have been obtained, especially when the workshop would address issues related to contaminants transport across international borders. The goal of regional water managers would then be to find out the best ways to pick up these matters. For RIWA Maas it would be important that also the participation platform for the Meuse is invited to participate in such a workshop.
However, people in close contact with the IMC advised us not to organize a workshop in this setting, because at present a number of the issues to be discussed are subject of negotiation at a high political level or in dedicated fora. Consequently, it would be impossible, or extremely difficult to bring forward satisfying workshop discussions.
Because of this advice, we decided to use an alternative way to get feedback from Meuse stakeholders on the way P(H)S are dealt with in the RBMP and on results and conclusions drawn from the interviews, regarding the best way to assist P(H)S reduction policy in the DSS, especially in the next generation RBMPs. Therefore, we set up a questionnaire (see annex 2). The questionnaire consisted of two parts. The first part was primarily meant to get feedback on the way P(H)S are dealt with in the RBMP and how it could be improved in the next RBMP. Points are raised such as: does the RBMP offer sufficient insight into the costs and effects of measures for control of point sources, and other management measures? The second part concerned the WFD implementation process and institutional aspects. The aim of this part was to identify possible improvements in the process, specifically with respect to international co-operation.
The questionnaire was sent to the institutions mentioned in Table 3. Where desired or necessary, the persons addressed were subsequently approached by telephone to increase the response.

Table 3 Institutions addressed for the additional Meuse case inquiry

	Organizations
1	CSN
2	RWS
3	Project Office KRW Maas
4	RWS
5	DGW
6	VMM
7	VROM
8	Province of N-Brabant
9	Water board Brabantse Delta
10	Water board de Dommel
11	Water board de Dommel
12	Water board Peel en Maasvallei
13	Water board Roer en Overmaas
14	Water board Aa en Maas
	Stakeholders within Participation platform RBO Meuse:
15	RIWA-Maas
16	Environmental federation of Brabant
17	Port Authority of Rotterdam
18	Agriculture Union of Limburgs
19	Industrial Water Company
20	Environmental federation of Z-Holland

3.2.2 Inquiry results

The inquiry was answered by four water boards (regional water managers), the WFD project office Maas, and RIWA-Maas (stakeholder, representing drinking water companies) (see Table 1). All respondents have contributed to the RBMP, but are not responsible for the final result. Responsible for the final result is the Dutch national government (V&W). Because of the limited extent and response of the inquiry, a statistical analysis is not meaningful. However, the responses contain very valuable signals for a better insight into the WFD implementation in the Netherlands and bring in valuable suggestions for the next generation of RBMPs.

Measures
All respondents state that measures in the national part of the Meuse RBMP should be more related to the defined water quality objectives. To select the most effective measures, the pollution sources should be known. However, this knowledge on sources is not always available. The measures mentioned are general (e.g., prohibition of substances, plans for reduction of use) and not specified to deal with the problem of exceeding standards in certain water bodies or to reduce the responsible pollution sources. The link between the measures mentioned in the RBMP and water quality

improvement is missing. Because more detailed measures are presented in the underlying regional water plans, it is questionable whether the RBMP should be more elaborated in this respect. For two water boards, the P(H)S problem is not considered an issue and in these cases the description of European measures in the RBMP is qualified as sufficient. On the EU and national scale, other types of measures are appropriate than on the regional and local scale. The former are more in the field of admission and application regulation of P(H)S; the latter are more in the field of emission reduction.

One respondent mentions that the measures presented are not ‘new’ (innovative) and show only a continuation of existing policy. This respondent holds the view that a more innovative approach could lead to better solutions. One should think beyond technical measures; sometimes it is more effective to solve financial or executive problems first. In addition, enforcement of rules is also mentioned as an important issue. Unfortunately, taking care that rules are complied with is more difficult than laying down the rules on paper.

An assessment in the RBMP of the efficacy of the measures is performed on a national scale; it is presented as percentages of the water bodies which will reach the chemical and ecological objectives (Ligtvoet, 2008). For the regional water managers however, it is essential to know the effects of national measures on the regional water bodies, in order to estimate the necessary additional measures. In the opinion of the WFD project office, such an assessment is not possible. In the case of regional water management one should follow ‘learning by doing’ (monitoring). The assessment by Ligtvoet and others (2008) also showed that for a number of P(H)S the water quality targets will not be met with implementation of national measures as proposed in the national action programme on diffuse sources (Min. VROM, 2007). It is concluded that objectives for the P(H)S can not be met without European measures (Ligtvoet, 2008).

Availability of the information
All information necessary to write the RBMP was available to the parties involved. Especially water boards have the experience that mistakes were made when their information was used at a different scale. Mistakes can occur when interpreting detailed information to a larger (basin or subbasin) scale; nuances were lost or final conclusions did not match the ideas of the water boards. Another aspect is that information on P(H)S is very technical (e.g., uncertainty on the methods used for setting the objectives) and therefore difficult to value its impact. Because of their direct interest, the drinking water companies (surface water quality) and industry (emission limits) are the only parties interested in the matter of P(H)S. Other stakeholders (such as agriculture and environmental organizations) did not show great interest in matters concerning P(H)S.

Other substances than P(H)S
According to the drinking water sector, water quality problems are not limited to P(H)S. Monitoring data show that several other chemical pollutants are present in surface waters and could form a threat for the production of drinking water (e.g. pharmaceutical components). Although health risks are not quantified as maximum concentrations of these substances, drinking water companies do not allow them to be present in their product. If concentrations of such compounds will increase, purifications techniques will have to be more extensive. According to the opinion of the drinking water sector, such an increase is in disagreement with the content of the WFD (article 7) regarding the protection of water bodies to prevent the need for more complex water treatment technology for drinking water production.

Changes in Dutch water management

The implementation of the WFD has changed a lot in the organization of Dutch water management. All respondents value the increased cooperation and the application of standardized methods (for instance monitoring methods) as a positive change. On the other hand, respondents also notice that the level of ambition is tempered by European obligations of reaching objectives within a certain timeframe. Possible penalties from Brussels if these obligations are not met, are seen as a cause of the low ambition level.

The cooperation within the river basin has improved, both on a national and international (IMC) scale. Most respondents have experience within the IMC and see this Committee as a very formal setting, mainly focused on WFD processes and procedures. Respondents would like to see more initiatives from the IMC for discussions on possible measures to improve the Meuse quality. One respondent thinks a discussion on the subject of problem translocation and how to deal with cross-boundary pollution within the IMC would be fruitful. The IMC is only concerned with the main stream of the Meuse and this is considered to be a problem. More attention for regional water crossing borders is as important (e.g. the Mark, the Dommel, the Roer). At this moment, bilateral cooperation on regional water exists, but the officials involved have no mandate for implementation of the WFD objectives.

The objectives within the WFD methods are well defined. The execution of measures, however, is not clearly stated. In other words, it is not clear who is responsible for taking which measures. In addition, some respondents do not find it clear what happens, if some measures are not taken. The drinking water sector stresses that the responsibility for implementation of WFD article 7 is not clear.

Stakeholder involvement

All respondents agree that stakeholder involvement was well organized on a national level. Stakeholders were well informed during all steps leading to the RBMP and could suggest improvements. In this way, the stakeholders have acted as critical reviewers during composition of the RBMP. However, stakeholders had no decision power and stakeholders were not involved in the Regional Administrative Consultation Group. After publication of the draft RBMP on December 22nd, 2008, stakeholders have six months to give their official views (5.1.1). Based on these views, the final RBMP can be changed.
On an international level, stakeholder involvement was judged to be less adequately organized.

4 Results for the French part of the Meuse river basin

The French contribution in the Socopse Meuse case study consists in implementing the hydrological model PEGASE with cadmium in the French part of the Meuse water district. Cadmium was selected, because – as opposed to e.g. atrazine - emissions are is not forbidden yet, its sources are well identified and it has been researched and found in 2005 in the Meuse watershed. PAHs are more problematic substances in terms of their presence in the watershed, but the model could not be calibrated on these substances. Indeed, there is an important lack of individual data on PAHs and pollution by PAHs seems to be mainly composed of atmospheric deposition, which constitutes too high scientific and technical difficulties for a calibrating exercise.

Once calibrated, the model implementation aims at setting correspondences between abatement measure emission values, associated substance fluxes and concentration values in the watershed. However, because of time restrictions, calibration stage results are presented in this report only. The next step would have been to realize scenario simulations in terms of discharges in the Rhine-Meuse watershed and check how scenario emission values have impact on cadmium fluxes in the watershed.

4.1 Interview results

Several meetings have been organized to pilot the integration of cadmium in the PEGASE model for implementation in the Meuse watershed:

May 15th, 2008: Meeting with Meuse Regional Water authorities
Participants: INERIS, Rhine-Meuse Water Agency, AQUAPOLE unit from the University of Liège (Belgium).
Discussed issues:
- Project objectives;
- Area of concern;
- Reference year;
- Choice over the micro-pollutants;
- Data availability.

October 28th, 2008: Meeting at the French Ministry of Ecology
Discussed issues:
- PEGASE model principles;
- Data collection process;
- Preliminary modelling results and first lessons;
- How PEGASE outcomes are used to calculate predictable fluxes and Emission Limit Values;
- Ending discussion on the fact that the French legislation is treating too many substances (currently about 200 substances), and that they should be distributed into different hazardous level classes. The most hazardous one would then be treated separately.

November 27th, 2008: Workshop on modelling
Participants: French water agencies, local ministry representatives, from all regions of France.
Discussed issues:

- Substance concentration modelling (presentation of first PEGASE results);
- How to build emission reduction strategies at the river basin scale in order to reach EQS? ;
- How to determine Emission Limit Values? ;
- Presentation of PEGASE model principles and outcomes.

March 16th, 2009: WFD hazardous chemical substances: towards operational tools to set local Emission Limit Values and management at the river basin scale
Same issues as November meeting, but a larger audience is expected with presence of industry, scientists …
Presentation of more advanced modelling results with PEGASE and other models (SENEQUE) on the Meuse and other watersheds.

Figure 3: The Meuse valley before confluence with the Chiers tributary in France (picture taken from http://www.riwa-maas.nl/)

4.2 Modeling methodology

4.2.1 General aspects

INERIS has developed a methodology to set Emission Limit Values (ELV, in terms of substance flux) of substance discharges within a water body in a way to reach EQS (in terms of substance concentration) in the whole water body. The approach consists, first, in setting Maximum Acceptable Fluxes (MAF, in terms of local flux in milligrams per day) in a water body in order to reach EQS in this water body, and, secondly, in allocating local ELVs to discharges pertaining to this water body in a way that total discharges do not exceed MAFs. This approach leads to the building of a “panel board”

designed for locally managing an ELV strategy. In other words, this panel board indicates local ELV-MAF correspondences.
Next figure illustrates our general approach.

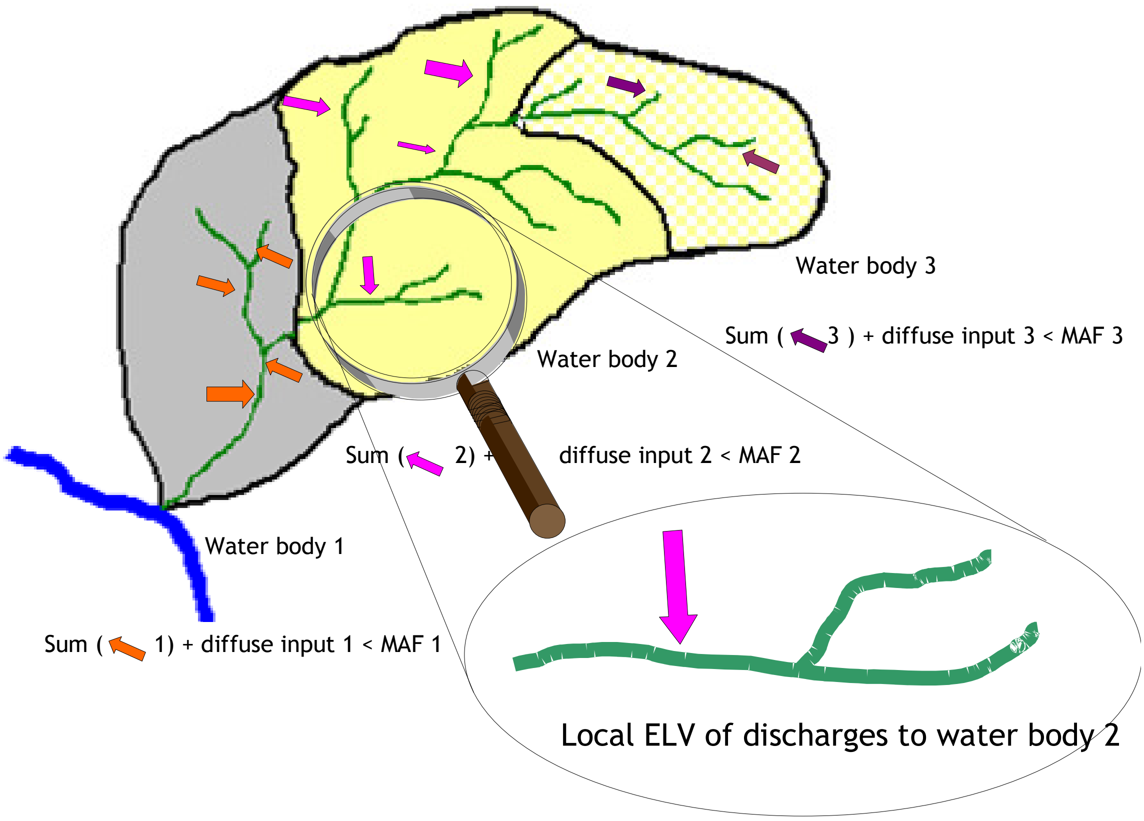

Figure 4: Relationship between MAF and ELV in three water bodies of a watershed

We can observe that in water body 2, the sum of local ELVs (pink arrows) and diffuse sources should not exceed the water body 2 MAF.

In order to get correspondences between local ELVs and a MAF in a water body, we use the PEGASE model (Planification et Gestion de l'ASsainissement des Eaux). This model was developed by the AQUAPOLE unit from the University of Liège (Belgium). It is an integrated model of hydrographic basins/rivers which makes it possible to calculate in a deterministic way river water quality as a function of discharges and pollutant inputs for different hydrological situations:

- Stationary hydrological conditions: hydro-meteorological factors (rate of flow, temperature, insulation) are considered as being constant
- Non-stationary hydrological conditions: hydro-meteorological factors vary every day, which allows calculating yearly evolution of measured concentrations in the overall modelled river basin

It also makes it possible to calculate projections of river water quality which results from treatment measures or discharge abatements.
Inputs and outputs are treated (simulated) and visualized by a Geographical Information System (GIS).

4.2.2 *Socopse modeling*

AQUAPOLE has developed the PEGASE model in order to integrate a sub-model for micro-pollutants such as cadmium.

Micro-pollutant behaviour in surface water is dependent on adsorption and desorption phenomena between water and sediment particles. Besides, these phenomena are also extremely dependent on physical and chemical sediment characteristics (micro-pollutants are strongly adsorbed by small particles like clay and very weakly adsorbed by big sediment particles).

This sub-model is not operational yet for data availability reasons. The currently used sub-model is an intermediate one which, nevertheless, includes mechanisms such as:

- Water transport (liquid phase);
- Transport through sediments in suspension (solid phase);
- Micro-pollutant adsorption from the liquid phase to the solid phase;
- Micro-pollutant adsorption on bottom sediments;
- Desorption of adsorbed substances;
- Sedimentation of adsorbed micro-pollutants in the water column solid phase;
- Possibly, linear degradation.

AQUAPOLE was thus asked to calibrate and validate PEGASE model for cadmium in the French Meuse district using 2005 data from the French Rhine-Meuse water agency and INERIS. The model having been already calibrated for macro-pollutants and for 2005 in the Rhine-Meuse water district[1], time and budget restrictions oriented our choice towards 2005 as a reference year. Besides, simulations were also realised for 2006 and 2007, years for which environmental data were numerous, too.

4.3 PEGASE Input and output

4.3.1 *Input*

Data input for SOCOPSE are the following:

- Watershed description:
  - Surface water cadmium concentrations from RSDE data base (national action on research and reduction of hazardous substance discharges into water)
  - Water agencies' data base networks
- Hydrodynamic (Rhine-Meuse water agency data base)
- Hydrometeo (Rhine-Meuse water agency data base)
- Activities discharges:
  - Urban discharges : Cadmium inputs are estimated per capita equivalent for 1 day (0.13mg/c.day of cadmium estimated)
  - Industrial discharges : data from national inventories (GEREP data base, see Figure)
  - Discharge from cattle : emission factors from Belgium (1 mg/LU of cadmium estimated value for one Livestock Unit)
  - Other diffuse pollution agriculture : emission factors from Belgium (0.075 mg/m^3 of Cadmium estimated in the dissolved phase ; 0.025 mg/m^3 of cadmium in the particle phase)

[1] This calibration was realised in the framework of a study from the Rhine-Meuse water agency.

Except for cadmium discharges from the industry (GEREP data) which are from 2004, all data are from 2005. Besides, cadmium concentration data are from 2005 to 2007. They were collected at three monitoring stations, namely:

- Goncourt (km 45, upstream);
- Donchéry (km 359, downstream);
- Ham sur Meuse (km 469, downstream).

The next figure presents measured cadmium concentrations at these three monitoring points from 2005 and 2007.

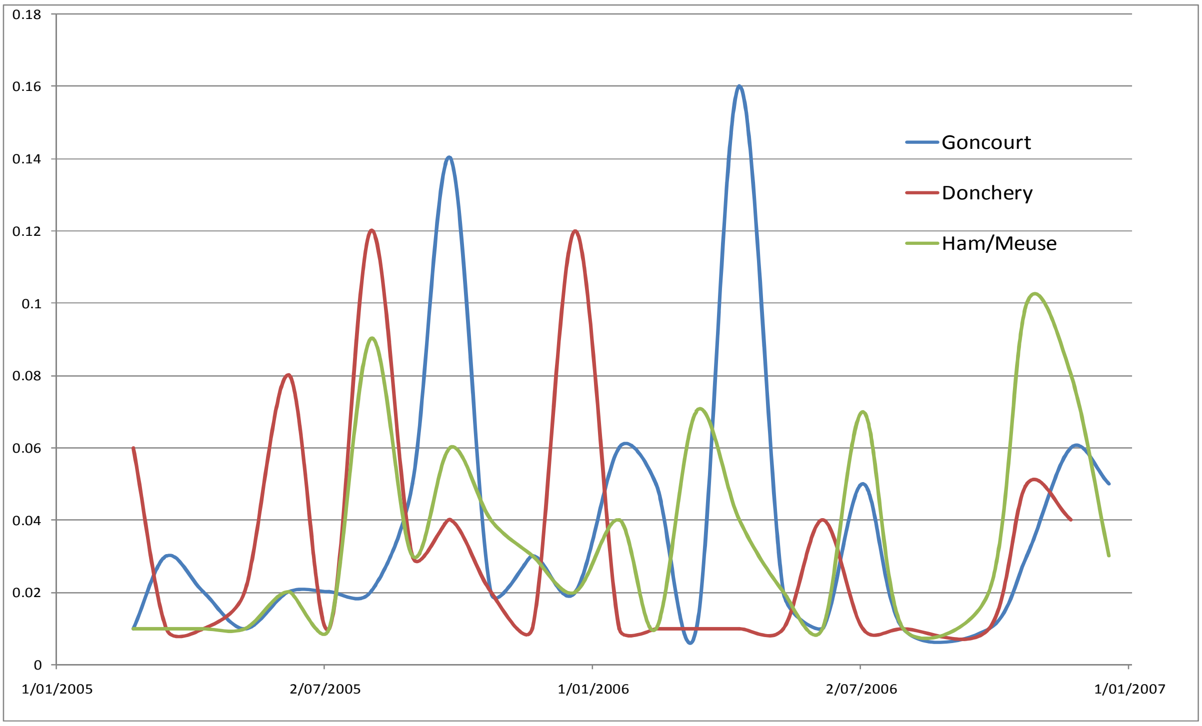

Figure 5: Cadmium concentration from 2005 to 2007 (Source: AQUAPOLE)

We observe that cadmium values are relatively low, but quite fluctuating for every monitoring point. Besides, the more downstream the measure, the smaller the variations.

The GEREP data base provides only three significant industrial discharge points. The next table presents these point fluxes.

Dm	CodeInd	CodeSta	Xreel	Yreel	Iriv	CZIm	DistSour	Tp	TxRac	Debit	Cadmium	Cuivre	Zinc	Plomb	Nom du Rejet Industriel	Nom du bassin
RM	57.011	0	783813	2526565	1	B503	355341	0	0	0.41	0.00	0.00	3.32	0.00	DELPHI SITE DE DONCHERY	Chiers-Meuse
RM	57.011	0	789495	2515141	163	B501	2200	19	0	0.33	0.00	2.08	25.92	0.00	TURQUAIS INDUSTRIE	Chiers-Meuse
RM	62.008	0	833232	2434260	1	B222	175612	84	0	18.63	0.00	496.00	1960.00	0.00	Huntsman Surface Sciences Fı	Moyenne Meuse
RM	62.046	0	819893	2469200	1	B301	235507	89	0	5.04	0.04	4.24	36.08	1.68	PROGILOR BOUVART - Usine	Moyenne Meuse
RM	57.011	0	757829	2545168	78	B551	3900	3	0	0.39	0.60	0.00	4.96	7.80	METALBLANC	Meuse Hercynienne
RM	57.012	9	784411	2529909	1	B503	353141	15	1	7.08	0.82	0.00	45.32	6.68	AGC Automotive Europe Doncl	Chiers-Meuse
RM	57.011	11	785963	2526195	1	B503	348341	84	1	143.26	0.00	368.00	0.56	0.00	TARKETT SAS	Chiers-Meuse
RM	57.011	0	797874	2515835	1	B321	325507	2	0	2.93	0.00	0.00	0.84	0.00	SOLLAC MOUZON	Chiers-Meuse
RM	62.007	744	855906	2502217	185	B401	0	84	1	0.01	0.00	0.00	0.96	0.00	METZELER Automotive Profile	Bassin Ferrifère -
RM	57.011	0	766023	2551623	1	B701	432997	19	0	0.08	0.00	0.00	1.36	0.00	ARDAM	Meuse Hercynienne
RM	62.005	82	844830	2496140	220	B413	20448	3	1	2.83	0.00	2.84	3.04	1.76	FAURECIA Sièges d'Automobi	Bassin Ferrifère -
RM	57.011	0	771297	2532707	1	B560	386714	3	0	1.44	0.00	0.00	3.60	0.00	VISTEON ARDENNES INDUS	Meuse Hercynienne
RM	62.003	0	846400	2505000	137	B402	22163	19	0	7.48	0.00	0.00	11.00	5.48	LORRAINE TUBES (ex ARCEI	Bassin Ferrifère -
RM	62.008	0	849380	2482590	276	B430	1100	19	0	0.22	0.00	0.00	20.00	0.00	SLTS - Dito	Bassin Ferrifère -
RM	62.008	0	838211	2424544	1	B213	154032	2	0	0.74	0.00	16.00	40.00	0.00	TREFILEUROPE COMMERCY	Moyenne Meuse
RM	57.024	0	779252	2529323	112	B504	12378	2	0	0.02	0.00	0.00	44.40	0.00	GALVA 08	Chiers-Meuse
RM	62.003	744	851030	2510240	137	B400	14724	84	1	14.60	0.00	18.00	48.00	1.60	LONGLAVILLE PERFORMAN(	Bassin Ferrifère -
RM	57.011	0	775187	2545611	62	B611	97292	2	0	0.16	0.00	0.00	72.88	0.00	S.M.A.	Meuse Hercynienne
RM	57.012	0	781590	2528504	112	B504	11578	19	0	0.86	0.00	0.00	124.27	0.00	MECANO GALVA	Chiers-Meuse
RM	62.009	0	805976	2503731	1	B315	298184	14	0	195.05	0.00	0.00	253.75	0.00	AHLSTROM LABELPACK	Moyenne Meuse
RM	57.011	0	775631	2529273	1	B520	372236	2	0	0.00	0.00	0.00	992.00	0.00	PCA Peugeot Citroën Automot	Meuse Hercynienne
RM	62.008	564	807202	2490147	1	B307	278418	1	1	595.31	0.00	0.00	0.00	0.00	FROMAGERIES BEL	Moyenne Meuse

Figure 6: Excerpt from GEREP (Source: GEREP, 2004)

Globally, cadmium discharges represent 1.46 g per day, which is a relatively low value.

4.3.2 *Output*

PEGASE outputs are:

- Discharges in watershed;
- Flows and temperatures;
- Biomass production;
- Water quality.

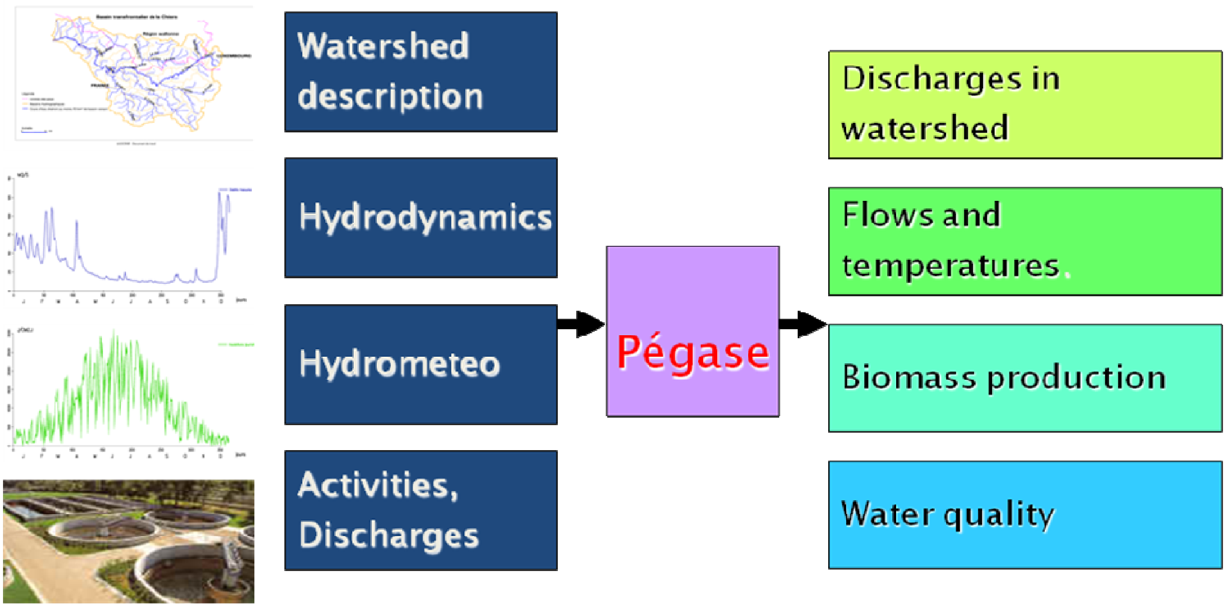

Figure 7: PEGASE inputs and outputs

4.4 Calibration and validation

4.4.1 Principle

Most parameters used by PEGASE are physical parameters. Unlike statistic models, there is thus no global calibration in which parameters are adjusted until getting reasonable harmony between measured values and calculated ones. However, a validation step remains necessary: If it shows a negative outcome, input data must then be checked and some of them may possibly be changed, or even the model itself (if an important process is badly represented).

4.4.2 PEGASE validation for Socopse

Simulation tests were realised for the year 2005. The validation of simulations is based on a comparison between calculated values (total cadmium concentrations: dissolved + particles) and measured values (measurements on raw water) at the Agency's monitoring station network.
The next figure shows simulated and measured cadmium concentrations during the year 2005 at the Ham sur Meuse station.

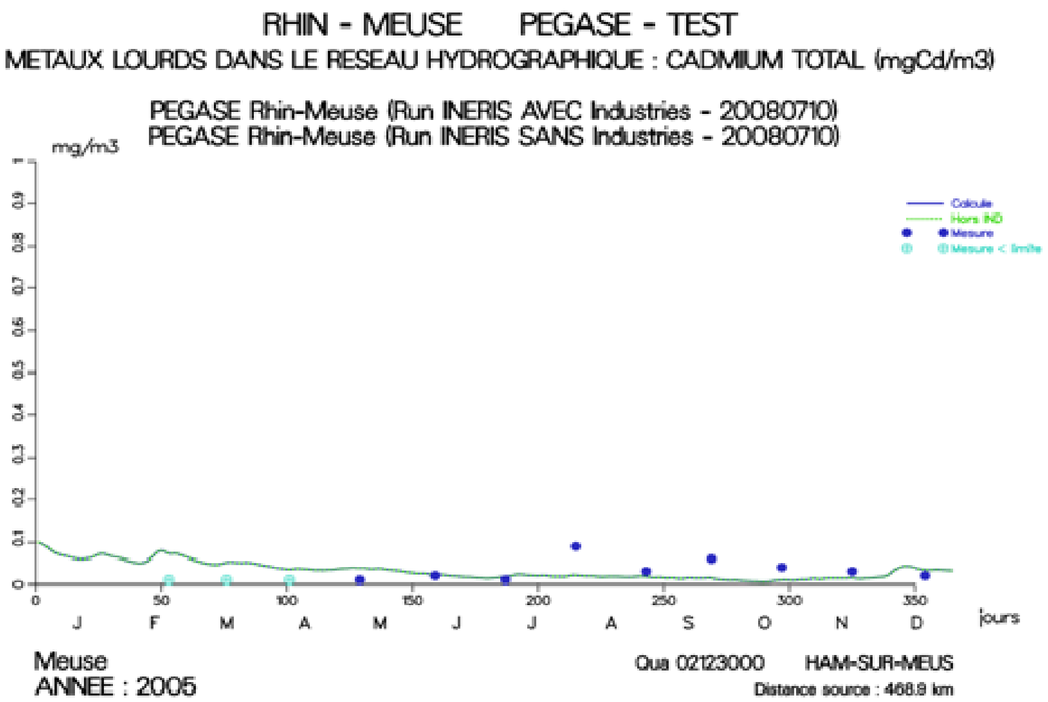

Figure 8: Simulated and measured Cadmium concentration at Ham sur Meuse station during 2005 (Source: AQUAPOLE)

We observe a quite satisfying correlation between calculated and measured values. However, it must be noted that measured values are quite low (closed to "background noise") and that an industrial discharges effect is hardly visible (at least in the Meuse river).

4.4.3 PEGASE validation for Socopse : year 2006 and 2007

The 2005 validation is partial because:

- The number of monitoring stations with usable measures is too low;
- There are uncertainties regarding the quality of discharge data.

Besides, the Rhine-Meuse water agency has increased the number of heavy metal measurements in 2006 and 2007. It has also started to measure dissolved cadmium. It was therefore interesting to realize an additional validation for 2006 and 2007. This involved gathering 2006 and 2007 data on:

- Hydrometeorological characteristics;
- Discharges (except for industrial discharges where 2005 data were reused).

Next figure presents simulated and measured cadmium concentrations in 2007 at Givet station close to the Belgian border (486 km).

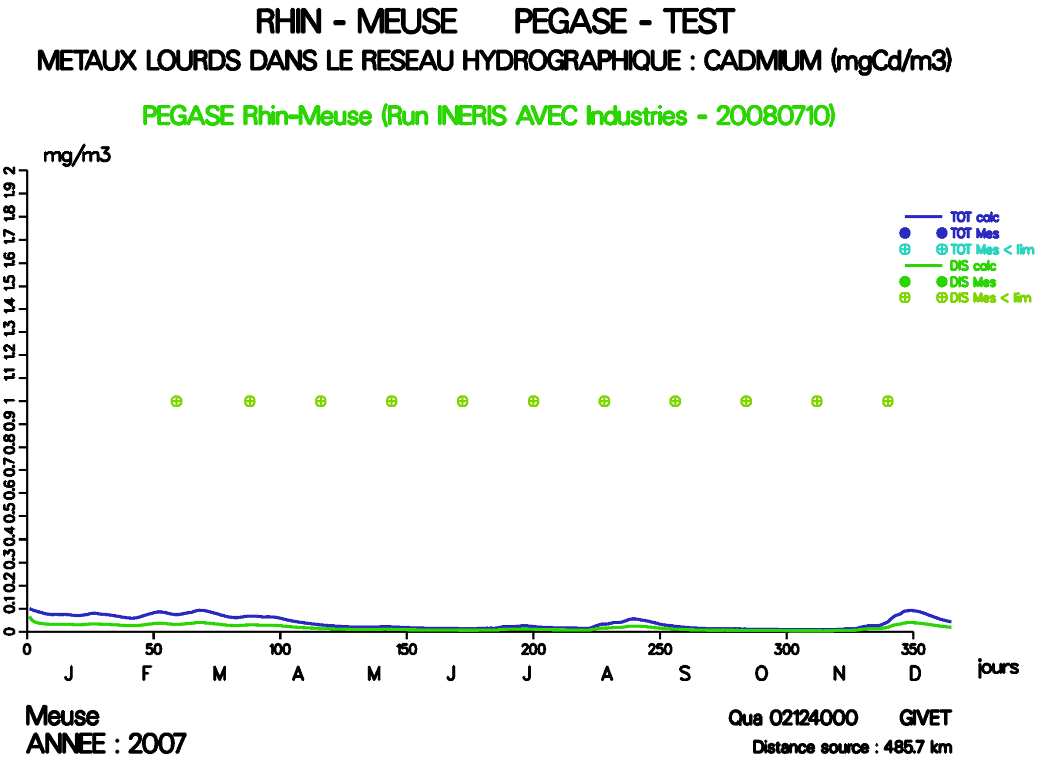

Figure 9: Simulated cadmium concentration and measured dissolved cadmium concentration at Givet station during 2007. Total simulated values are in blue, dissolved simulated values are in green. (Source: AQUAPOLE)

We observe that calculated cadmium values are clearly inferior to the detection limit of dissolved cadmium. Moreover, measured concentrations of dissolved cadmium never exceed the detection limit (1 µg/l). Even if the model does not contradict measurement data, it is not possible to validate it from these measurements.

4.5 The effect of industrial discharges

This section is dedicated to the observation of the impact of industrial cadmium discharges on watershed cadmium concentrations. For that, simulated and measured concentrations are presented in another way: longitudinal profiles from the spring to the confluence of rivers. These profiles were realized on the basis of statistical values calculated from daily simulated concentration values on each point of the hydrological net.

Next figure shows longitudinal profile of simulated cadmium concentrations for year 2005 along the French part of Meuse river. When available, measured cadmium concentrations are presented, too.

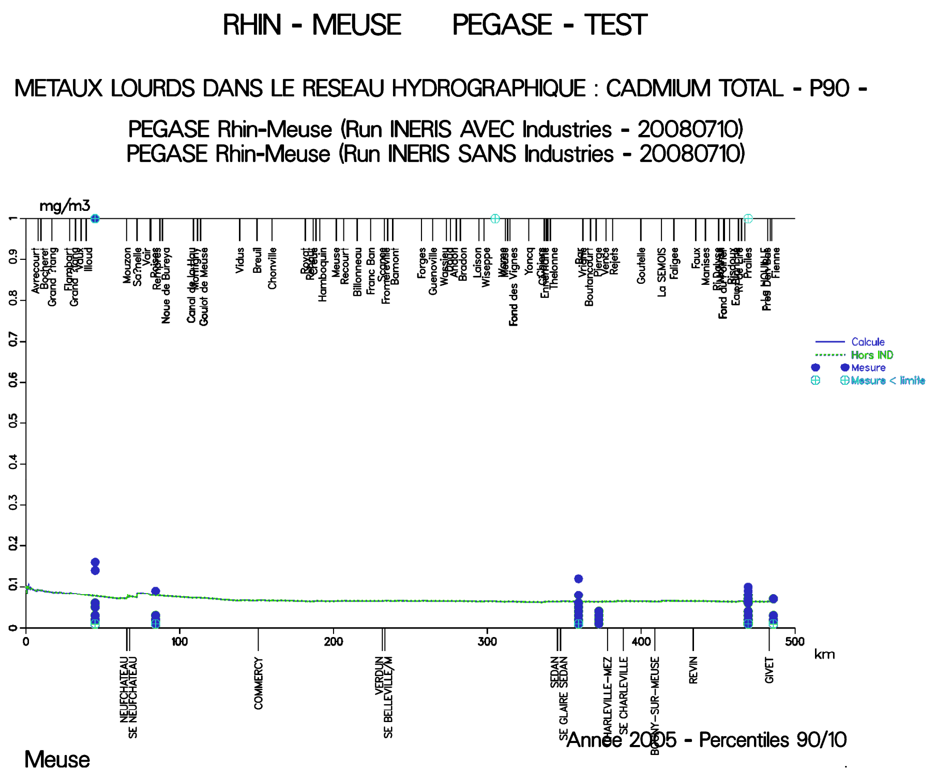

Figure 10: Simulated and measured cadmium concentration along the Meuse in 2005

We can observe two things:

- here is still a good correlation between simulated and measured concentrations;
- There is no significant concentration variation resulting from industrial discharge.

The next two figures show the longitudinal profile of simulated and measured cadmium concentrations, first, along the Rouge Fontaine spring until its convergence to the Sormonne river (km 28), and, along the Sormonne river.

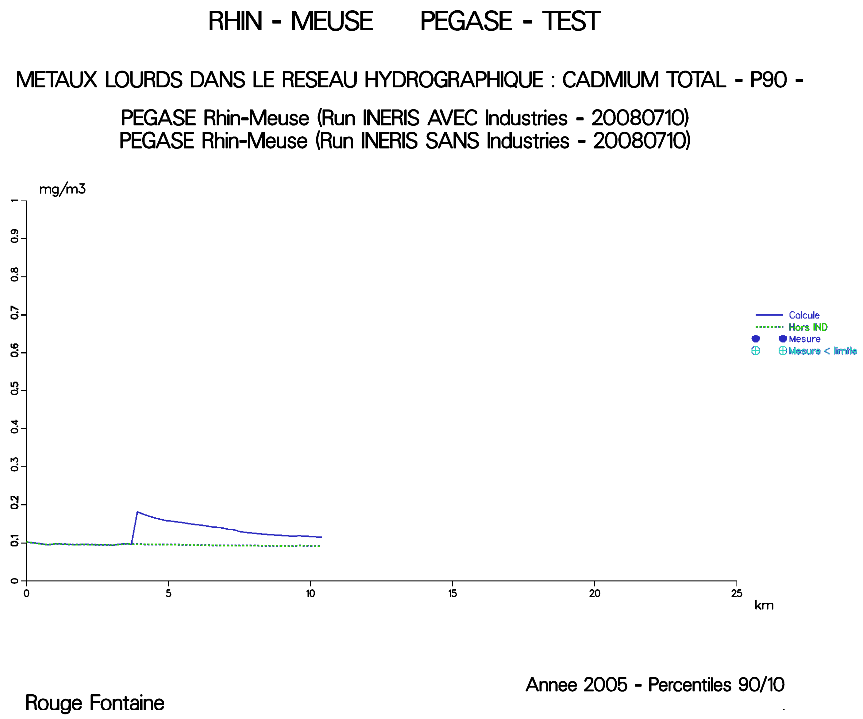

Figure 11: Simulated and measured cadmium concentration along the Rouge Fontaine spring in 2005

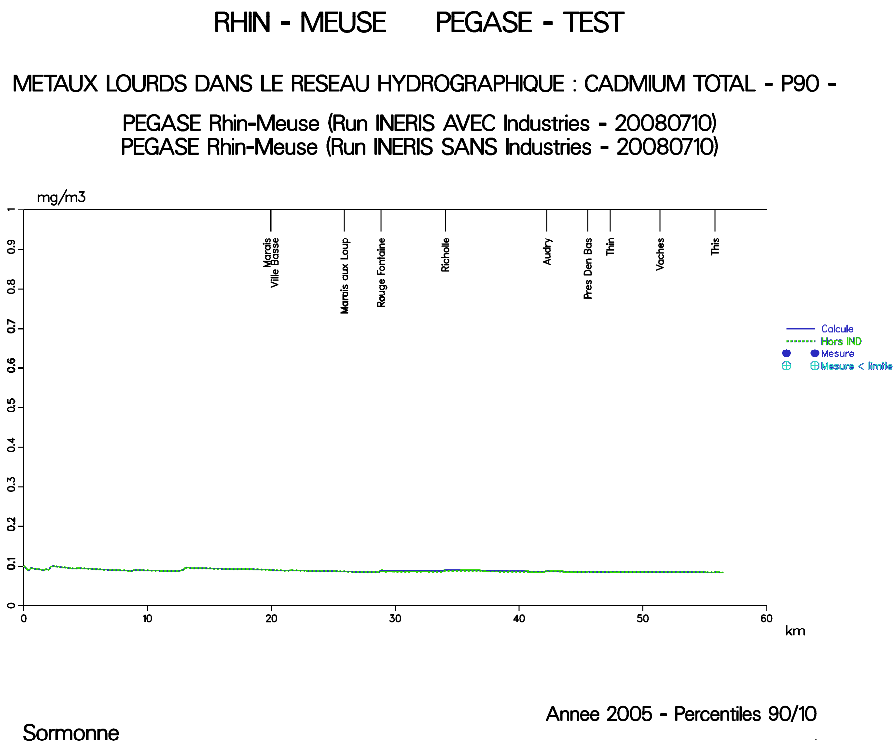

Figure 12: Simulated and measured cadmium concentration along the Sormonne river in 2005

From the first figure, a small, but still measurable impact of cadmium discharge can be observed in the Rouge Moulin spring. However, this concentration variation is not observable anymore in the Rouge Moulin spring confluent (Sormonne).

A first conclusion from 2005 validations/simulations is therefore that the influence of cadmium industrial discharges in the French part of the Meuse river basin surface water is weak and strictly local.[2]
It is also important to remark that cadmium concentration monitoring data should be improved still in order to get a better validated model. A higher validation level would then make it possible to realize scenario simulations.

[2] It should be noted here that this conclusion does not refer to the effect of cadmium spills in the Wallonian Meuse basin that have taken place in the period 2005 - 2006. This resulted in elevated cadmium concentrations in downstream river sections that were observed at various monitoring stations during several months.

5 RBMPs and policy documents

This chapter shows information on the first generation of RBMPs written by the member states of the Meuse river basin (except Germany and Luxembourg[3]). Also the international WFD plan for the Meuse River has been studied. The processes leading to an RBMP differ from state to state. Therefore, each paragraph describes briefly how WFD processes are organized in each Meuse river basin member state.

On a European level, standards have been set for 41 individual substances or groups of substances [EU, 2008 (a) and (b)]. The EU guideline on priority substances has been published in the official Journal of the European Union (2008/105/EC) on December 24th , 2008. Member States are obliged to incorporate this into national legislation within one and a half year, starting 20 days after the date of publication. On a number of conditions, substances can be added to the list in due time. The European Commission has set up a working group that will develop a method to label substances as hazardous before a problem in the water quality arises. This new approach will be based on the characteristics and the use of substances.

5.1 Dutch part of the Meuse rive basin

5.1.1 WFD processes

In the Netherlands, the implementation of the WFD is managed by the national government. Issues that need to be addressed on a national level include basic monitoring principles, and the criteria for denominating the various types of water bodies. All these issues are coordinated by the Ministry of Transportation and Water Management (V&W). As far as possible, however, decisions are made in close co-operation with other relevant ministries, provinces, water boards and municipalities.

A national basin area coordinator has been appointed for coordinating the drafting of the four RBMPs. For each basin area, the regional directorate of the Ministry of V&W (Rijkswaterstaat), provinces, water boards and municipalities[4] have partial responsibility for water issues and must closely co-operate in drawing up the management plans, as well as executing the programme of measures contained in these plans (see also the process description in 3.1.1).

As an obligation of the WFD, three official publications have preceded the RBMPs, the article 3 (list of authorities) [Min V&W, 2004], the article 5 report (characterization of the river basin) and the article 8 report (monitoring programme). For the RBMPs basic information was taken from the national [Min V&W, 2005] and international [IMC, 2005] article 5 reports. These reports give an estimation of pollutant emissions and

[3] The German and Luxembourg plans can be downloaded from http://www.flussgebiete.nrw.de and http://www.waasser.lu , respectively.
[4] The national and local governments in each river basin are organized in a consultation group called RBO (‘Regionaal Bestuurlijk Overleg’). The RBO does not have a legal status, but is a means to organize the co-operation and coordination of the measures within the basin. For the second generation of the RBMPs this organization method will be evaluated.

indicate which water bodies will be at risk of not reaching the WFD standards. In the article 8 report [Min V&W, 2007], the monitoring programme and planned monitoring activities for the Meuse river basin have been described in order to assess the ecological and chemical status of the surface water and groundwater within the river basin (including the protected areas). Special attention has been paid to the water bodies that had been reported 'at risk'.

Public involvement is an important part of the WFD. NGOs are involved on both a national and a regional level. Organizations are given the chance to participate in national or in one of the four regional 'participation platforms'. The platform members have the chance to discuss on important issues, read concept decision-making documents (protocols, methods, standards etc.) and advise the regional or national government. Moreover, these organizations can also participate in different working groups and contribute with their specific expertise in certain areas. The 'participation platform' within the Meuse river basin has 50 members, consisting of representatives from drinking water companies, environmental issue groups, agricultural organizations, industry, commercial and recreational sectors.

The Dutch RBMPs are publicly available[5] from December 22nd, 2008. Until June 22nd, 2009, all stakeholders are invited to give their views. After June 22nd, the RBMPs are adjusted, the stakeholders answered, and the RBMPs will be politically finalized. The schedule is aimed at the closing date of December 22nd, 2009, the day at which the RBMPs should be sent to Brussels.

The measures in the RBMPs – the WFD measures - are incorporated as a chapter on water quality in the water plans of the responsible regional water authorities. These water plans – and (pre-WFD) existing obligations – are also called 'underlying plans'. The relevant authorities are: national government (National water plan), the water boards for the regional surface waters, Rijkswaterstaat (Directorate General for Public works and water management) for the main rivers, canals and big lakes (e.g., IJsselmeer) and the provinces for groundwater. In this way, the Dutch water managers have committed themselves to implement the necessary WFD measures in the water bodies under their authority.

The implementation of the WFD has led to tuning the time schedules of publication of the WFD plans and the existing water plans in the Netherlands. Therefore, the underlying plans are also open for consultation during the same period as the RBMPs, although shorter (six weeks instead of six months). The adaptations of the various plans will be tuned and finalization is synchronized.

5.1.2 *WFD measures*

The standards for the priority substances are implemented in Dutch legislation, 'Decree on Quality Demands Monitoring Water' (in Dutch, BKMW) [Staatscourant, 2008]. The parameters for the good ecological and chemical status, the required water quality at drinking water abstraction points, standards for the quality of groundwater can also be found in this Decree. It is to be expected that the Decree will be in force from the

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[5] Available at http://www.kaderrichtlijnwater.nl/?ActItmIdt=19927

middle of 2009. All Dutch RBMPs have incorporated the standards from the draft version of the Decree.

In the Dutch RBMP, national measures are given, that apply to all water bodies (e.g., legislation on point source pollution, or national measures to reduce diffuse sources). In addition, regional measures are given that are specifically designed to meet the objectives in the water bodies of the Meuse river basin. These measures are described in general terms, for example: purification at 18 POTWs will be improved, or at 44 locations sewage overflow will be reduced. In the underlying water plans, these measures are described in more detail by the responsible water manager.

National action programme on diffuse sources [Min. VROM, 2007]: The programme shows possible measures for each substance which exceeds objectives. It also gives a possible time schedule when (and if) the objectives will be met. The programme distinguishes between priority substances which should be addressed on a European scale and substances which can be sufficiently reduced by taking national measures. The objectives for the priority hazardous substances cadmium and PAHs cannot be met without European measures. A European working group (under the working group E ‘priority substances’) has been established which will identify the sources and formulate necessary measures. These measures will be incorporated in the second generation of the RBMPs.

Measures concerning priority substances are mentioned in one paragraph of the RBMP. These are:

- Permission/admittance of pesticides and biocides will be judged on the basis of criteria to protect human health and environment. The criteria are laid down in Dutch legislation based on EU guidelines (EU91/414 and EU 94/43). With regard to risks for water organisms, the national assessment will be tuned with the WFD objectives for water.
- If necessary, additional guidelines for the application of pesticides and biocides will be introduced.
- Permissions on emission from point sources will be based on national legislation which is in agreement with the European guidance.
- Application of BREFs (Best available techniques Reference documents) or other emission reducing measures to meet the demands of best available techniques (BAT).
- Point source emissions are judged on their effects on water quality by performing an ‘emission / water quality’ test.
- Application of the standstill principle; this is interpreted as maintaining the present level of protection.

Most of the above mentioned measures are related to one of the following European guidelines: the guideline on regulation of plant protection products (91/414/EEG), biocides guideline (98/8/EG), IPPC-guideline (96/61/EG), guideline on pollution of dangerous substances (2006/11/EG, before 76/464/EEG) and the REACH regulation (EC 1907/2006). Therefore, in the RBMPs references are made to these guidelines

The costs of the measures are not given in the RBMP. On a national scale, the WFD costs are estimated at 4.2 billion Euros (2007-2027), significantly lower than the first estimates of 6.5 billion Euros [Ligtvoet, 2008]. The last calculation was presented by the responsible minister to the Dutch Parliament on February 10th, 2009 and was based on the data in the underlying plans of the draft RBMPs. All costs will be covered by water revenues.

The Common Implementation Strategy (CIS) guidances are used as sources of information for the contents of the RBMP for the Meuse. In addition, Dutch protocols are used that are all publicly available. The RBMP gives an extensive list of used reports (57) and shows the websites where most of the reports can be traced. Data on emissions of various sources are publicly available on a website (www.emissieregistratie.nl). This website shows the yearly releases (emissions) of the most important pollutants in the Netherlands and gives an estimate of the quantity entering the Netherlands from neighboring countries. Data on water quality is obtained from the various water authorities. Monitoring data from the Dutch part of the Meuse is publicly available (www.waterbase.nl)

5.2 Belgian part of the Meuse rive basin

Environmental issues are the responsibility of the three districts of Belgium (Brussels, Flanders and Wallonia). Therefore, two RBMPs refer to the Belgian part of the Meuse basin; one Flemish and one Walloon plan. The federal government is authorized – as far as the WFD is concerned – to establish product standards, economical aspect of drinking water production and permission or legislation of pesticides or biocides.

An important federal initiative is the federal programme PRPB (Programme for Reduction of Pesticides and Biocides). This program aims at risk-reduction of 25% by 2010 for agricultural pesticides (reference year 2001). For non-agricultural use of pesticides and biocides the target is 50% risk reduction. A method (called PRIBEL) is introduced to measure the evolvement of the risk factor. Measures in the Flemish and Walloon RBMPs are initiated by this federal programme.

5.2.1 WFD processes and measures in the Flemish part of the Meuse rive basin

The Coordination committee Integrated Water management (CIW) is the Flemish authority for implementing the WFD. Writing the RBMP for the Flemish Meuse is another CIW responsibility. CIW coordinates between the different authorities and stakeholders. Each authority has still its own water plan showing the local responsibilities. The RBMP is publicly available and open for consultation from December 16th, 2008, until June 15th, 2009[6]. After that date the RBMPs will be finalized and sent to Brussels.

The Flemish RBMP includes also measures concerning the quantity of surface water, flooding and safety and polluted sediments. In this respect the Flemish RBMP is much broader than the Dutch or Walloon plan.

For the water quality it gives the planned measures, as well as the additional measures necessary to meet the WFD objectives. It is not yet sure which of the proposed additional measures will be executed. An analysis of costs versus effectiveness will be decisive. This analysis has still to be performed. Similar to the other RBMPs, the

[6] Available at http://www.volvanwater.be/stroomgebiedbeheerplan-maas/overzicht-downloads

measures are described in general terms, they are not quantified and no estimate of the effects on water quality is given.

The Flemish RBMP does not include a specific paragraph on priority substances. The following proposed measures will reduce the emission of some of the priority substance and have a positive effect on the chemical water quality:

- Stricter criteria for permissions
- Zones along water bodies where use of pesticides is not permitted.
- Stricter guidelines for the use of pesticides.
- Improving the percentage of households connected to a POTW.
- Reducing the emissions from sewage overflows.

The RBMP does not refer to the CIS guidances.

5.2.2 *WFD processes and measures in the Walloon part of the Meuse rive basin*

In Wallonia, the responsibility for the application of the WFD lies with the Direction Générale Opérationnelle de l'Agriculture, des Ressources Naturelles et de l'Environnement de la Région Wallonne (DGARNE), the former 'Direction Générale des Ressources Naturelles et de l'Environnement' (DGRNE). Stakeholder consultation started on June 16th, 2008 and ended on December 16th, 2008. The RBMP is available on the internet[7] and views can still be sent in. In addition, another consultation period is planned in 2009.

A large number of measures are given in the Walloon RBMP. The description is general and not quantified. The Walloon district is investing enormously in building POTWs and connecting households to these plants. These efforts are induced by the Council Directive 91/271/EEC concerning urban waste water treatment and will result not only in reduced emissions of nutrients, but also of priority substance to the surface waters of the Meuse river basin.

The Walloon RBMP does not have a specific chapter on priority substances. However, it does contain measures on 'industries'. The RBMP states that Wallonia meets the IPPC standards and other industries are subjected to national legislation.

The measures which aim at a reduction of the emission of pesticides will also effect the emission of some priority substances. Several measures are proposed, for example:

- Zones along water bodies where use of pesticides is not permitted.
- Retraction of permission for certain substances. No criteria or examples are mentioned.
- Guidelines and certificates for the use of pesticide will be introduced.
- Stimulation of non-chemical treatment of plant diseases or pests.
- Giving good examples 'bonnes pratiques et bonne gouvernance')
- Research measures to assess the pollution of drinking water resources (groundwater) by pesticides.

The RBMP does not refer to the CIS guidances.

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[7] Available at http://environnement.wallonie.be/directive_eau/pg/tm.asp

5.3 French part of the Meuse rive basin

5.3.1 WFD general implementation

Since 1964, France has been managing its water resources by river basin. Its territory is divided into six river basins, one of which is the Rhine-Meuse river basin. Each river basin has a political organization and a technical one. The political organization is composed of the Basin Committee and of the Basin Administrative Commission. The technical organization is composed of the Water Agency and the Regional Directions of the Environment (DIREN) of the administrative regions localized in the water basin. A French river basin may include one or more WFD equivalent districts. The Meuse river basin is one of the two Rhine-Meuse river basin districts.

The WFD was transposed in the French law on April 21st, 2004. Its implementation relies on five main steps:
- Characterization of the hydrographic district by 2004 (WFD, article 5);
- Establish the register of protected areas by 2004 (WFD, article 6);
- Implementation of a monitoring program by 2006 (WFD, article 8);
- Establish a river basin management plan by 2009 (WFD, article 13);
- Definition of a program of measures by 2009 (WFD, article 11).

As regards the river basin management plan building, France has some specificities, acquired from its water management organization. WFD management plan prescriptions are integrated in currently implemented management schemes called SDAGE (Water Settlement and Management Scheme - Schéma Directeur d'Aménagement et de Gestion des Eaux). Former SDAGEs applications being wider than WFD river basin management plans, revised SDAGEs will cover a larger field than the WFD (for instance, flooding risk prevention, aggregate extraction, security of drinking water supply…).

In the Meuse river basin district, the three first steps (WFD articles 5, 6 and 8), have been realized (the consolidated document was adopted by French authorities May 24th, 2005) and the two last ones are in progress[8].

The main conclusions of the Meuse river basin water state assessment[9], i.e. WFD article 5, are that the principal causes for designating water bodies as being "at risk" by 2015 are:
- for surface waters: pesticides, modifications of and discontinuities in the water course (hydro-morphology), nitrogen, phosphorous and organic pollutants.
- for groundwater: excessive abstraction and contamination by nitrates and pesticides;

Two SDAGEs have been adopted, one for the Rhine district, one for the Meuse district. In order to integrate management plan prescriptions, the Meuse district has initiated the revision of its SDAGE in 2005. Until its adoption, expected in 2009, the current SDAGE remains implemented (it was adopted in 1996). The Meuse SDAGE revision is carried out through the following steps:

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[8] Dedicated internet site on the WFD implementation in both Rhine and Meuse districts: http://www.eau2015-rhin-meuse.fr/dce/site/index.php
[9] Available at http://www.eau2015-rhin-meuse.fr/fr/etat/district-meuse/index.php

- Definition of a pre-revised SDAGE project[10] by political organizations (Basin Committee and Basin Administrative Commission) by 2007;
- Submission of the pre-revised SDAGE project to public consultation in 2008[11];
- Submission of the pre-revised SDAGE project to the local assemblies (department and regional councils, Chamber of Commerce, Chamber of Agriculture, …) beginning of 2009.
- Entry into force of the revised SDAGE expected on January the 1st, 2010.

The river basin technical organization ensures the management and the follow-up of the whole approach.
Concerning the program of measures, the same calendar and approach are being pursued.

The Meuse pre-revised SDAGE is composed of the following six issues:

1. Health: to improve the sanitary quality of water destined to human consumption and swimming
2. Pollution: to guarantee good quality of all waters, superficial or underground
3. Nature and Biodiversity: to regain fundamental ecological equilibrium of the aquatic environment
4. Scarcity: to avoid overexploitation of water resources
5. Land management: to integrate balanced management principles of water resources into land management
6. Governance: to develop, into an integrated approach at the Meuse and Rhine river basin scale, a participative, united and trans-boundary water management.

Each of them is composed of sub-issues at stake, in which orientations and their respective motivations are developed. A programme a measures is then suggested by orientation.

5.3.2 *Implementation of the WFD part on priority substances*

WFD articles on priority substances and the Council Directive 76/464/CE on pollution caused by certain dangerous substances discharged into the aquatic environment have been transposed into the French law in the National Programme on the Reduction of Hazardous Substances in Water (Programme National de Réduction des Substances Dangereuses dans l'Eau – PNRSDE). This text encompasses about 100 substances among which the 33 WFD priority substances and eight pollutants from Annex I of Directive 76/464/CEE.
Besides, the Ministry of Ecology circular letter of May 7th, 2007 defines "Provisional Environmental Quality Standards" for the 41 substances involved in the water body chemical state assessment (33 from WFD and eight from Directive 76/464/CEE) and for other relevant substances from the PNRSDE. This circular letter sets national objectives on these substance emission reductions, too. The achievement of these objectives implies the implementation of mitigation measures for industrial discharges (IPPC plants) and other sectors, too (craft industries, agriculture, domestic uses, …). Mitigation measures require, among other, the setting of emission limit values in discharges which should enable to get EQS conformity.

In the Meuse pre-revised SDAGE, priority substances are more particularly treated in:

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[10] The pre-revised SDAGE project defined by political organizations aims at achieving a good water status in 60% of body of waters by 2015 thanks to implemented programs of measures by this date.
[11] Available at http://www.eau2015-rhin-meuse.fr/dce/site/documents_bassin_rm.php

- The 1st issue (Health) as regards the guarantee to provide, in a continuous way, a good quality drinking water: Proposed measures are (i) *to complete knowledge on sold and used quantities of hazardous substances until 2012,* (ii) *to assess the impact of risky substances on the environment until 2015.* Other emerging pollutants than priority substances are also considered (e.g. antibiotics).
- The 2nd issue (Pollution) as regards the monitoring and reduction of emissions of substances with toxicity risks. Proposed measures are (i) *when delivering discharge permits to economic activities using priority substances, the Community must take SDAGE priority substances objectives into account*, (ii) *when priority substances and hazardous priority substances are observed in influent of waste water treatment plants, water police services must impose a diagnosis study in treatment agglomerations of more than 600kg DBO5 in order to determine the origin of priority substance flux. These studies may beneficiate of a public subsidy according to eligibility conditions into force.* This global orientation aims at favoring the reduction of toxic substances discharges at the source. "Toxic substances" include WFD priority substances and other substances identified as toxic in the PNRSDE.
- The 6th issue (Governance) on anticipation by implementation of a long term water management giving equal importance to the different sustainability pillars, namely economical, environmental and social aspects. The proposed measure is that *priority substances and hazardous priority substances sources must be limited at the source.* Other emerging pollutants than priority substances are also considered (e.g. antibiotics).

5.4 International Meuse District

On December 3rd, 2002, France, Luxemburg, Germany, the Netherlands and Belgium (and its regions: the Walloon Region, the Flemish Region and the Brussels-Capital Region) signed the International Meuse Treaty in Ghent, Belgium. In this Treaty the International Meuse Committee (IMC) was established. Purpose of the international co-operation is a sustainable and integrated water management of the Meuse river basin. The Meuse Treaty has become effective on December 1st, 2006.

One of the IMC tasks is coordinating the obligations of the WFD (www.meuse-maas.be). Therefore, the IMC is responsible for the international RBMP. Each member state should include this international part into their national RBMP that is sent to Brussels (art. 13 WFD). On December 22nd, 2008, the draft international RBMP has become available[12]. It will be finalized after the end of the consultation rounds of the IMC members.

No new information on measures is found in the international RBMP of the Meuse district. This plan summarizes the contributions of the members of the IMC. The IMC states that the priority substances constitute a problem for the water quality and the quality of sediment of the Meuse River. The plan concludes that the European standards for the priority substances cannot be met in all water bodies in 2015. This compliance will be postponed to 2021 or 2027.

In addition to the priority substances, the IMC has appointed a few 'river basin relevant substances'. These are: the nutrients (total load of N and P), copper, zinc and PCBs. The

[12] Available at http://www.meuse-maas.be/files/files/projet_pfpg_meuse_n_def.pdf

reason behind the selection of these substances is that the present concentrations prevent the good ecological status of certain water bodies of the Meuse. In order to reduce the concentrations of these substances, the members of the IMC have committed themselves to collaborate.

6 Conclusions

6.1 P(H)S reduction options in the RBMPs of the Meuse river basin

Due to the obligations of the WFD, the information on the measures aimed to improve the water quality of the Meuse can be compared. The RBMPs of the Meuse river basin for the different countries / regions do not have the same structure, which makes direct comparison difficult. For example, the Belgian plans are more focused on the sources and therefore do not contain a separate paragraph on the measures for priority substances. Relevant similarities between the studied RBMPs are:

- Good chemical status will not be reached in 2015. In all RBMPs chemical objectives are deferred to next planning periods (2021 or 2027).
- The RBMPs show a large number of measures on reduction of pollution from municipal wastewater and agriculture (nutrients, BOD, pesticides, ...). Particularly the planned waste water treatment plants in the Walloon Region are promising in this respect. These measures will also result in reduction of P(H)S concentrations.
- The largest efforts are aimed at improving the hydro-morphological situations and reducing the nutrient levels to create better conditions for a good ecological status of the Meuse.
- For the chemical status, emerging substances were not mentioned. However, the Dutch RBMP states that a research program has been developed on the impact of emerging substances in water (e.g. pharmaceuticals).
- A large number of measures (good agricultural practice, e.g. buffer strips) aim at the reduction of agricultural pesticides emissions to surface water and groundwater. This will also affect some P(H)S.
- The implementation of the WFD has not changed existing institutional settings. Additional organisations, however, have been created for the implementation of the WFD. The main task of these organisations was to coordinate the information and to tune the national and regional policy (e.g. CIW in Flanders and CSN in the Netherlands).
- The completion of the first RBMPs has led to an increased coordination on water quality issues between various authorities within each member state.
- Links to the Marine Strategy Framework Directive are not included in the RBMPs.
- Knowledge on the effects of measures on water quality is not available. In the Dutch RBMP this is noted as ‘issues-to-be-addressed in the future’.
- Little or no attention is paid to the problem that quality targets cannot be reached as a consequence of contaminants input from upstream areas (translocation, see below).
- In the RBMPs no distinction is made between PS and PHS.

Reduction of point sources is regulated by the IPPC guideline. The competence of water managers is restricted to imposing BREFS and other IPPC standards. They cannot stipulate product requirements or specify more enhanced treatment measures than best available techniques. Therefore, only very little improvement can be expected from tackling industrial emissions. Diffuse sources of P(H)S emissions can still be reduced. On a local or regional level, water managers are able to take concrete measures for reduction of diffuse pollution, more often than it would seem possible, given the apparent dependence on national policy.

The problem of translocation (in Dutch: ‘afwenteling’) is an important issue in sustainable river basin management. Different types of translocation can be distinguished:

- Translocation in time (either in the short term, or to next generations)
- Translocation in space (to upstream or downstream river basin stretches, or to other environment compartments (soil, water, sediment)
- Translocation to another function (agriculture, nature, safety, ...) or another institution

Some types of translocation may lead to legal consequences. Important questions are:

- Which mutual responsibilities and which interests are relevant?
- How can translocation effectively be made explicit in such a way that it entails further action?

These questions can be raised for all policy levels or scales that are present within the river basin (international, river basin, national, regional, local). It is important that these issues are addressed in an objective way in the next RBMPs.

6.2 Recommendations for the next generation of RBMPs

From the inquiry results a number of recommendations for river basin management and the next generation RBMPs can be summarized:

- Adjust management scale to the specific problem (source characteristics, emission routes). Frequently occurring high concentrations require different measures from incidental concentration peaks. Local problems require local investigations and local management. For P(H)S that pose a basin-wide problem, measures should be taken on a national or EU level, e.g. in the field of P(H)S admission, application regulation and other legal measures to reduce diffuse emissions. On a regional level, measures that regulate or reduce local emissions are appropriate.
- In the selection of measures always check the degree of application of existing regulation first. Often substances are still used due to lack of knowledge or enforcement. Enforcement of existing laws and regulations may be more effective than creating new rules or imposing new measures.
- Evaluate the effects of measures taken in relation to water quality objectives within water bodies, insofar these effects can meaningfully be assessed.
- More creative power when formulating measures; think beyond existing technological measures; more focus on strategic dialogues about sustainable development and turning back trends; less on technical details.
- In the up-scaling of the management level (from regional water management plans via the national RBMPs to the international basin management plan), be aware of pitfalls in haphazard abstraction and combination of detailed (local) data. Otherwise, decisions on measures taken and priorities selected will not be understood at the local level.
- Increase international cooperation; enhance the influence of the IMC on the regional level in bilateral border committees.
- Pay more attention to the issue of international problem translocation (in Dutch: “afwenteling”); make efforts in bringing together emittents and affected parties.
- A further harmonization of the content of the various water plans on a regional, national and international scale would be advisable.

- The responsibility for meeting the WFD article 7 targets (long-term decrease in purification efforts for drinking water production) should be more clearly stated. In the RBMPs it should be made explicit how this obligation will be fulfilled.
- Pay more attention to the new substances; emerging substances are likely to create more and more water quality problems in the future.

When a lack of information or high uncertainty is established, this can either be accepted (using a risk management approach), or it can be decided to work on knowledge improvement (including learning by doing, if this is feasible), or on learning to deal with differences. See the paragraph on handling uncertainties in 6.4.

6.3 The WFD implementation process

The WFD has resulted in a number of important advantages. It has been an impulse for taking up treatment of municipal wastewater in Wallonia, which will lead to a better water quality in the near future. On the national level it has led to more cooperation of regional authorities with national authorities, to an enhanced connection between water quality management and ecological management and to a better cooperation of water boards with regional and municipal authorities, stakeholders and knowledge institutions. Furthermore, it has been an impulse for the improvement of data management (e.g. standardized presentation of monitoring data) and for the development of a decision support system (WFD Explorer) with an integral view on water quality and ecology, pressures, measures, effects, costs.
From the inquiry results the following recommendations for the further progress of the WFD implementation can be noted:

- Mandate regional water managers for WFD implementation on cross boundary regional waters issues. International cooperation for WFD implementation should not only cover the main stream of the river, but also the smaller transboundary rivers and brooks. Cooperation on water quality issues does take place, but the interviewees feel the need for a more official structure to implement the WFD when transboundary issues are involved for small rivers and brooks.
- More focus on WFD goals; less on WFD procedures.
- Improve stakeholder involvement on the international level; put effort in interesting stakeholders.
- Combine the WFD implementation process with that of the EU directive on floods (in the Regional Administrative Consultation Group).

6.4 Recommendations for the Socopse DSS

Recommendations for the DSS were extracted from the results of the interviews and enquiries and from the own observations made by the authors of this report. Below, a number of recommendations are presented. Some of them may be immediately applicable to the present Socopse DSS; others may be too sweeping or drastic for an immediate application and can be seen as suggestions for a ‘next generation’ DSS.

Enhance DSS flexibility

- Adapt the DSS in such a way that it is easier to apply for new/other substances. For instance, by adding specific measures for emerging/new/other substances.

- Adapt the DSS scheme in such a way that it can be used by policy developer as a target group. This would imply a pre-selection of policy instruments and would make it easier to include a complete set of measures aimed at reduction of diffuse pollution.
- In the present DSS shifting to other policy fields is tackled in Step 6 as ‘other effect’ to be weighted with MCA or SCBA. It would be better to set up the DSS at a higher level in which policy measures are included in the set of measures to be evaluated (see previous and next item).
- In order to broaden the scope of the DSS and enhance the practical usefulness, the effects of measures on ecology should be taken into account. In that respect, it may be worthwhile to investigate the possibilities of a combination with other support tools being developed, such as the WFD Explorer in the Netherlands.

Increase user-friendliness
- Make the DSS as concise as possible, at least for the ‘average’ user
- Starting-up the DSS, a clear user guide for the DSS should be presented to the user, from which he gets a clear picture:
    - what he can expect (and evenly important) what he cannot expect from the DSS
    - which are the targeted user groups of the DSS
    - if different targeted user groups are distinguished, for each group the specific support they can expect from the DSS should be indicated
    - which types of measures are included in the DSS

Extend the information on measures
- Include information on applicability for other substances. For instance, a measure could have added value if it applies to more P(H)S, but it has even more added value when it applies to copper, zinc, emerging substances and/or nutrients, too. Therefore, the fact sheets with measures should provide information on the application range of the measure (for which substances does this measure apply) to facilitate combination of measures.
- Include information on parties/stakeholders that need to be involved in the implementation of the measure. This depends on the local situation (institutional aspects, legislation, etc.).
- Include information on the implementation feasibility of the various measures. This includes technical and legal feasibility, but also support from stakeholders, etc.
- Indicate which parties/stakeholders take direct or indirect advantage or disadvantage from the measure. This depends on the local situation (institutional aspects, legislation, etc.).
- Add non-technical measures, for instance measures that act upon people’s behaviour
- Include information on the time of implementation of a measure
- Quantify cost figures of the measures as much as possible
- Provide a preference list of measures (e.g. prefer source control measures over end-of-pipe measures)

Handle uncertainties
- Quantification of the effects of measures is very difficult. At present, the approach is more directed towards ‘learning by doing’ (adaptive management). When a ‘next generation’ DSS is built, this should be suited for such an approach.
- Provide the DSS user with tools to handle uncertainties. Useful guidelines for handling uncertainties in adaptive water management can be found in Brugnach (2009). Combining three type of uncertainty (unpredictability, incomplete knowledge and multiple knowledge frames) with the three sub-system types of a

river basin system (natural system, technical system and social system) a comprehensive overview of existent uncertainty can be obtained. As a general approach for dealing with uncertainty is suggested: create solutions that are flexible and easy to adapt to changing conditions and unexpected developments. The type of uncertainty determines the strategies needed:
  - Coping with unpredictability requires “Accepting not knowing (better)”; relevant strategies are: to develop robust solutions that are suitable under different scenarios, and /or to diversify the measures and solutions applied making sure that at least one measure is effective;
  - Coping with incomplete knowledge requires “Work on improving knowledge”; relevant strategies are: to estimate uncertainty ranges (confidence intervals), and /or to collect more data or to carry out research to improve factual knowledge.
  - Coping with multiple knowledge frames requires “Learning to deal with differences”; relevant strategies are: cognitive problem solving, and /or dialogic learning.
- For the French part of the Meuse basin, INERIS concludes that the DSS requires a large amount of information, which raises two issues at least:
  - data may not be available
  - data may show aberrant values

  Then, using hydrological models in DSS (step 0 to 2) is a solution to tackle both problems. It makes it possible to
  - create data on concentrations in the watershed from emission flux information, and
  - check if collected data values are reasonable according to the model outcomes.

7 References

Brugnach, M., 2009	Uncertainty in adaptive water management. Concepts and Guidelines M. Brugnach, H.J. Hendriksen, P. van der Keur and J. Mysiak (eds) University of Osnabrück, Insititute of Environmental System Research, Osnabrück, Germany 2009
Busch, S. (ed.), 2004	Characterization of the Meuse river basin in the Netherlands (in Dutch, draft), commissioned by Regionaal Bestuurlijk Overleg (RBO) Maas
van Duijnhoven, N., 2008	KRW artikel 5: belasting grond- en oppervlaktewater N. van Duijnhoven, B. van der Grift, N. de Boorder Achtergronddocument update, Deltares report under commission of RWS Waterdienst, 2008
EU, 2000	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
EU, 2007	Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks
EU, 2008 (a)	Proposal for a Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and 2000/60/EC- outcome of the European Parliament's second reading, Strasbourg, June, 16-19, 2008
EU, 2008 (b)	Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council, Official Journal of the European Union, L 348/84, December 24, 2008
IMC, 2005	International River Basin District Meuse – Analysis, Roof Report, International Meuse Commission, 2005
IMC, 2008	Ontwerp van het overkoepelend deel van het beheersplan voor het internationale stroomgebiedsdistrict van de Maas (in Dutch, also available in French and German) International Meuse Commission, December 2008 http://www.meuse-maas.be/files/files/projet_pfpg_meuse_n_def.pdf

Ligtvoet, 2008	Kwaliteit voor Later Ex ante evaluatie Kaderrichtlijn Water. Planbureau voor de Leefomgeving (PBL), Bilthoven, June 2008. PBL publicatienummer 50014001/2008 (in Dutch)
Middelkoop, H. (ed.), 1998	Two rivers: Rhine and Meuse in the Netherlands, RIZA-report 98.041, 1998 (in Dutch)
Min V&W, 2004	List of authorities WFD Meuse (in Dutch). Article 3 report (2000/60/EC). http://www.kaderrichtlijnwater.nl/publicaties/de_krw_rapportages/
Min V&W, 2005	Characterization of the Meuse river basin in the Netherlands (in Dutch). Article 5 report (2000/60/EC). http://www.kaderrichtlijnwater.nl/publicaties/de_krw_rapportages/
Min V&W, 2007	Background report WFD Monitoring Meuse River Basin (in Dutch). Article 8 report (2000/60/EC). http://www.kaderrichtlijnwater.nl/publicaties/de_krw_rapportages/
Min. VROM, 2007	Uitvoeringsprogamma diffuse bronnen waterverontreiniging (in Dutch) December 2007, Ministerie van VROM
NBW, 2003	Nationaal Bestuursakkoord Water (in Dutch), Den Haag, July 2003 www.helpdeskwater.nl/aspx/download.aspx?File=/publish/pages/473/nationaal_bestuursakkoord_water.pdf
Oosterwijk, 2008	Onzekerheid in implementatie Kaderrichtlijn Water (in Dutch), Milieudossier, 2008-5, pp. 26-28
PBL, 2008	Kwaliteit voor Later, Ex ante evaluatie Kaderrichtlijn Water. Planbureau voor de Leefomgeving (in Dutch) Bilthoven, June 2008. PBL publication nr. 50014001/2008 http://www.planbureauvoordeleefomgeving.nl/nl/publicaties/ex-ante-evaluatie-kaderrichtlijn-water
Project Office Meuse, 2008	Basisdocument KRW Maas – bestuurlijke samenvatting, toelichting en achtergrondnota's. (in Dutch), http://www.kaderrichtlijnwater.nl/uitvoering/maas/publicaties/
RBMP Dutch Meuse, 2008	Stroomgebiedbeheerplan Maas, 2008 (in Dutch) http://www.kaderrichtlijnwater.nl/?ActItmIdt=19927
RBMP Flemish Meuse, 2008	Ontwerp Stroomgebiedbeheerplan voor de Maas, 2008 (in Dutch) http://www.volvanwater.be/stroomgebiedbeheerplan-maas/overzicht-downloads
RBMP French Meuse, 2008	Programme de mésures 2010-2015 du district Meuse et Sambre (in French) http://www.eau2015-rhin-meuse.fr/dce/site/documents_bassin_rm.php

RBMP Walloon Meuse, 2008	Avant-projet de plan de gestion (in French) http://environnement.wallonie.be/directive_eau/pg/tm.asp
RBO Maas, 2005	Karakterisering Nederlands Maasstroomgebied (in Dutch), Regionaal Bestuurlijk Overleg Maas, March 2005
RIZA, 2006	De strategische MKBA van de Europese Kaderrichtlijn Water (in Dutch), Ministerie van V&W, Rijkswaterstaat/RIZA, 2006
Senhorst, 2006	Snelle kennis van zwevende stoffen (in Dutch) H. Senhorst RWS RIZA report 2006.033, December 2006
Staatscourant, 2008	BKMW, Besluit Kwaliteitseisen en Monitoring Water (in Dutch), Staatscourant, 6 november 2008 nr. 476
de Wit, 2008	Van regen tot Maas (‘From rain to Meuse’, in Dutch) Grensoverschrijdend waterbeheer in droge en natte tijden M. de Wit ISBN-9789085712305, Veen Magazines, Diemen 2008

A Annex 1 - Meuse case description according to DSS steps

This description has been composed primarily for the Dutch part of the river basin. DSS steps 0, 1 and 2 have been elaborated to a higher level of detail than the remaining steps, because taking these steps requires more information than is available. This regards for instance the expected development of diffuse pollution, measures to abate this type of pollution and the effects of these measures.

1. System definition (DSS step 0)

The international Meuse river basin district is composed of the Meuse river basin, its associated groundwater bodies and coastal waters. It covers a total land area of almost 35.000 km^2 in a fairly densely populated area (about 250 inhabitants per km^2) in five different countries: France, Luxemburg, Belgium (Walloon and Flemish Region), Germany and the Netherlands. In table 1 the surface area and the number of inhabitants for the different parts of the basin is shown [IMC, 2005].

The Meuse River originates at an altitude of 384 m above sea level in Pouilly-en-Bassigny, France, and flows through Belgium into the Netherlands. Its length, from the source to the mouth in the North Sea, is 905 km. At Heusden, it flows west via the Bergsche Maas canal and the Amer river to the Hollands Diep estuary and then into the North Sea.

Table A1 Surface area and number of inhabitants for the Meuse river basin in the different countries [IMC, 2005]

Country / Region	Area (km^2)	Number of inhabitants (x 1000)
France	8919	671
Luxemburg	65	43
Walloon Region	12300	2189
Flemish Region	1596	411
Germany	3968	3500
The Netherlands	7700	1994
Total	34548	8808

The International Meuse Commission (IMC), see the text box below, prepared an overview of the Meuse characteristics, the environmental impacts of human activities and an economic analysis of water use in the so-called ‘Roof Report’, required by Article 5 of the WFD [IMC, 2005]. More detailed information can be found in the underlying reports for the various subparts of the river basin. For the Dutch part of the Meuse this is collected in the main characterization report [RBO Maas, 2005].

The International Meuse Commission (IMC)

The International Meuse Commission (IMC) was created in 2002 with the signing of the Meuse Treaty (Ghent treaty). This treaty is an agreement between France, Luxembourg, Germany, the Netherlands and Belgium (Walloon Region, Flemish Region and Brussels-Capital Region) regarding the protection of the Meuse River. It replaces the earlier treaty of Charleville-Mézières (1994). The Ghent treaty lays down rules for the implementation of the European Water Framework Directive. The treaty has been in force since 2006. Based in Liège, the IMC has as its most important tasks:

- coordinating the obligations of the European Water Framework Directive;
- providing advice and recommendations to parties for improved flood prevention and risk management;
- providing advice and recommendations to parties for preventing and combating water pollution (warning and alarm system).

For the preparation of its annual meeting the IMC have five permanent working groups and a few temporary project groups. The IMC has three working languages (French, Dutch and German) and has a permanent secretary in Liège (Belgium): secr@meuse-maas.be . Its website is www.meuse-maas.be .

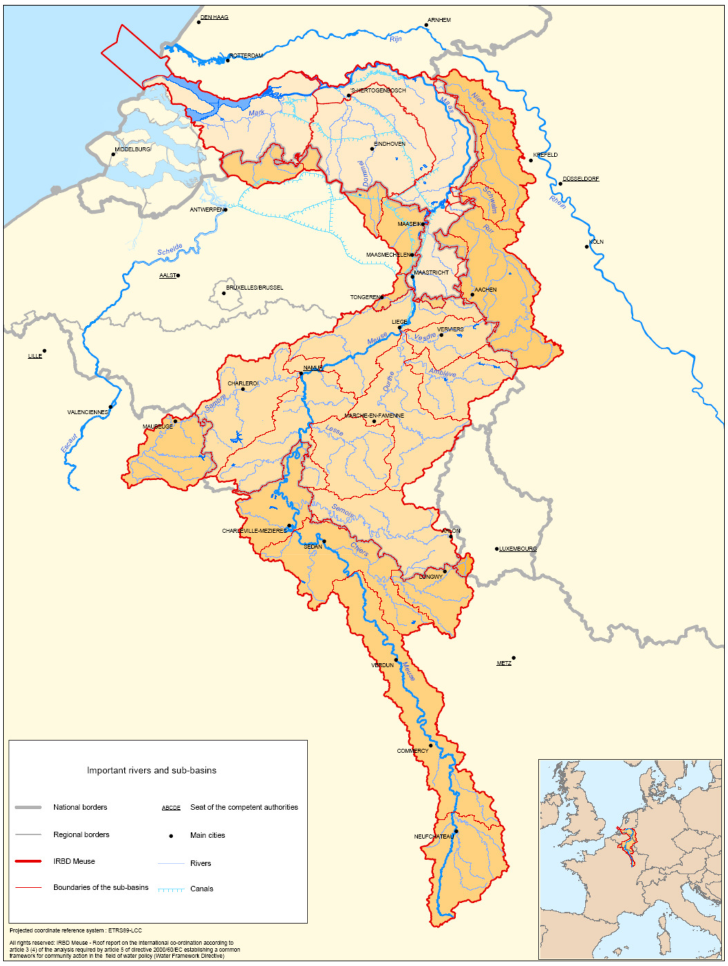

Figure A1 The Meuse river basin and its situation in Western Europe [IMC, 2005]

Figure A1 shows a map of the Meuse river basin and its situation in Western Europe, including the main tributaries to the Meuse: Chiers, Semois, Lesse, Sambre, Ourthe, Roer, Swalm, Niers, Dommel and Mark. The Meuse is a typical rain-fed river. Its discharge changes with the season and differs from year to year. It depends on the amount of precipitation compared to evaporation and the volume of water stored in the subsoil. The average amount of precipitation varies between 700 and 1400 mm/year, with the largest values in the Ardennes region (Walloon region of Belgium). The low soil permeability, especially in the Walloon part of the river basin is an important factor causing large peak discharges after heavy showers. The rainwater storage capacity of the subsoil is rather small, so that the summer and fall discharges are generally low.
High discharges generally occur during the winter and the spring season. Peak discharges > 3000 m^3/s can result, such as observed during the flood of 1993 at the Eijsden monitoring station (near the Belgian / Dutch border). During very dry years prolonged discharges < 50 m^3/s can be observed, in the Dutch part even as low as 10 m^3/s. In low-discharge situations a substantial part of the water supply is used for the canals in the Flemish region (e.g. the Albert Canal) and for the Dutch canal Zuid-Willemsvaart. This apportioning of water has been regulated in an international agreement signed between Flanders and the Netherlands. A very good overview of water quantity issues is presented in a recent book of Marcel de Wit [de Wit, 2008], titled ‘From rain to Meuse’ (in Dutch, French translation will be available shortly). The average discharge near Eijsden is 230 m^3/s; near the mouth it is about 350 m^3/s.

Figure A2 Lower course of the Meuse river (picture taken from http://www.riwa-maas.nl/)

Besides the natural factors mentioned above, human activities, for instance for maintaining navigation or counteracting floods (canals, sluices, weirs, dams, dikes, etc.) have changed the river course and influenced the Meuse river discharge values. It is worthwhile to mention that the river Meuse, together with its tributary the Sambre, was the main artery of mainland Europe’s first industrial revolution. All these activities have largely damaged the natural look of the river [IMC, 2005].

About 50 % of the total river basin consists of agricultural area, situated largely in the Netherlands, the Walloon region and France. The highest cattle density (pigs, cows, poultry) is found in the Netherlands and the Flemish region. In the Dutch, German and Walloon parts of the river basin district a substantial part of the drinking water usage is abstracted from surface water (46, 39 and 30 %, respectively). The number of public wastewater treatment facilities is by far the largest in Wallonia, but these facilities are relatively small because of the thinly populated area. This explains why, in spite of the high number of facilities, only about 30 % of the Walloon population is connected to POTWs, whereas in the Dutch, German and Flemish part of the river basin district this is almost 100 %.

On the basis of geo-morphological and physical characteristics the Meuse river basin can be subdivided in three areas:

Zone 1: from the source to Charleville-Mézières (near the French-Belgian border). The subsoil in this part of the basin is calcareous and porous, whereas the river summer bed is largely composed of gravel. The mainstream is still rather narrow here and the flow rate is small, due to a slight river drop. Navigation is largely diverted to the parallel “Canal de l’Est”. Starting from Troussey also the Meuse has been canalized. Pressures on this part of the Meuse river are still relatively light, because of the low navigation intensity in the river, and the small population density, little industrialization and urbanization of the area.

Zone 2: from Charleville-Mézières to Liège. This part of the Meuse river basin is characterized by the Ardennes hills and the presence of impermeable rock formations. The main river gets broader and during heavy rainfall the basins of tributaries (Semois, Lesse, Sambre and Ourthe) may cause a large and fast increase of the Meuse discharge. The main stream is strongly influenced by human interventions aimed at an improved navigability. Around this river stretch and in the Sambre basin many urbanized and industrialized regions are situated.

Figure A3 'Border' Meuse at low discharge (picture taken from http://www.riwa-maas.nl/)

Zone 3: from Liège to the mouth in the North Sea. This is a highly varying part of the Meuse. Between the cities of Liège and Maastricht the subsoil largely consists of limestone and the main stream is relatively narrow, with wooded slopes. North of Maastricht the river bed is mainly sandy, with gravel in the winter bed. This part is called the 'Grensmaas' (Dutch for 'Border Meuse'), where the river has a more or less natural and dynamic character, without weirs, or sluices. Navigation is not possible in this part of the river and is diverted to a parallel canal, the 'Julianakanaal'. Downstream the city of Roermond the Meuse is navigable again, which causes severe restrictions for the natural hydrological dynamics. This area has a high population density and intensive agriculture and industry. Between the cities of Roermond and Den Bosch the Maas has a sandy bed and is thus called the 'Zandmaas' (Dutch for 'Sand Meuse'). The northwestern part of the Meuse river basin is an open area, with urban harbour areas near the mouth. It is part of the Rhine-Meuse delta area. The tidal influence reaches until somewhere between the villages of Lith and Heusden [Middelkoop (ed.), 1998], [Busch (ed.), 2004].

For the Meuse river basin and the following major pressures (arising from urbanization, industrialization, agriculture and navigation) have been identified [IMC, 2005]:

- emissions, losses and discharges of pollutants;
- sluices, weirs and dams (flood protection, navigation and hydropower generation);
- canalization, artificial banks and dikes;
- water abstractions (i.e. for canals, agriculture, industry and the production of drinking water.

These pressures result into potential or observed impacts and consequences for quality and quantity of surface water and groundwater. In this report we shall confine ourselves to the first pressure mentioned (emissions, losses and discharges of pollutants)

2. Problem definition (DSS step 1)

Based on the EU guideline, every country/region has specified its own list of environmental quality standards (EQS) which is used as basis to assess whether or not the good chemical status has been attained, according to the ‘one out, all out’ principle. For assessing the ecological status, annex G of the Dutch RBMP [RBMP Dutch Meuse, 2008] presents the environmental quality standards for a large number of specific substances relevant for the river basin, including many plant protection agents. When in two or more countries / regions the EQSs for a given substance are exceeded, international coordination is defined as relevant for that substance. In the draft RBMP for the Meuse river [IMC, 2008] among these substances are the following priority substances: cadmium, chloropyrifos, diuron, isoproturon, lead, PAH (specifically benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene).

P(H)S have been monitored and evaluated for status and trend monitoring at 27 locations and for operational monitoring at 56 locations in the Dutch Meuse river basin. The chemical status in the Dutch Meuse has been pointed out as ‘good’ for 70% of the water bodies. The evaluation took place by comparison to the yearly average concentration value and the MAC (maximum allowed concentration) value. For the designation ‘good chemical status’ both criteria have to be met. Some substances (such as benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene) were not taken into account, e.g. because of analytical problems (high detection values). The substances that most frequently exceed the EQS are hexachlorobutadiene, pentachlorobenzene, trichlorobenzene, trifluralin, endosulfan, mercury and cadmium (5-20% of the water bodies). The anthropogenic influence on surface water quality has been classified according to different routes. For point sources and diffuse sources a national analysis has been made in co-operation with the water managers, in which all substances were included that exceed the EQS in the Dutch Meuse river basin [Duijnhoven, 2008].

Probably the desired targets cannot be realized in 2027 for all contaminants and ecological parameters. For the contaminants this refers to some specific PAHs, TBT, copper, zinc and a number of plant protection agents [RBMP Dutch Meuse, 2008, Senhorst, 2006]. Besides that, for PS there is the demand that the emissions, discharges and losses should be reduced and for PHS they should be eliminated. In order to attain these targets in the Dutch Meuse it is important that measures are taken on a European level, both in the Netherlands as in upstream countries / regions. However, in the present RBMP the targets have not been lowered yet, because of uncertainties with respect to (1) the tasks that remain after implementation of the existing and planned measures and (2) the additional (cost-effective) measures to be taken in EU context, based on the policy regarding diffuse sources, manure, (re)development and management of water systems after 2015.

For the assessment / evaluation of the ecological status the following general biological quality parameters are designated as relevant: COD, $N\text{-}NO_3$, $N\text{-}NO_2$, NH_4, N_{Kj}, P_{tot}, as well as the following specific parameters: copper, zinc and PCB. The same steps were followed as for the evaluation of the chemical status, except that for the general parameters the seasonal averages have been used. In case of absence of WFD standards for other relevant substances 90 percentile values have been used instead of yearly averages and MAC values. A large number of plant protection agents could not be monitored because of analytical difficulties. Some of the ‘specific’ substances that exceed the standards are not regarded by water managers as causing a problem for the water quality, because of the low chemical or biological availability (e.g. copper and zinc, in spite of the fact that they cause the majority of standard transgressions). In most of the cases the biological and general physical chemical parameters determine the final judgement of the ecological status.

Dutch industries have taken many measures to comply with the IPPC-guideline and further reduction of the emissions of contaminants is very difficult to be achieved in a cost-effective way. Tackling diffuse sources and upstream, (international) border-crossing supply of polluting substances is thus becoming more and more important. Regional water managers regard this type of measures as hardly belonging to their competence. They hold the view that the responsibility for the implementation of these measures and making international agreements lies at the level of national or European policy.

The Meuse case in the Socopse project aims to describe processes relating to priority substance issues in the river basin. As stated above, the problem of diffuse emissions is gaining importance. In the near future, this will be the case in more and more European countries, as IPPC measures take their effect. Handling the problems involved with diffuse emissions and with pollutants transported across international borders requires an approach not only at the regional (water board) level, but also at the national or European level. To get a clear picture of the present situation and the views of key persons working in water policy and water management in the Meuse River basin, a number of interviews have been held with regional and national water basin managers, stakeholders (drinking water production sector), producers of management plans and policy authorities.

INERIS has conducted interviews with policy authorities in the French part of the Meuse river basin. Furthermore, they have made runs with the Pégase model (Liège University) for (amongst other substances) cadmium concentrations in the French part of the Meuse river basin. These runs were based on default Walloon figures for diffuse pollution, and data available on point discharges at the Rhine-Meuse water agency. The first results indicated that the order of magnitude of simulated concentrations is satisfactory. They also show that the data on point discharges are probably missing quite a lot of emissions. The next step will be to assign default emissions to some sectors that have zero discharges according to the Water Agency, and also to investigate whether sediments are a possible cause of discrepancy between calculated and monitored emissions.

When the calibration of the model is acceptable, runs for some future scenarios will be made, mainly for illustrative purposes, and an estimate of cost and efficiency for these scenarios will be calculated. Subsequently, a national meeting with French government authorities, water agencies, etc. is planned to present the model results and to discuss whether modelling is useful in preparing cost-effective strategies for priority pollutants. Based on the outcome of this meeting, the Socopse DSS structure and steps contents will be commented.

3. Inventory of sources (DSS step 2)

In Table A2 the relative importance of pressures on water quality of the Dutch Meuse is given for point sources and diffuse sources.

Table A2 Relative importance of point source and diffuse source pressures on water quality in the Dutch Meuse river basin [RBMP Dutch Meuse, 2008]

Pressure	Judgment	Explanation	Total nr. of significantly loaded water bodies
1. Point sources			
POTWs		Important	34
Sewer overflow		Important	34
Sludge treatment plant		Present, but not significant	0
IPPC industries		Less important	15
Non-IPPC industries		Less important	2
2. Diffuse sources			
Urban run-off		Very important	110
Agricultural activities		Very important	137
Traffic (road/rail) and infrastructure		Important	54
Accidental spills		Present, but not significant	0
Abandoned industrial areas		Not present	not applicable
Discharges non-sewered areas		Less important	23
Remaining sources		Important	38

Besides in the category of ‘Diffuse sources’, very important pressures can also be found in the categories of ‘Regulation of water transport and morphological adaptations’ and ‘Other loads’ (Intensive management and maintenance, including river banks). These categories are omitted from table 3.1 as they do not primarily refer to P(H)S.

Urban run-off water (notably from traffic) and agricultural activities are the main sources in the Meuse river basin. These sources are significant for more than 50 % of the water bodies. Also loads from POTWs (20 %), sewer overflows (20 %), traffic and infrastructure (30 %) and remaining loads (notably atmospheric deposition) are important.

Agricultural activities are an important (diffuse) source of nutrients, heavy metals and plant protection agents (see figure A.4). Nitrogen and phosphate originate from agriculture for 60 % and 40 %, respectively. For cadmium the agriculture contribution is 30 %, for zinc and copper this amounts to 15 – 20 %. Dimethoate originates from agriculture for 100 %. Also substances such as hexachlorobutadiene and trifluralin, which are not admitted anymore, have still been found in a number of surface water bodies in 2005.

POTWs are a main (point) source of nutrients and heavy metals. Their contribution to nitrogen and phosphate exceeding the standards is 30 % and almost 60 %, respectively. For cadmium and mercury, the contribution is 30 – 40 % and this also holds for zinc.

Furthermore, POTW effluents constitute the main source of trichlorobenzene emissions to surface water bodies. Sewer overflows give a relatively limited contribution to the total emission of copper and zinc (see figure A4), but the loads occur in a concentrated form in short periods of time (strong peak discharges) and therefore cause serious problems for the local ecology in the relatively small surface water bodies. Besides nutrients and heavy metals, also pesticides and other organic micropollutants are present in the overflow discharges.

Traffic (inclusive of shipyards and recreation) and urban run-off (traffic and construction materials) are important sources of copper (together 30 %) and zinc (together 20 %). For cadmium (30 %), mercury (40 %) and benzo(a)pyrene (70 %) the remaining sources contribute significantly to the load. This concerns mainly atmospheric deposition.

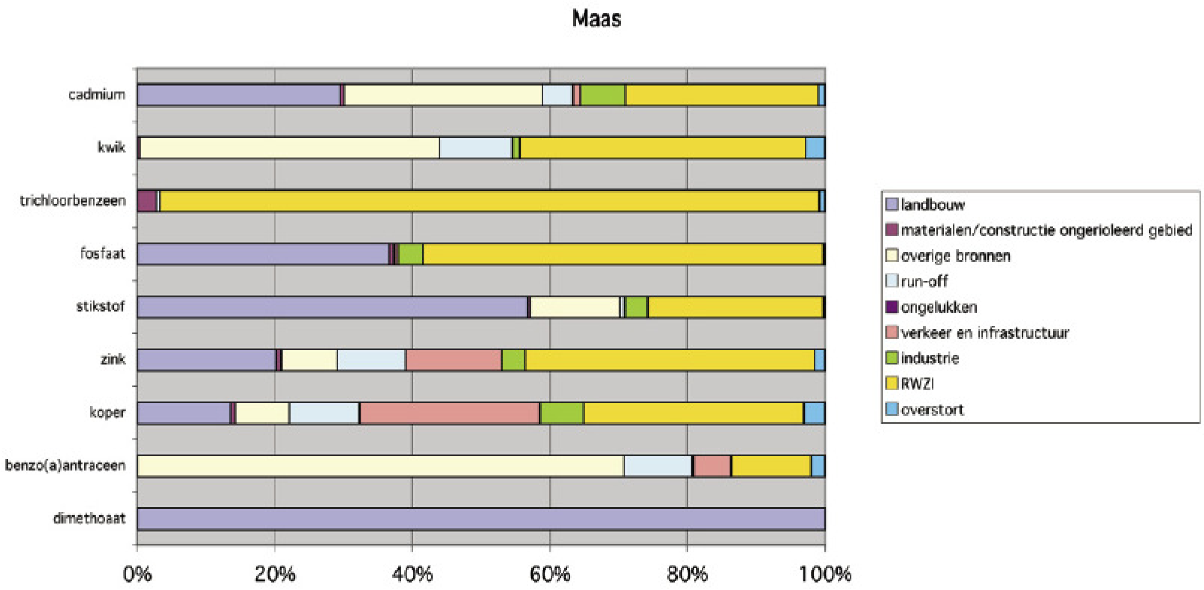

Figure A4 Portion of point sources and diffuse sources for substances most frequently exceeding standards in the Meuse river basin for the year 2005: Cadmium, Mercury, Trichlorobenzene, Phosphate, Nitrogen, Zinc, Copper, Benzo(a)anthracene, Dimethoate, from top to bottom.
Categories given in the legend are (from top to bottom): Agriculture, Materials/construction non-sewered area, Remaining sources, Run-off, Accidents, Traffic and infrastructure, Industry, POTW, Sewer overflow.
The relative loads do not include transboundary supply [RBMP Dutch Meuse, 2008].

POTWs are regarded as point sources, although also diffuse sources such as road traffic and corrosion of construction metals partly enter the sewer system and thus contribute to the load from these POTWs. Within the Dutch Meuse river basin 52 POTWs discharge into surface water bodies. They are mainly located around concentrated population areas. More than 98 % of the households and most of the small to medium-sized companies are connected to a POTW.

The industrial wastewater from a total number of 57 plants in the Dutch Meuse river basin is not connected to POTWs and these are therefore categorized as a separate type of point source. These discharges often cannot be treated by biological water treatment, so a physical-chemical treatment is used instead. The loads of some specific substances (where figures were available) have been collected in table A3.

Table A3 Number of industrial point source discharges and loads of substances that most frequently exceed standards (year 2005) [RBMP Dutch Meuse, 2008]

Type of industry	**Number of companies**
IPPC	47
Non-IPPC	10
Total	57
Substance	**Load (kg/yr)**
Benzo(a)anthracene	< 5
Cadmium	10
Copper	1230
Dimethoate	< 1
Mercury	< 1
Nitrogen	588000
Total Phosphorus	43000
Trichlorobenzene	< 1
Zinc	2950

Diffuse sources of surface water contamination (either dissolved in water or adsorbed to soil or dust particles) may enter the water in the following ways:

- through the air: e.g. atmospheric deposition, splash water, drift (e.g. from application of plant protection agents), fire-works display (heavy metals)
- through the soil / groundwater: e.g. wash out, leaching or erosion of historically contaminated sediments
- through run-off of rain water (urban or rural): e.g. roofing, crash barriers, paved areas, agricultural parcels

In table A4 diffuse sources and loads of substances that frequently exceed standards in the Meuse river basin are presented. Loads of PAHs such as benzo(a)anthracene are largely caused by traffic and enter surface waters via urban run-off, traffic/infrastructure and remaining sources (e.g. atmospheric deposition). Nutrients loads are caused mainly by agricultural activities. Not only present activities are important. Examples of loads caused by past activities are the historical atmospheric deposition of cadmium and zinc in the Kempen area, (former) use of phosphate containing fertilizers on soils that are saturated with phosphate, use of plant protection agents that are now banned, use of cattle fodder containing high levels of copper or zinc, etc. Historical polluting activities can also be seen as a main cause of sediment contamination.

Table A4 Loads of substances from diffuse sources that most frequently exceed standards [RBMP Dutch Meuse, 2008]

Substance	Diffuse source loads (kg/yr)						
	Agri-cultural activities	Non-sewered areas	Accidental spills	Remaining sources	Urban run-off	Traffic and infra-structure	Total
Benzo(a)anthracene	< 1	< 1	< 1	120	20	10	150
Cadmium	40	< 1	< 1	40	5	< 1	85
Copper	1760	90	< 1	1010	1330	3410	7600
Dimethoate	1	< 1	< 1	< 1	< 1	< 1	1
Mercury	< 1	< 1	< 1	30	5	< 1	35
Hexachlorobutadiene	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Nitrogen	9524000	56000	< 1000	2188000	101000	29000	11898000
Total Phosphorus	416000	8000	< 1000	< 1000	2000	5000	431000
Trichlorobenzene	< 1	5	< 1	< 1	< 1	< 1	5
Zinc	12150	440	0	4880	5990	8340	31800

4. Definition of a baseline scenario (DSS step 3)

This step can only be elaborated very globally, because a detailed discussion would require more information than is available. This notably regards the expected development of diffuse pollution. This is made even clearer from table A5 in which the present situation (2007) is compared to the expectation for 2015 with regard to the number and length of water bodies in the international Meuse river basin district that are not in a good chemical status. Either there are no data available, or the expectations for 2015 are the same as the situation in 2007.

Table A5 Number and length of water bodies not in good chemical status [IMC, 2008]

Country/region	Natural				Heavily modified / artificial			
	Number		Length		Number		Length	
	2007	*2015*	*2007*	*2015*	*2007*	*2015*	*2007*	*2015*
France	5	5	197	197	0	0	0	0
Walloon region	188	??	nm	nm	69	??	nm	nm
Luxembourg	1	1	13	13	nm	nm	nm	nm
Flemish region	4	??	63	??	nm	??	nm	??
The Netherlands	3	3	nm	nm	72	72	nm	nm
Germany	17	17	136	137	29	29	185	185

?? = no data (yet) ; nm = not mentioned

Given the uncertainties (see chapter 3.1.4) of this report, especially for diffuse emissions, this is not a surprising result. An important development that is expected to have significant positive effects on the water quality of the Meuse is the increase in the number of POTWs in the Walloon Region. However, it is very hard to predict to what extent these measures will lead to a reduction of P(H)S concentrations. Another positive

effect can be expected from emission reductions from agricultural activities as a result of policy measures and an increased awareness of environmental values that can be observed among farmers (use of ‘best practices’).
A development that should be mentioned here as well, is the climate change caused by the emission of greenhouse gases, leading to more extreme river discharge situations (lower in summer, higher in winter periods). Also changes in land use can have an effect on river discharges, especially on flooding intensities. Extreme conditions may make it more difficult to reach the environmental quality targets. For the assessment and management of flood risks the European Directive 2007/60/EC on the assessment and management of flood risks entered into force on 26 November 2007. Based on this directive criteria are given under which a temporary deterioration in water quality is admitted.

5. Inventory of possible measures (DSS step 4)

This step can only be elaborated very globally, because a detailed discussion would require more information than is available. This especially regards the measures to abate diffuse types of pollution.
The main point sources are industrial discharges and POTWs. Industrial discharges are largely regulated by IPPC measures)
Dutch legislation with respect to surface water quality has made tremendous progress since the seventies of the last century. A large-scale system of collection and treatment of wastewater (both domestic and industrial) has been set up. At present almost 100 % of the households is connected to a sewer system. Also a system of permits and law enforcement has been set up. This resulted in a much better surface water quality (strong decrease of oxygen demand and micropollutant loads). Besides tackling the point sources, a growing attention was paid to the eutrophication problem and to diffuse pollution by heavy metals and plant protection agents. More and more, water quality, water quantity, soil, sediment and surface water quality were seen as part of a total system. Generic measures have been combined with tailor-made solutions in which also restoration and (re)development of nature reserve areas took place. These measures can be caught under the term ‘Integrated water management’. International agreements such as the Rhine and North Sea Action Programs, OSPAR and the EU nitrate directive have assisted in attaining a more adequate water quality management.

Integrated river basin management conform the WFD can be regarded as rounding-off the developments mentioned in the preceding paragraph. WFD measures come down to sharpening and completing existing policy. Additional point source reduction measures that will be taken up to 2015 are:

- removal of nine untreated discharges
- tackling 74 sewer overflows
- treatment performance improvement of 19 POTWs
- disconnection of 287 ha of paved surface from the sewer system
- remediation of five contaminated soil locations

As mentioned several times in this report, diffuse sources present the most difficult challenge. In 2007, the National Action Programme Diffuse Sources [Min. VROM, 2007] has been published.
The programme shows possible measures for each substance which exceeds objectives. It also gives a possible time schedule when (and if) the objectives will be met. The

programme distinguishes between priority substances which should be addressed on a European scale and substances which can be sufficiently reduced by taking national measures. The objectives for the priority hazardous substances cadmium and PAHs cannot be met without European measures.
In addition to the measures taken by regional authorities, the following actions have been defined:

- dredging of 325000 m^3 contaminated sediments from regional waters and remediation of 1213 ha of State waters that have a problem with contaminated sediment
- establishing zones (total length 362 km) where spraying of pesticides and application of manure is omitted, based on voluntariness.

6. Assessment of the effects of the measures (DSS step 5)

This step, too, can only be elaborated very globally, because a detailed discussion would require more information than is available. This regards for instance the uncertainties with respect to the effects of the measures that can be defined for abating diffuse sources of contamination.

A large portion of the measures in an RBMP has not yet been detailed or implemented. Hence, it is yet unknown to what extent they will contribute towards achieving the WFD targets. The relation between a specific measure and water quality is often ambiguous or not very clear, especially when the measure involves reduction of diffuse sources. So, even if measures have been taken and the concentrations of substances have been monitored for a sufficiently long period, it is often still very hard to ascribe an observed decrease in concentration to a specific measure, because in general a number of changes (both natural and anthropogenic) occur simultaneously with the implementation of the measure.

For priority substances and other relevant contaminants a gradual improvement of the chemical status is expected, as a consequence of:

- continuation of the existing policy of source reduction and issuing permits, as well as application of an 'emission-immission' assay[13] (involving e.g. the WFD EQSs)
- further improvement of POTWs, remediation of untreated discharges and improvement of sewers by tackling sewer overflows and disconnection of paved surface
- remediation of contaminated sediments in regional and state waters
- a further reduction of plant protection agent emissions by sharpening the policy of admission for new agents and tackling bottlenecks regarding drinking water supply
- the implementation of measures in upstream countries and regions

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[13] The relation emission-immission is approached from two sides: from the water system and from a specific source. The first approach results in prioritized list of substances and groups of sources on a water system level. The second approach (immission test) comprises the evaluation of the admissibility of the 'rest discharge' (the discharge that remains after application of the best practicable techniques) for the receiving surface water. For more information, see http://www.helpdeskwater.nladviesgroepemissies.

In 2006 a strategic SCBA has been made on a national level [RIZA, 2006]. Based on a long list of possible measures, three scenarios have been composed, made up of sets of measures. For these sets an estimate has been made of costs, effects and (globally) benefits. For contaminants it turned out that more strict emission reduction measures (supplementary to existing policy) are very expensive and have only little additional benefits. With respect to ecological quality, the main bottlenecks are found in the hydro-morphological state of many surface waters, and in the high nutrient levels. Particularly measures aimed at improvement of the hydro-morphology turned out to be cost-effective. The same conclusion was drawn in the 'Ex ante evaluation' of the WFD [PBL, 2008].

For a number of substances it is clear already now that the EQS will not be attained in 2015 and that a phased realisation of the targets will be necessary. For a few substances (notably PAH, TBT, nitrogen, phosphorus, and some plant protection agents) also realisation in 2027 will not be possible and lowering the targets seems unavoidable. Uncertainties with respect to description of future measures on an EU level, together with uncertainties about development of new cost-effective techniques are the main argument for not claiming this lowering of targets at this moment, but stepwise take the planned measures and evaluate the necessity of doing so in 2021.
Besides the impracticality to reach the targets for the substances mentioned, also the planned zero-emission, - discharge and - loss of P(H)S is regarded as unrealistic.

7. Selection of the best solutions (DSS step 6)

Again, this step can only be elaborated very globally, because a detailed discussion would require more information than is available. Not only technical, but also political and administrative measures should be taken into account, especially for the reduction of diffuse emissions.
As has been indicated in the preceding chapter, an SCBA has been organised on a national level [RIZA, 2006]. This SCBA has been used in the 'regional processes' that have been carried out under direction of the water boards. In these processes the specific problems for a certain (sub)region were taken as the basis for the discussions. Possible measures were identified and evaluated, based on an estimation of costs, practicality, feasibility for daily water management and support from the stakeholders involved. As stated before, especially hydro-morphological measures received the highest scores. An integral procedure was followed in which not only WFD targets were considered, but also the tasks for prevention of water excesses and shortage (WB21, Water Management in the 21st century) and the tasks for Natura 2000 areas were taken into account.
For each (partial) river basin this has resulted in a proposition for a regional set of measures, supplementary to the national generic measures.

B Annex 2 - Questions for additional inquiry Meuse case

Your name:
Company:
Telephone nr.:

1 Priority (hazardous) substances in the river basin management plans

Q: How do you rate the detail level of the measures for handling priority (hazardous) substances, as included in the RBMP? (Should they be more elaborated or is a reference to REACH and IPPC sufficient?)

A:

Q: Does the RBMP present an assessment of the effects of the measures for priority (hazardous) substances on the water quality? If not, is such an assessment necessary?

A:

Q: Is it possible (based on existing knowledge) to make a well-reasoned selection of measures for reduction of priority substance concentrations? At which level (technical / local management / national policy / EU policy) should these measures be taken in order to have maximum effect? If possible, differentiate your answer for specific substances or substance groups (examples?).

A:

Q: Is the background information used to formulate the measures publicly available? Has - in your opinion - all available information been used?

A:

Q: How do you rate the attention paid to the new compounds (emerging substances) in the RBMP? Please motivate your answer

A:

Q: Which recommendations do you have for the content of the 2nd generations RBMP with respect to priority substances?

A:

Other remarks:

2 WFD process and institutional aspects

Q: In which way did the implementation of the WFD change the approach to water quality management at your institute? For example: new cooperation with other water operators, gaining more knowledge, hiring experts in other fields, application of new models or methods, etc.

A:

Q: What benefits can be expected from a WFD international approach and who would get the most out of it?

A:

Q: Did you require international co-operation in the WFD process up to now?
If yes, did you achieve to establish this co-operation? Has the International Meuse Commission (IMC) directly or indirectly been involved?

A:

Q: Did you co-operate with the IMC at some point? What was the nature of this co-operation? How could the IMC improve their coordinating role in the WFD process?

A:

Q: Do you think the responsibilities for meeting the WFD objectives are clearly stated in the RBMP? If not, do you think it is necessary to clarify the responsibilities in the (next generation) RBMP?

A:

Q: Do you think the stakeholder involvement is / was well organized? If not, how can this be improved?

A:

Q: Has the input from stakeholders been taken into account? If not, were the arguments made clear why their input was rejected? Please motivate your answer.

A:

Q: Which recommendations do you have for the 2nd generation RBMP process?

A:

Other remarks: