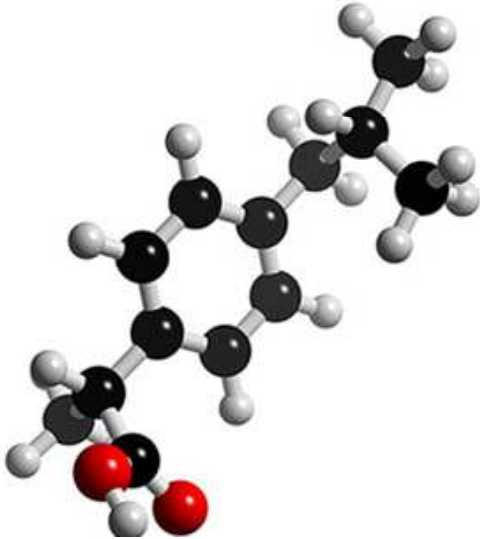


Reduced emission of organic micropollutants to the Meuse

A network analysis aimed at identifying preventative measures that a drinking water company can take

Part of MSc thesis



Josanne Derks

January 2010

Reduced emission of organic micropollutants to the Meuse

*A network analyses aimed at identifying preventative measures that a drinking water company can take
Part of Master of Science Thesis*

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Abstract

Drinking water company *Dunea Duin en Water* produces drinking water from the Meuse River, which contains a variety of organic micropollutants (OMPs) from upstream activity in Belgium, France, Germany in Luxembourg. OMPs found in Dunea's source are plant protection products, pharmaceuticals, hormones and endocrine disruptors and X-ray contrast media. Continuous development of measuring equipment has resulted in lower detection limits for most substances and measuring programs are expanded yearly. Consequently, more substances are found in the Meuse River and other surface water bodies. Current treatment technology such as membrane filtration, Granular Activated Carbon filtration, dosing of Powdered Activated Carbon combined with Artificial Recharge and Recovery (ARR) do not provide a robust barrier against micropollutants.

Dunea's intake point is located just downstream of an agricultural area that uses and consequently discharges pesticides. The project *Zuiver Water in de Bommelerwaard* was started in 2002, aimed at reducing the emission of plant protection products to aquatic environment of the Bommelerwaard. Dunea is interested in the possibilities and development of prevention oriented measures outside of the Bommelerwaard. This analyses aims at identifying and qualifying those possibilities.

A large and complex network of stakeholders is involved in the emission, removal and prevention or reduced emission of OMPs to surface waters. By analysing and mapping the network, Dunea can perhaps utilize her position within this network in a more beneficial way. Dunea is already very capable of utilizing her position in the *drinking water network*. She cooperates and shares knowledge with other drinking water companies, national and internal, and knowledge and research institutions. The problem of OMPs is not confined to the (drinking) water sector; the network that is to be explored consists of a multitude of sectors.

From the stakeholder analysis can be concluded that many parties have internally conflicting objectives. All acknowledge the importance of pollutant free surface waters, especially if the water is to be used for production of drinking water. Unfortunately other interests like maintaining the competitive position of the agricultural sector and access to safe, affordable medication cause contamination of drinking water sources. Moreover, parties responsible for collection and treatment of wastewater will be faced with increased costs if the quality of discharged WWTP effluent is to be increased, which can turn them into opponents.

From the development of policies at the EU level, the increasing media attention to the issues of organic micropollutants in surface and drinking water and the increasing awareness of the public, can be concluded that investments in either alternative sanitation or advanced post-treatment of wastewater cannot be prolonged indefinitely. Investing in research, development and implementation of those preventative measures is not the responsibility of a typical drinking water company such as Dunea. Her responsibility lies in producing safe and reliable drinking water.

The author recommends Dunea to continue to invest in research, development and implementation of advanced drinking water treatment technology in order to remove or convert organic micropollutants from her source water. It also recommended that Dunea continues the transfer of her responsibility within the project *Zuiver Water in de Bommelerwaard* to the responsible waterboard and monitor the progress and results from the sidelines. As to Dunea's activities in the broader field of preventative measures, the author recommends continuance of the current approach. Dunea should not take a leading role in development of prevention oriented technologies – refrain from activities outside the core-business – but should at the same time not completely turn its back towards it. Moreover, Dunea is advised to closely monitor the development of policy (at the national but primarily EU level), the level of attention to the issue in the media and its resulting impact on the public opinion. Whenever the issue regarding traces of pesticides, pharmaceuticals and hormones found in drinking water is highlighted by the media, Dunea should respond by stating that although the found concentrations are almost undetectable and pose no immediate threat to public health, ongoing research is performed towards the occurrence and removal of those substances during the drinking water production.

List of illustrations

<i>Figure 2.1: Meuse river basin (adapted from the Meuse Treaty, 2002)</i>	13
<i>Figure 3.1: System diagram OMPs in source for drinking water</i>	18
<i>Figure 4.1: Network water and sanitation regarding the issue of OMPs in drinking water sources</i>	25
<i>Figure 6.1: Effects of programs pesticide reduction on Dutch surface waters</i>	30
<i>Figuur 6.2: Water system Bommelerwaard</i>	31
<i>Figure 6.3: Average monitoring results all locations</i>	33
<i>Figure 7.1: Urine separation</i>	35
<i>Figure 7.2: Tested sanitation concepts</i>	36
<i>Figure 7.3: 1-Step filter for removal of nitrate, phosphate and organic micropollutants</i>	37
<i>Figure A1.1: Pesticides found in Meuse near Keizersveer</i>	51
<i>Figure A2.1: Cause and effect diagram</i>	53
<i>Figure A3.1: Objectives Dunea Duin en Water</i>	55
<i>Figure A4.1: Drinking water and sanitation sector, the Netherlands</i>	57
<i>Figure A4.2: Drinking water and sanitation sector, Belgium (Flanders and Wallonia)</i>	59
<i>Figure A4.3: Drinking water and sanitation sector, France</i>	60
<i>Figure A4.5: Drinking water and sanitation sector, Germany</i>	61
<i>Figure A11.1: Water system Bommelerwaard</i>	84
<i>Figure A11.2: Monitoring results Bommelerwaard</i>	87
<i>Figure A11.3: Monitoring results intake Dunea</i>	87
<i>Figure A11.4: Average monitoring results all locations</i>	87
<i>Figure A12.1: Reduction environmental impact of pesticides to Dutch surface water</i>	89
<i>Figure A12.2: Trends in risk for aquatic environment</i>	90
<i>Figure A12.3: Spreading equivalent pesticides Flanders</i>	90
<i>Figure A12.4: percentage of Walloon surface water samples exceeding the norms for pesticides</i>	91
<i>Figure A12.6: Quality French surface water regarding pesticides</i>	91

List of tables

<i>Table 4.1: Summary drinking water and sanitation providers</i>	20
<i>Table A1.1: Priority substances threatening drinking water production Dunea</i>	48
<i>Table A1.2: Maximum concentrations of pesticides (µg/l) in river Meuse near Keizersveer</i>	49
<i>Table A8.1: Associations water and utility sector Germany</i>	69
<i>Table A9.1: stakeholder classification</i>	71
<i>Table A9.2: Stakeholder analysis</i>	72
<i>Table A11.1: Preventative measures Bommelerwaard</i>	85
<i>Table A13.1: proposed measures for emission reduction pesticides</i>	94

Contents

Part 1: Problem identification	11
1. Introduction	11
1.1 Cause	11
1.2 Problem characterization	11
1.3 Research objective and questions	11
1.4 Structure of the report	12
2. Demarcation	13
2.1 Geographical demarcation	13
2.2 Administrative demarcation	13
3. Problem analysis	15
3.1 Problematic substances	15
3.2 Emission routes OMPs	15
3.2.1 Pesticides	15
3.2.2 Pharmaceuticals and hormones	15
3.2.3 Endocrine disruptive substances	16
3.2.4 Additional emerging substances	16
3.3 Relation with drinking water production and possibilities for intervention	16
3.3.1 Expend the post-treatment	16
3.3.2 Expend the pre-treatment	17
3.3.3 Emission prevention	17
3.4 Analysis of Dunea's objectives	17
3.4.1 Drinking water production in harmony with nature	17
3.4.2 Criteria regarding water quality	17
3.5 System identification	17
Part 2: Network exploration	19
Introduction	19
4. Water, drinking water and sanitation sectors Meuse river basin	20
4.1 Structure of sectors	20
4.2 Committees, agencies and associations	21
4.2.1 International	21
4.2.2 National committees and agencies	21
4.3 National networks for policy making	22
4.4 Professional associations	22
4.5 Knowledge institutes and NGOs	23
4.6 Pollution causers	23
4.6.1 Producers, distributors and users of pesticides	23
4.6.1 Producers, distributors and users of pharmaceuticals	23
4.7 Results stakeholder analysis	24
5. Legislation and policies	27

5.1 European Legislation	27
5.5.1 Water Framework Directive	27
5.1.3 WFD and its relation to pollution by organic micropollutants	27
5.1.4 Conclusion	27
5.2 National legislation	27
Part 3: Preventative measures	29
6. Measures for reduced emission of pesticides	29
6.1 National programs for reduced use and consequences of pesticides	29
6.1.1 The Netherlands	29
6.1.2 Germany	29
6.1.3 Belgium	29
6.1.4 France	30
6.1.5 Conclusions regarding effects national programs	30
6.2 Local prevention: Zuiver water in de Bommelerwaard	31
6.2.1 Motivation	31
6.2.2 Preventative measures Bommelerwaard	32
6.2.3 Monitoring program	32
6.2.4 Results and conclusions Bommelerwaard	32
7. Measures for reduced emission of pharmaceuticals	35
7.1 Separate urine collection	35
7.2 Advanced post-treatment of wastewater	36
8. Conclusions and recommendations	39
8.2 Conclusions regarding preventative measures	39
8.2.1 Reduction in pesticide emission	39
8.2.2 Reduction in pharmaceutical emission	39
8.2.3 Conclusions regarding preventative options for Dunea	40
8.3 Recommendations	40
REFERENCES	43
ANNEX 1: Threats to Dunea's drinking water production	48
ANNEX 2: Cause and effect diagram of emissions	53
ANNEX 3: Analysis objectives Dunea	55
Drinking water production in harmony with nature	55
Criteria regarding water quality	55
ANNEX 4: Exploration of drinking water networks	57
The Netherlands	57
Belgium	58
France	60
Germany	61
ANNEX 5: International committees and associations	63
ANNEX 6: National committees and agencies	65

ANNEX 7: Networks for policy making	67
ANNEX 8: Professional associations	69
ANNEX 9: Stakeholder analysis	71
ANNEX 10: Legal framework - Legislation and policies	79
<i>European Water Framework Directive</i>	<i>79</i>
<i>National legislation</i>	<i>80</i>
ANNEX 11: Zuiver water in de Bommelerwaard	83
ANNEX 12: Preventative measures – pesticides	89
ANNEX 13: Preventative measures – pharmaceuticals	93

Part 1: Problem identification

1. Introduction

1.1 Cause

Dunea duin en water is a drinking water company supplying over 1,2 million customers with reliable drinking water of high quality. Dunea uses water from the *Afgedamde Maas* – a dead end side stream of the river Meuse - as the source for the production of drinking water. The quality of the Meuse water depends on the activities that take place upstream of the intake (Belgium, France, Germany and Luxembourg). Particularly the presence of organic micropollutants (OMPs) such as plant protection products, pharmaceutical residues, hormones and endocrine disruptive substances is of interest. Dunea is currently performing research towards the degradation of these unwanted substances. From an environmental and economical point of view it makes sense to invest in measures that can reduce the emission of OMPs to the aquatic environment.

Dunea's intake point is located just downstream of an area with a cluster of agri- and horticulture that uses and consequently discharges pesticides. Together with involved stakeholders, the project *Zuiver Water in de Bommelerwaard* was started in 2002, aimed at reducing the emission of plant protection products to aquatic environment of the Bommelerwaard. Dunea is interested in the possibilities and development of prevention oriented measures outside of the Bommelerwaard. This analyses aims at identifying and qualifying those possibilities.

1.2 Problem characterization

The occurrence of OMPs in surface water bodies can be characterized as a complex problem since it has multiple dimensions. First of all it is *scientifically complex*. The term organic micropollutants refers to a wide range of substances that are of natural or man-made origin, can be persistent and/or mobile in the environment, can have toxic or disruptive effects on ecological state of the environment and human health. Well known examples of OMPs are pesticides, pharmaceuticals and endocrine disruptive substance. Little is known about potential chronic effects on public health associated with long term exposure trough drinking water consumption. Secondly, the problem is *technologically complex*. Several types of technologies are applied for removing OMPs. The efficiency of the removal or degradation differs between technologies and between substances: different substances have different chemical compositions and characteristics.

Thirdly, the occurrence of OMPs in surface water is *complex in the administrative/policy-making dimension*. A multitude of parties is responsible for the emission of priority substances to surface water bodies. Farmers and horticulturists for instance use pesticides for the protection of their crop and life stock. Part of the used substances run off to the surface water. Pharmaceuticals like non-prescription medication (anti-inflammatory, pain killers etc), prescription medication and anti-conception pills excreted via the urinary tract are only partly removed at a municipal wastewater treatment plant and are discharged along with the treated water. A large volume of OMPs with a medical origin (specific pharmaceuticals, x-ray contrast media, chemotherapy degradation products etc) originate from hospitals, elderly homes, nursing homes and mental institutions: those institutions could perhaps play a viable role in reducing the emission of OMPs. Also, discharged wastewater with an industrial origin contributes to the emission of OMPs.

1.3 Research objective and questions

The objective of this research can be described as follows:

Identification of measures that Dunea can take to reduce the emission of organic micropollutants, by addressing the administrative dimension of the problem

A large and complex network of stakeholders is involved in the emission, removal and prevention or reduced emission of OMPs to surface waters. By analysing and mapping the network, Dunea can perhaps utilize her

position within this network in a more beneficial way. This will yield advantages such as (Enserink et al., 2009):

- Finding common interests can increase support or form possibilities for exchange of interests, which can yield to better solutions.
- Smarter relation-management with allies and opponents when threats and opportunities are recognized.
- Utilization of knowledge and expertise from other stakeholders.

Dunea is already very capable of utilizing her position in the *drinking water network*. She cooperates and shares knowledge with other drinking water companies, national and internal, and knowledge and research institutions. The problem of OMPs is not confined to the (drinking) water sector; the network that is to be explored consists of a multitude of sectors.

Dunea is Dutch drinking water company located at the end of the Meuse River basin. In order to identify possible allies and opponents, the water sectors upstream of Dunea's intake are analysed and mapped. In the Netherlands many different authorities (municipalities, waterboards, provinces and miniseries) are involved in the water and sanitation sector, a structure that has been formed by the course of history. What are the structures of the drinking water and sanitation sectors in the upstream countries: does it differ much from the Netherlands and can possible allies or opponents be identified? The problem is however not confined to the water sector: the origin of the problem lies with the producers, distributors and users of organic micropollutants.

As becomes apparent from this brief description of involved parties, many different types of stakeholders can be distinguished. Each stakeholder has their own perception towards the problem of OMP occurrence and removal. Furthermore, different types of parties have different individual interests and goals that can be conflicting. Also, some stakeholders have formal power (authority based on legislation), some might have informal power (ability to influence public opinion for instance) and will utilize their power to realize their goals. Some have other viable resources such as money or knowledge at their disposal.

1.4 Structure of the report

This report is the result of an iterative process and consists of three parts. Part 1: problem identification starts with the demarcation in geographical and administrative terms (chapter 2), followed by the analysis of the problem (chapter 3) in which the problematic substances and their emission routes are described, followed by the relation with drinking water treatment and the objectives of Dunea. The results of chapter 3 yield a system identification; a graphical overview of the problem situation.

Part 2: Network exploration, starts with a description of the water, drinking water and sanitation sectors along the Meuse river basin and the parties that cause the pollution (chapter 4), resulting in a stakeholder analysis. The relevant policies, both national and international are described in chapter 5.

Part 3: Preventative measures. The countries along the Meuse river basin have all implemented programs for the reduced use and consequences of pesticides (paragraph 6.1). The results of the project Zuiver Water in the Bommelerwaard are discussed in paragraph 6.2 Measures for the reduced emission of pharmaceuticals can be found in chapter 7. Conclusions and recommendations are formulated in chapter 8.

For the sake of readability, the main text has been formulated as concise as possible. The performed analyses are described briefly in the main text and are elaborated in more detail in annex 1 to 13.

2. Demarcation

2.1 Geographical demarcation

The geographical demarcation is basically defined by the Meuse river basin; from its origin in France up to Dunea's abstraction point. Dunea is not the only water company using the Meuse for drinking water production: more than 6 million people consume drinking water that is produced from Meuse water (RIWA-Meuse, 2008). As mentioned previously, along the river basin treated domestic and industrial wastewater is being discharged.

The river Meuse rises in the Langres plateau, France and flows via Belgium to the Netherlands, where it terminates just south of Rotterdam. The Meuse river basin and its tributaries comprise a total area of 35.000 km² and also include Luxembourg and Germany. Approximately 34% of the total river basin area is located in Wallonia, 26% is in France, the Netherlands make up 23% of the area, Germany 11%, Flanders 6% and just 1,4% of the river basin area can be found in Luxembourg. Since the Luxembourg part of the river basin area is very small in relation to the other countries, Luxembourg is omitted from the analyses.

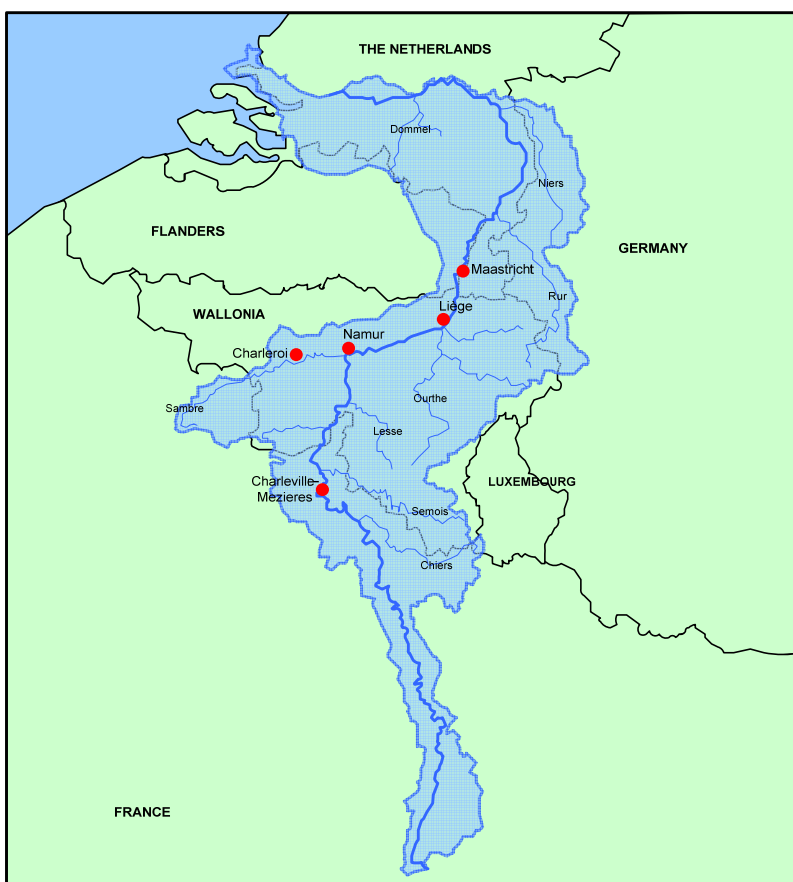


Figure 2.1: Meuse river basin (adapted from the Meuse Treaty, 2002)

2.2 Administrative demarcation

Along the river basin of the Meuse, many (de)centralized governments, agencies, committees, and institutions are involved in water management issues. Municipalities form the lowest level of decentralization and are in many cases responsible for the collection, transport and treatment/discharge of (domestic) wastewater. Identifying every individual municipality along the Meuse river basin is beyond the scope of this research. In this analysis, the role, responsibilities and sources of power of the European Commission, national governments (e.g. ministries involved in policy making), regional governments (e.g. waterboards and their equivalents) and parties responsible provision of drinking water and sanitation services is described and related to Dunea's objectives and interests. Associations of professionals, companies and industries play a vital role in policy making, mostly their influence via various lobby activities.

3. Problem analysis

This chapter concerns the analysis of the problems and describes the substances that threaten Dunea's drinking water production (paragraph 3.1), the emission routes or origins of the identified substances (paragraph 3.2), the relation with drinking water production and the possibilities for intervention (paragraph 3.3). In annex 2 a cause and effect diagram can be found, displaying the causal relations between the relevant aspects of the problem.

3.1 Problematic substances

Since research has shown that treatment technology such as membrane filtration, Granular Activated Carbon (GAC) filtration, dosing of Powdered Activated Carbon (PAC) possibly combined with Artificial Recharge and Recovery (ARR) do not remove all substances (Verliefde, A. 2008, Beerendonk et al 2006 and Segers et al 2007), Dunea has acknowledged the need for further research. On request of and in cooperation with Dunea, *KWR Watercycle Research Institute* and *HWL* (Dutch laboratory for drinking water) took an inventory from (priority) substances which may threaten the treatment of Dunea, today and in the near future. The inventory is limited to chemical water quality parameters only. The most recent data is used, at the disposal of RIWA – Meuse, HWL, KWR Watercycle Research Institute and RIZA. In this paragraph a summary of the identified substances is given. For further information on this specific research and the used methods, you are referred to Puijker et al (2008).

A specific priority substance threatening the drinking water treatment was selected if one or more of the following characterisations apply:

- A. Possible norm exceedence, found regularly in surface water
- B. Found in drinking water, undesirable, found regularly in surface water or infiltrate
- C. Highly polar mobile ($\log KOW < 3$) and/or persistent (poor biodegradability) difficult to remove, found regularly in surface water
- D. Carcinogenic or toxicological relevant substance found in surface water
- E. Substance has high production volume and is found regularly in surface water
- F. Relevant for infiltration license

A total of 44 substances were selected: plant protection products (12), pharmaceuticals (9), hormones and endocrine disruptors (9), X-ray contrast media (5), additional emerging substances (11). A list of identified substances and the specific uses and emission routes can be found in annex 1.

3.2 Emission routes OMPs

3.2.1 Pesticides

Intensive cultivation of crops requires the use of plant protection products (pesticides, herbicides, fungicides etc.) for protection against pests and diseases. A proportion of the used chemicals find their way into the surface water (via runoff or drift) and are harmful to the natural environment. A continuous growth of the world population increases the demand for agricultural products which causes further intensification of agriculture. The Dutch government recognizes the existence of a tension between reaching environmental goals and maintaining or improving the competitive position of the agricultural and horticultural sector, a large contributor to Dutch economy. The Belgian, French and German agricultural sectors may be less intensive but run-off of plant protection products to surface waters is a recognized problem. National governments of European states have launched programs aimed at reducing the use and the associated environmental impact of pesticides (see annex 12 for more information).

Access to information regarding the consequences of pesticide use could increase the public awareness of the environmental impact. Increased awareness may reduce the usage of pesticides. Furthermore, availability of more ecological friendly plant protection products and application technologies could also contribute towards a reduction in pesticide runoff to the aquatic environment.

3.2.2 Pharmaceuticals and hormones

The usage of pharmaceuticals, both non-prescription and medication prescribed by physicians, increases annually. Ageing of the population is amongst others of influence on usage of pharmaceuticals. Furthermore, the amount of prescribed medication is of direct influence of the total use. Over the past years it has been shown that the pharmaceutical industry has a large influence on the amount and types of medication that

doctors prescribe (Bouma, 2006 and IGZ, 2009). The industry has a market value of \$17,6 billion and employs over 630.000 people in Europe (Espicom, 2009 and EFPIA, 2009). The European Federation of Pharmaceutical Industries and Associations (EFPIA), represents the producers and distributors of pharmaceuticals active on the European market.

Pharmaceuticals¹ are biologically active substances, designed to have an effect at relatively low concentrations. Most pharmaceuticals are highly polar – easily dissolved in water- since they are designed to spread well via the bloodstream. The problematic substances found in waters include a large number of human and veterinary pharmaceuticals, veterinary food additives and the formed metabolites (degradation products). Almost 100% of total amount of pharmaceuticals and hormones found in wastewater treatments come from human urine, which consists of only 1% of the total wastewater volume (Scheffer, 2007).

Wastewater from *hospitals* contains high concentrations of x-ray contrast agents, specific types of anti-biotics and cytostatics (anti-cancer medication). *Domestic* wastewater contains in accordance with general usage in households painkillers, contraceptives, cholesterol- lowering agents, β -blockers, anti-epileptic drugs and smaller concentrations of x-ray contrast agents. Veterinary pharmaceuticals - mostly anti-biotics and anti-parasitics - end up in the aquatic environment when manure is used for fertilization. Furthermore, the fish-farming industry uses large volumes of anti-biotics that can find their way into the surface water (Min V&W, 2003).

Unfortunately statistics concerning the concentrations of pharmaceuticals and hormones in the river Meuse were not readily available.

3.2.3 Endocrine disruptive substances

Several endocrine disruptive substances other than (synthetic) hormones and contraceptives were identified as a threat to Dunea's drinking water production (Annex 1). A typical example are phthalates, which are additives used to improve the flexibility of plastics, mostly PVC (90%). Plasticized PVC is used for the production of various products like vinyl carpets, packaging materials, flexible hoses, artificial leather, toys, car interiors and medical applications.

During the entire life-cycle (production, use and disposal) of PVC plasticizers emission to environment occurs. Exact data is not available but the total yearly emission to the environment (soil, water and air) is estimated to be 170 tonnes. Because the emission is very diffuse and the fact that phthalates are persistent, the environmental impact is difficult to tackle (Moleveld, 2006).

Since 2007 various phthalates (including DEHP and BBP) are banned from use in toys and personal care products (2005/84/EC) but are still allowed in other applications.

Due to a limited amount of available time and the diverse nature and application of the substances, the origin is not further investigated.

3.2.4 Additional emerging substances

The remainder of the micropollutants found in and near the Afgedame Maas include a variety of substances, the majority of which has an industrial origin. Due to a limited amount of available time, the origin of these substances is not further investigated.

3.3 Relation with drinking water production and possibilities for intervention

The relations between the emission routes were elaborated in the previous paragraphs. This paragraph focuses on the relation with drinking water production and possibilities for intervention.

3.3.1 Expend the post-treatment

The quality of the produced drinking water depends on the applied treatment scheme, the level of treatment during dune passage and the remaining concentration of OMPs in the produced drinking water. When the concentration of OMPs in the abstracted water regarded as fixed, Dunea's options for intervention are limited: Dunea can expend the post treatment. The level of treatment during dune passage cannot be influenced.

¹ The term pharmaceuticals is used to describe the following types of substances: human and veterinary medications, hormones, contraceptives and x-ray contrast agents.

3.3.2 Expend the pre-treatment

The dune areas used for infiltration have the status of nature reserve; the infiltration water should comply with the *Infiltratiebesluit Bodembescherming*. The Province of South-Holland will renew Dunea's infiltration license in 2016 and it is expected that the allowed concentrations of OMPs will be lower than is currently allowed.

3.3.3 Emission prevention

Reduction of the emission of plant protection products and pharmaceuticals, are described and analysed in chapters 6 and 7.

3.4 Analysis of Dunea's objectives

A detailed elaboration of Dunea's objectives and the applied criteria can be found in annex 3. Moreover, a visual representation of the objectives and the criteria can be found in annex 3 as well.

3.4.1 Drinking water production in harmony with nature

Dunea's main objective is to *produce good and reliable drinking water in harmony with nature*. The dunes fulfil multiple functions; a combination of water abstraction, nature conservation and recreation. The slogan clean water from a clean environment describes Dunea's mission statement (Dunea, 2009).

Production of good and reliable drinking water in harmony with nature includes the following aspects:

- Production of high quality drinking water (in compliance with the standards set by the Drinkwaterbesluit),
- Reliable distribution (in complying with norms regarding supply, quality and security),
- Good management of the dune areas,
- High quality of nature in the dune areas.

3.4.2 Criteria regarding water quality

Criteria for the quality of the produced drinking water are norms defined by the *Drinkwaterbesluit* which are in many cases expressed as maximum concentrations in mg/l. The norm set for concentration organic micropollutants is as follows: the concentrations of individual substances cannot exceed 0,1 µg/l and the total concentration of compounds found in a sample should be <0,5 µg/l.

The water infiltrated in the dunes should meet the criterion defined by the MTR (maximum toelaatbaar risico/ maximum allowable risk): the calculated concentration of a substance in the environment with no adverse effects to 95% of the present organisms. Norms are also defined for the distribution and treatment. Those norms are not further elaborated here due to time constraints.

3.5 System identification

The results of analysis the problem situation - Dunea's objectives and criteria, the problem of organic micropollutants (types, emission routes) and possibilities for intervention - can be summarized and visualized with a system diagram (figure 3.1).

The problem of occurrence of organic micropollutants in Dunea's source for drinking water consists of three subsystems:

- Runoff of pesticides to the aquatic environment
- Pharmaceuticals present in discharged effluent of wastewater treatment plants,
- Emission of endocrine disrupters and other emerging substances (marked with grey, not further investigated).

The main causes of the problem are the use of organic micropollutants such as pesticides, pharmaceuticals, endocrine disrupters and additional emerging substances. Criteria used by Dunea are the standards defined by the drinking water norms, MTR and Infiltratiebesluit Bodembescherming. Another important criterion is the amount of confidence that the bound users have in Dunea; the level of consumer trust. The quality of nature

found in the dune areas is defined by the variety in ecosystems, species and genes. Good recreational opportunities depend on the amount of routes available for pedestrians and cyclists.

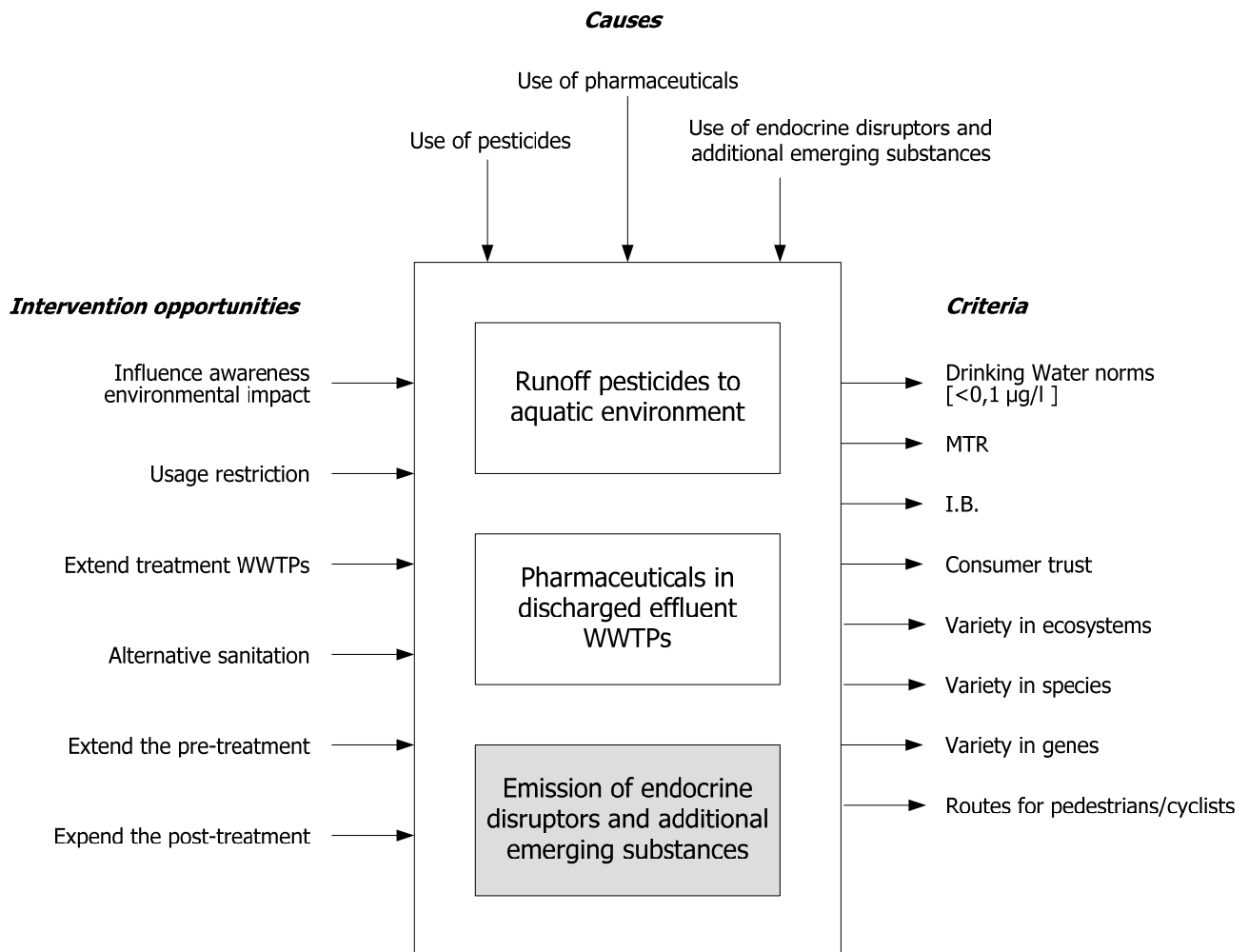


Figure 3.1: System diagram OMPs in source for drinking water

Part 2: Network exploration

Introduction

The term stakeholder or actor is generally used to describe a social entity, person, organization or party that is able to act on to exert influence on a decision. In other words: actors are those parties that have a certain interest in the system and/or that have some ability to influence that system, either directly or indirectly using their available resources and power (Enserink et al., 2009). Examples of resources and power are: legislation, financial resources, knowledge, the power to influence public opinion or ownership of specific installations like water treatment plants, sewer systems etc. By exploring the network, Dunea can gain increased insight to her position within the network. What parties are potential allies or enemies and how critical is the cooperation of the specific parties in working toward a solution for Dunea's problem? Furthermore, it yields insight in the activities of the involved stakeholder in terms of prevention or reduction in emission of OMPs. A basic procedure for exploration of the network consists of six steps:

1. Formulation of a problem as a point of departure
 - chapter 3
2. Inventory of the actors involved
 - chapter 4
3. Exhibiting the formal chart: the formal tasks, authorities, and relations of actors and the current legislation.
 - chapters 4, 5 and 6
4. Determining the interests, objectives and problem perceptions of actors
 - stakeholder analysis in annex 9
5. Mapping out the interdependencies between actors by making inventory of resources and the subjective involvement of actors with the problem.
 - stakeholder analysis in annex 9
6. Determining the consequences of these findings with regard to the problem formulation.

The formal structure of the water, drinking water and sanitation sectors along the Meuse river basin is analysed in paragraph 4.1 and annex 4. Several committees, agencies and associations are involved in water resource management and the corresponding policy-making issues (paragraph 4.2 and annex 6). In an attempt to organize the network in the field of water management, several national platforms and partnerships have been established (paragraph 4.3 and annex 7). Professional associations are identified and described in paragraph 4.4 and annex 8, NGOs and research institutes in paragraph 4.5. The stakeholders responsible for emission of organic micropollutants, the pollution causers are analysed in paragraph 4.6. The network exploration yields in a stakeholder analysis, the results of which can be found in paragraph 4.7

4. Water, drinking water and sanitation sectors Meuse river basin

4.1 Structure of sectors

In order to identify possible allies for Dunea, the structure of the drinking water and sectors along the Meuse River basin is analysed and compared to the situation in the Netherlands. A complete description and visual representations of the sectors can be found in annex 4.

When comparing the situations in Belgium, France and Germany to the situation in the Netherlands, several conclusions can be drawn.

On the national levels the number of ministries involved in water policymaking differs: Belgium (0), the Netherlands (2), Germany (3) and France (4).

In the Netherlands there is a strict separation between the production and supply of drinking water and the collection and treatment of wastewater. Amsterdam is the exception to the rule: Waternet is responsible for the production and supply of drinking water and for the collection and treatment of wastewater.

In France and Germany the production and supply of drinking water and the collection, transport and treatment of wastewater are the responsibility of municipalities that can delegate this to local public or private companies. Flanders and Wallonia have a regional sanitation company that can delegate its responsibilities (construction and operation of sewage systems and wastewater treatment plants).

The Dutch drinking water companies much larger in terms of supply area and number of customers compared to the drinking water suppliers in France, Germany and most suppliers in Belgium.

Table 4.1: Summary drinking water and sanitation providers

	The Netherlands	Belgium		France	Germany
		Flanders	Wallonia		
Production and supply of drinking water	Public limited companies (600.000 – 5.4 million customers)	Municipalities, delegated to - municipal company - inter-municipal company.	SDWE (70% total volume and intercommunale (municipal level) drinking water companies	Municipalities/ municipal organisations (1500) or private companies (5000)	Municipalities, delegated to - municipal company - private company - PP-partnerships - inter-municipal company.
Collection and transport of wastewater	Municipalities	Aquafin and municipalities	SPGE and provincially demarcated companies (intercommunales)	Municipalities/ municipal organisations (13.500) or private companies (4000)	
Treatment of wastewater	Waterboards (27 in total)				

4.2 Committees, agencies and associations

In this paragraph a short description of international committees involved in water resource management and the corresponding policy-making issues along the Meuse river basin is given.

4.2.1 International

The International Meuse Commission (IMC) was established in 2002 with the signing of the International Meuse Treaty by the national governments of France, Luxembourg, Germany, the Netherlands, Belgium and the regional governments of Brussels, Flanders and Wallonia. The most important tasks of the IMC are (IMC, 2002):

- Coordination of implementing European Water Framework Directive.
- Construction of a Management Plan for the international Meuse river basin.
- 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.

The Meuse Treaty is an addition to the *Treaty for the protection of the Meuse* (1994) in which Germany and Luxembourg took no part.

The Commission has formulated several Programmes for achieving its goals. The general short term goal is the conservation and improvement of the Meuse quality, especially the physio-chemical quality, the ecological quality, the drinking water function and other water uses (ICPM, 1998).

RIWA-Meuse is an international association of water companies that use water from the Meuse use as a source of drinking water. RIWA-Meuse aims at drinking water production from the Meuse through simple and reliable natural treatment and is highly aware of the treats posed by OMPs in the Meuse.

By means of lobbying, extending the existing network, by giving presentations at symposia and other events, RIWA-Meuse tries to stress the importance of the Meuse's drinking water function to local, national and international authorities. Furthermore, the association is has an extensive measuring programme, is involved in scientific research, performs an intensive lobby in the media, national, regional and municipal governments, European institutions, international committees, industry and the agricultural sector (RIWA-Meuse, 2005).

Several Dutch and Belgium (all in Flanders) drinking water companies are members of the association. The publication of RIWA-Meuse report on the quality of the Meuse water (2009) resulted in a headline "*Kwaliteit Maaswater voor drinkwaterfunctie teleurstellend*" (Disappointing quality Meuse water for drinking water) in various media sources.

The *Vlaams Nederlandse Bilaterale Maascommissie (VNBM)* is a bilateral integral discussion platform for civil servants that aims at improving the structure of Flemish-Dutch cooperation regarding the Meuse. The VNBM is installed based on the Meuse discharge treaty (1996) between the Flemish region and the Dutch national government. Its tasks include all issues regarding policy-making and management of the Meuse: high-and low-water management, water quality management, conservation and development, monitoring and research, shipping and wet infrastructure and legal affairs (VNBM, 2009).

4.2.2 National committees and agencies

Policy making in the water sector is scattered amongst varies national and regional authorities. Therefore the Netherlands, Belgium and France have installed committees or agencies for coordinating and structuring of policy making regarding water management.

Partners voor Water is an initiative of several Dutch ministries (BZ, V&W, LNV, VROM, EZ). One of the organisation's goals is to improve the coordination and tuning of policy making by various departments with a relation to water management. Coordination can be between the ministries (horizontal) and between the ministries and the water sector (vertical). (Partners voor water, 2008)

Geographically demarcated water systems are the basis for water management in Flanders. The most recognizable water systems are the river basins: the Yser, the Scheldt, the coastal polders and the

Meuse, which are further demarcated to part river basins. It was decided that cooperation only is not enough to reach effective integral water management in Flanders. Complete restructuring on the other hand is perhaps a step too far. Therefore the *Vlaams Integraal Wateroverleg Comité* (VIWC) was established in 1996 to shape policy making for integral water management in Flanders and to provide a platform for communication and knowledge sharing between those actors that are involved in policy making. Like in Flanders, Walloon water policy-making is organised via an administration, coordination and discussion body: the *Plate-forme permanente pour la Gestion Intégrée de l'Eau* (PPGIE) (La Région Wallon, 2002).

The *French national agency for water and aquatic environments* (ONEMA) is a national agency active in the field of the environment and public services, operating under the supervision of the Ministry of Ecology, Energy, Sustainable Development and Territorial Planning. The activities of ONEMA are: stimulation of research and development, protection of the aquatic environment and management of the French Water Information System aiming at supporting the formulation, implementation and evaluation of public water policies (ONEMA, 2009)

4.3 National networks for policy making

Several national platforms or partnerships have been established in an attempt to organize the network in the field of water management. The reader is referred to annex 7 for a more elaborate description.

The *Netherlands Water Partnership* (NWP) is a public-private network organisation that operates as an independent coordination and information source for the Dutch water sector. It aims at reaching a well-organised network in the Dutch water sector by stimulating cooperation between relevant parties. The NWP has more than 130 members among governments, knowledge institutions, companies and public institutions. One important activity of the NWP is reinforcement of the European and international network via contacts with the various international committees and agency's such as the Global Water Partnership, the World Water Council and Water Supply and Sanitation Technology Platform (NWP, 2007).

The previously mentioned VIWC (Flanders) has a double role. It functions as the formal institution responsible for coordinating water policy making Flanders. Besides its formal task, it also serves as the network in which actors other than authorities can contribute in policy making.

The *French Water Partnership* (FWP) is the French equivalent of the NWP and consequently has very similar goals and activities: it functions as a forum concerning policy-making, governance and management of water resources. The FWP brings together the French water stakeholders active on the international stage: Ministries, NGOs, local authorities, companies, river authorities and scientific and technical organisations. The FWP maintains a political decision-making focus on water issues (FWP, 2008).

The *German Water Partnership* (GWP) is the platform for stakeholders active in the German water sector. When comparing the GWP to the Dutch and French Partnerships, it becomes apparent that the GWP has an economical focus, rather than being policy-oriented; it has no governments or other authorities amongst its members. Thus, its focus is on grouping activities, information, research and innovation in the German water sector to strengthen the competitive economic position in the international field (GWP, 2009)

4.4 Professional associations

Professionals, companies and industries operating in the field of drinking water and sanitation have organized themselves in various associations. The reader is referred to annex 8 for a more elaborate description of the relevant professional associations

Vewin is the association of drinking water companies in the Netherlands and every Dutch drinking water company is a member. Vewin's main task is to represent the interests of members on the national and the European level, focussed mainly on legislation and policy-making and proposals and ideas that require several years of preparation (VEWIN, 2009).

The Dutch water boards are united in *the Unie van Waterschappen*, which represents their interests on both the national and international level. The union participates in many discussion and advisory organisations and is involved in national policy making and legislation (UvW, 2008).

Aqua Nederland is an association for private companies operating in water treatment (Aqua Nederland, 2009).

A relatively new association for professionals working in the Dutch water sector is the Koninklijk Nederlands *Waternetwerk*: a merger between two other associations (KVWN and NVA). The association promotes the exchange of knowledge and experience between their members (KNW, 2008).

Belgaqua is the Belgium association for companies involved in the production and distribution of drinking water and treatment of domestic wastewater. It represents the common interests of her members at the federal, European and international level and stimulates development of knowledge (scientific, technology, economically or administrative). Following the typical Belgium practice of regional delegation, Belgaqua is actually the umbrella organisation for the regional associations *Aquawal* (Wallonia), *Aquabru* (Brussels) and *SVW* (Flanders).

The *Fédération professionnelle des entreprises de l'eau* (FP2E) is the association of French companies involved in drinking water and sanitation. Like its Dutch and Belgium equivalents, it represents the member companies and aims at influencing policy-making and legislation (FP2E, 2009).

A multitude of associations is active in the German water and utility sector. The associations and their activities are summarized in the table A8.1 in annex 8.

4.5 Knowledge institutes and NGOs

The result of scientific research regarding organic micropollutants often serves as an input for policy making and vice versa. Obviously research institutes and universities play a very important role in the development of fundamental scientific knowledge about the emission and consequences of organic micropollutants and technology required for the removal and/or reduced emissions. Dunea for instance cooperates with KWR Water Cycle Research Institute, Philips Research, American Water Works Association Research Foundation (AwwaRF) and Delft University of Technology towards implementation of advanced oxidation in her treatment scheme. Moreover, drinking water company Greater Cincinnati Water Works is also involved in this research project.

Non governmental organisations (NGOs) often use their resources to the influence policy making via the public opinion. NGOs can be a potential ally but also a powerful opponent.

Due to time restrictions the roles of these two types of stakeholders is not investigated.

4.6 Pollution causers

4.6.1 Producers, distributors and users of pesticides

Plant protection products (pesticides, herbicides, fungicides) are used by the agricultural sector, local governments (maintenance public areas) and the general public. The European Crop Protection Agency (ECPA) represents the pesticide industry (producers and distributors) in Europe. The pesticide industry does not benefit from emission prevention via usage reduction: reduced use will reduce sales and thus result in decreased turnover. However, if the market and policy makers demand it, the industry will eventually be forced to develop more eco-friendly alternatives.

The users are aware that pesticide use has a negative influence on the (aquatic) environment but options for eco- alternatives are limited. Especially the agricultural sector – crop protection is essential – cannot refrain from pesticide use. The pesticide industry continues to develop new products and replaces a prohibited substance (atrazine) with even more persistent products (glyphosate).

4.6.1 Producers, distributors and users of pharmaceuticals

The general public has a double role (consumer of drinking water and pharmaceuticals) and as a consequence has internally conflicting objectives. On one hand, the public wants access to affordable, safe and reliable health care and pharmaceuticals. On the other hand, the public desires no traces of pharmaceuticals in drinking water. Furthermore, use of prescription drugs and x-ray contrast media is often not a choice but a necessity for maintaining/increasing the individual level of health.

Pharmaceuticals are prescribed by doctors (general practitioner, specialists working at health care facility etc) and their prescription methods may be influenced by the pharmaceutical industry (Bouma, 2006 and IGZ, 2009). Due to the introduction of competition, health care institutions are influenced by the insurance companies, investors, patient representatives and also pharmaceutical industry (van Spaendock, 2009). Some health care institutions have recognized their responsibility and are experimenting with separate urine collection (see paragraph 7.1).

4.7 Results stakeholder analysis

A simplified graphical summary of the network regarding the issue of organic micropollutants in drinking water sources can be found on the next page.

The network of stakeholders relevant to issue of organic micropollutants in drinking water sources is large and complex. First of all the emission of organic micropollutants to the aquatic environment has a diverse origin. The agricultural sector is responsible for the majority of emitted plant protection products (pesticides, herbicides etc). Municipalities and home owners also use plant protection products. Pharmaceuticals are secreted via the urinal tract and are only partly removed from wastewater that is discharged to the environment. Endocrine disruptors such as phthalates which are used for the production of plasticized PVC are emitted during the entire life-cycle of various types of products. Literally everyone contributes to pollution by organic micropollutants.

Second of all, the problem is not confined to one single area of policy making. The water quality of the Afgedamde Maas is depends on the impact of activities along the Meuse river basin, which are influenced by the relevant legislation regarding the fields of water resource management, public health, environmental law in the broad sense, agriculture, drinking water and sanitation.

Things are even further complicated by the fact that policy making regarding (drinking) water takes place at the European, national, regional and local level. Cooperation between and across different levels of decentralization is often very difficult and not as evident as one might think. National platforms for water policy making have been installed in an attempt to organize the network in the field of water management. Furthermore, several international committees are involved in water resource management and the corresponding policy-making issues along the Meuse river basin.

The drinking water and sanitation sectors of the countries along the Meuse river basin have very different structures. Companies responsible for the production and distribution of drinking water are very different in size, varying from very local (France) to regional/provincial (Netherlands). The same holds for wastewater treatment. In some cases the companies are publicly owned, others are privatised. In the Netherlands the production of drinking water and the treatment of wastewater are done by separate companies (with one exception) which is not always the case in the other countries. Larger drinking water companies have the funds and manpower to engage in research towards addressing the issues of OMPs in drinking water sources. For instance, Dunea currently has MSc and PhD students from the TU Delft working on their thesis research regarding the removal or degradation of OMPs from drinking water sources.

Professionals, companies and industries operating in the field of drinking water and sanitation have organized themselves in various associations. Those associations represent the interests of the members and attempt to influence policy making. Some of the associations are involved in the development of knowledge and technology, as do some of the member organisations themselves. If companies involved in sanitation services are confronted with extra costs (e.g. investing in advanced wastewater treatment or alternative sewer collecting), the associations will potentially frustrate the implementation of the proposed measures.

Research institutes and universities supply fundamental scientific knowledge about the emission of organic micropollutants and the consequences. They are also involved in the development of technology required for the removal and/or measures for reduced emission. Non governmental organisations (NGOs) often use their resources to the influence policy making via the public opinion. NGOs can be a potential ally but also a powerful opponent.

From the stakeholder analysis can be concluded that many parties have internally conflicting objectives. All acknowledge the importance of pollutant free surface waters, especially if the water is

to be used for production of drinking water. Unfortunately other interests like maintaining the competitive position of the agricultural sector and access to safe, affordable medication cause contamination of drinking water sources. Moreover, parties responsible for collection and treatment of wastewater will be faced with increased costs if the quality of discharged WWTP effluent is to be increased, which can turn them into opponents.

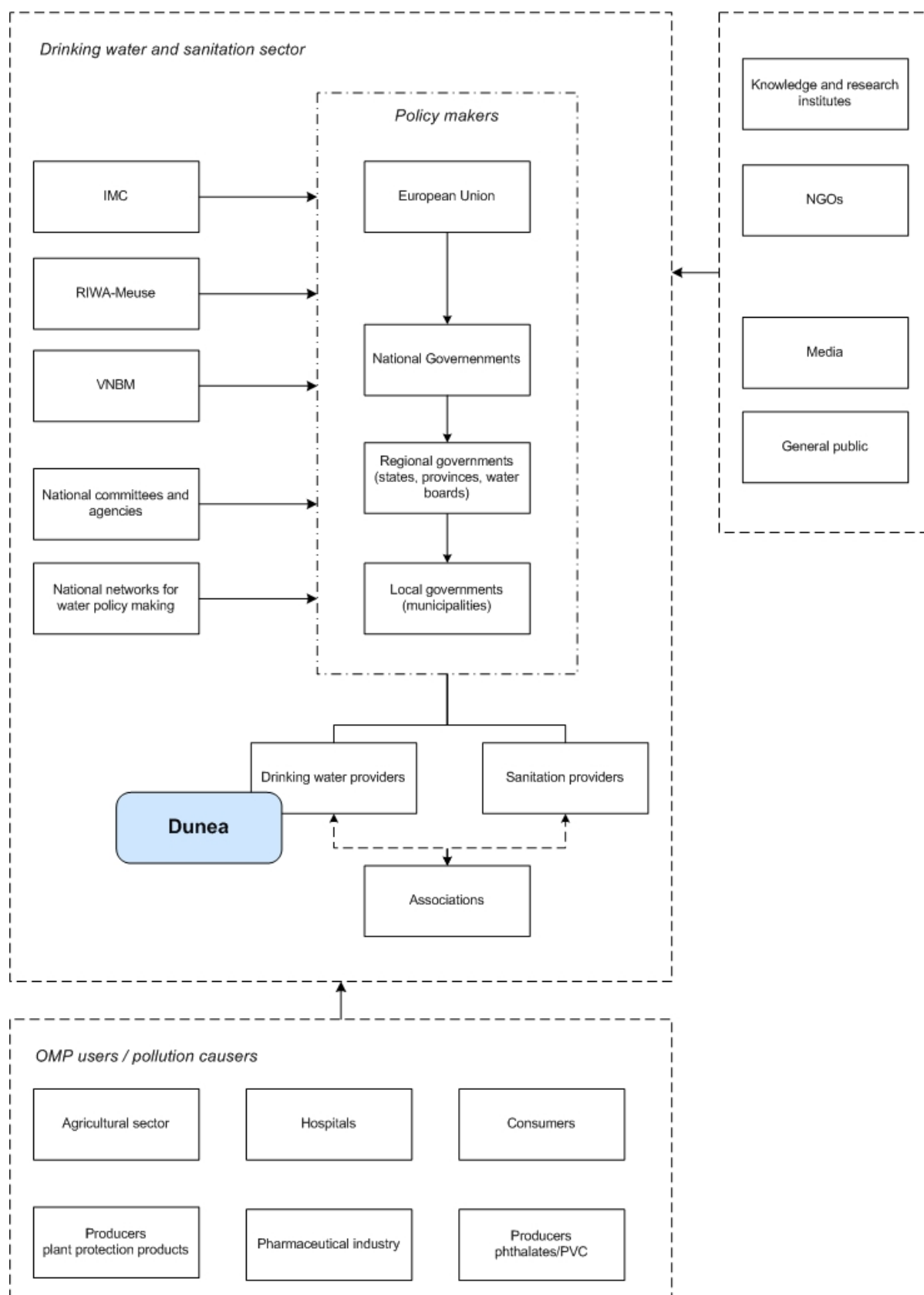


Figure 4.1: Network water and sanitation regarding the issue of OMPs in drinking water sources

5. Legislation and policies

5.1 European Legislation

5.5.1 Water Framework Directive

A multitude of European policies and legislation are relevant regarding the prevention of the emission of organic micropollutants to surface waters, reducing the environmental consequences and combating threats to drinking water production. Several Directives that do not have a direct focus on protection of water quality are relevant: the Integrated Pollution Prevention Control Directive (2008/1/EC), the Plant Protection Products Directive (91/414/EEC) and the Biocidal Products Directive (98/8/EC). However, the Water Framework Directive (WFD) aimed at maintaining and improving the aquatic environment, is the most important one.

The purpose of the Directive is to establish a framework for the protection of surface waters, transitional waters, coastal waters and ground waters. Specific environmental objectives are the central importance of the Directive. A *good water status* should be achieved by 2015 and deterioration of the water status and pollution should be prevented. For surface waters this implies a *good chemical status* and *good ecological status* and for groundwater this means a *good chemical status* and a *good quantitative status*.

Based on the WFD, (inter)national river basin management plans should be formulated that incorporate measures to achieve the environmental targets, taking not only the WFD into account but also the Integrated Pollution Prevention Control Directive, the Plant Protection Products Directive, the Biocidal Products Directive (98/8/EC) and the Directive on Priority Substances.

5.1.3 WFD and its relation to pollution by organic micropollutants

Article 16 of the WFD outlines a strategy against the pollution of water. The strategy includes the establishment of a list of priority substances, a procedure for the identification of priority substances/priority hazardous substances and the adoption of specific measures against pollution with these substances. In 2001 a list of 33 priority substances, including 11 priority hazardous substances was adopted (Decision 2455/2001/EC) as part of the WFD (annex X WFD). The discharge, emission and losses of these substances should cease within 20 years.

In 2008 the Directive on Priority Substances (2008/105/EC) was adopted to replace annex X of the WFD. This directive sets limits to allowable concentrations of these substances in surface waters by defining annual average environmental and maximum allowable concentration quality standards (AA-EQS and MAC-EQS). The average concentration of atrazine in inland surface waters for instance cannot exceed 0,6 µg/l.

5.1.4 Conclusion

According to article 16, European Parliament and the Council should adopt specific measures against the pollution of water, aimed at progressive reduction in discharge, emission and losses of priority substances and cessation of phasing out priority substances. Limits to allowable concentrations in surface water are defined at the European level and the placing of new plant protection products on the market is only allowed after EU approval. However, no measures for reduced discharge, emission or losses have been proposed on the European level so far. In absence of action at the European level, member states themselves are required to take action (Mostert, 2008).

5.2 National legislation

The European Water Framework Directive and all other European legislation are to be transposed into national legislation of the member states. An inventory of relevant national legislation regarding drinking water can be found in annex 10.

Part 3: Preventative measures

6. Measures for reduced emission of pesticides

6.1 National programs for reduced use and consequences of pesticides

Reducing the contamination of surface waters is one of the main objectives of the European Water Framework Directive, which is implemented via national legislation of the member states. The Netherlands, Belgium, Germany and France have implemented policies and programs aiming at a reduction of pesticide use and emission to the natural environment. A summary of the different policies and the effectiveness is given below, a more detailed description can be found in annex 12.

6.1.1 The Netherlands

The Dutch Ministry of Agriculture, Nature and Food Quality has formulated a target concerning the environment and the protection of crops: a 95% reduction of the environmental impact to surface waters in 2010 compared to 1998, in an economically sound way.

In order to reach this target the Ministry has formulated a memorandum (Nota Duurzame Gewasbescherming) with a dual approach: the implementation of admission and environmental policies in line with European policies and joint efforts of involved parties. The latter is realized via a formal agreement with 7 other relevant parties.

The effectiveness of the policy and the agreement in terms of reduced emission of pesticides has been monitored and it can be concluded that crop protection has become more environmental friendly. In 2005 an 86% reduction was reached: mainly via measures aimed directly at reduced emission such as no-crop zones along surface water and emission reducing equipment. Also, changes have been made to the package of authorised pesticides (90 substances were taken off the market). The intermediate goal was set at 75%, which has been sufficiently realized.

The quality of surface waters used for the production of drinking water has improved, but the intermediate target of 50% reduction in the number of drinking water problems has not been achieved. In 2005 a reduction of 18% has been reached. The reduction can be fully attributed to the prohibition of three atrazine, diuron and simazin. Illegal use in the Netherlands cannot be ruled out completely, however when the Meuse crosses the Dutch border, atrazine and diuron are already present. It is suspected that 27% of the problems concerning drinking water have an origin outside the Netherlands.

6.1.2 Germany

The Germany Ministry Food, Agriculture and Consumer Protection has formulated a policy that is very similar: the *Reduction Program Chemical Plant Protection* (2004) and the *National Action Plan on Sustainable Use of Plant Protection Products* (2006). The focus is on risk reduction rather than formulating specific targets on quantity reduction: it takes the relation between risk level and applied volumes of chemicals into account. Germany's plant protection policies have reduced the risk to the natural environment by more than 50% - in some cases by as much as 90% - since 1987 (BMVEL, 2006).

6.1.3 Belgium

Until 2005 no national plan toward reduced pesticide use existed in Belgium. Therefore the Federal Government has formulated the *Program for Reduction of Pesticides and Biocides* (FOV, 2005), which aims at a 50% reduction of the impact of pesticides to the environment.

Besides specific measures aimed at reducing the professional use and consequences of pesticides, the Federal government has also launched a campaign to reduce the home-use of pesticides by the general public.

In Flanders the spreading equivalent (Seq) is used, which is a measure for the emission of pesticides corrected for differences in eco-toxicity and *verblijftijd*. The year 1990 is used as reference level. In 2005 the achieved reduction was 47% (or index level of 53%) so the formulated target has not been reached (FOV, 2006). Information regarding trends in the spreading and/or risks associated with pesticide use in Walloon was not found.

6.1.4 France

France is the top user of pesticides in Europe (Scheuer, 2006). Pesticides are found in 80% of the surface water measuring stations and in 57% of ground water measuring stations. Plan Ecophyto 2018, an interministerial plan was launched to reduce the use and risks associated with pesticides by 50% in 2018 compared to 2008 (la Ministère de L'agriculture, 2008).

From 1998 onward, France has monitored the occurrence of pesticides in waters. Based on the found concentrations the water body receives a quality label that can vary from very good ($<0,1 \mu\text{g/l}$) to very poor ($>2,0 \mu\text{g/l}$). A positive trend in water quality regarding pesticides can be distinguished.

6.1.5 Conclusions regarding effects national programs

Comparing the results of the individual national programs is difficult due to the different target formulations. In the Netherlands the percentage of measurements exceeding the defined norms is used as the key indicator. The German focus is on risk reduction rather than formulating specific targets on quantity reduction, taking the relation between risk level and applied volumes of chemicals into account. In Flanders the spreading equivalent (emission of pesticides corrected for differences in eco-toxicity and residence time) is used. The French approach is to assign a quality label to surface water bodies based on found concentrations.

It can be concluded that the quality of surface waters in the Netherlands, Belgium, Germany and France has

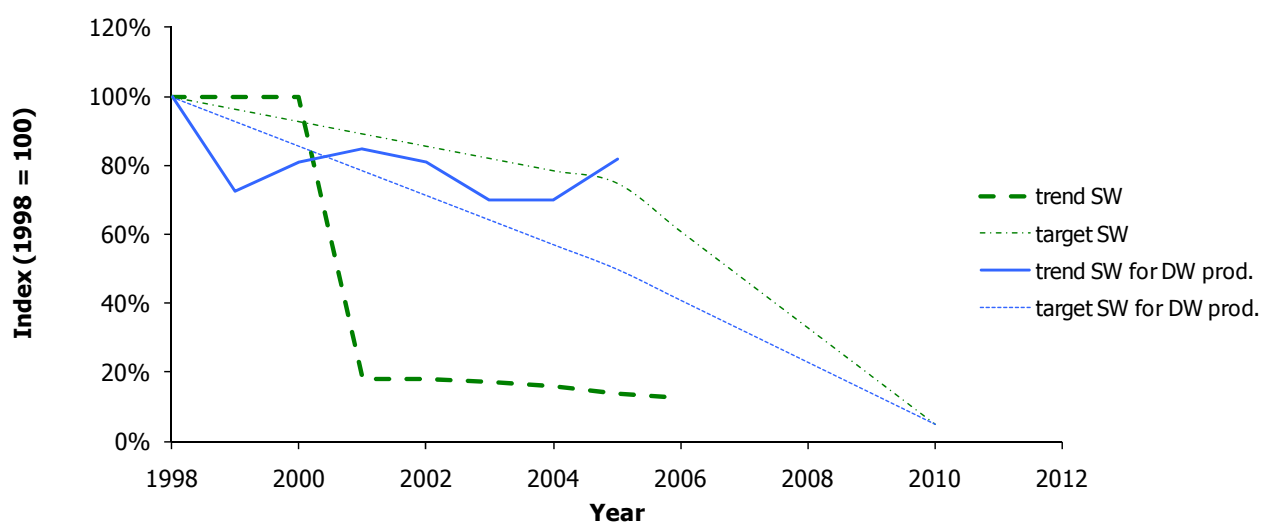


Figure 6.1: Effects of programs pesticide reduction on Dutch surface waters (percentage of measurements exceeding the norms)

6.2 Local prevention: Zuiver water in de Bommelerwaard

Approximately 40% of the total water volume in the Afgedamde Maas – Dunea’s source for drinking water - consists of Bommelerwaard-water the rest originates directly from the Meuse. It therefore makes sense to aim at reducing the emission of pesticides from the Bommelerwaard. The project *Zuiver-Water Bommelerwaard* aims at improvement of the surface water quality via preventative measures.

The project is an initiative of Dunea, water board Rivierenland (WSRL) and Rijkswaterstaat Direction South- Holland (RWS-DZH) and aims at reaching agreements with stakeholders towards reduced usage of pesticides. This paragraph briefly describes the relevant aspects and outcomes of this initiative, a more detailed elaboration can be found in annex 11.

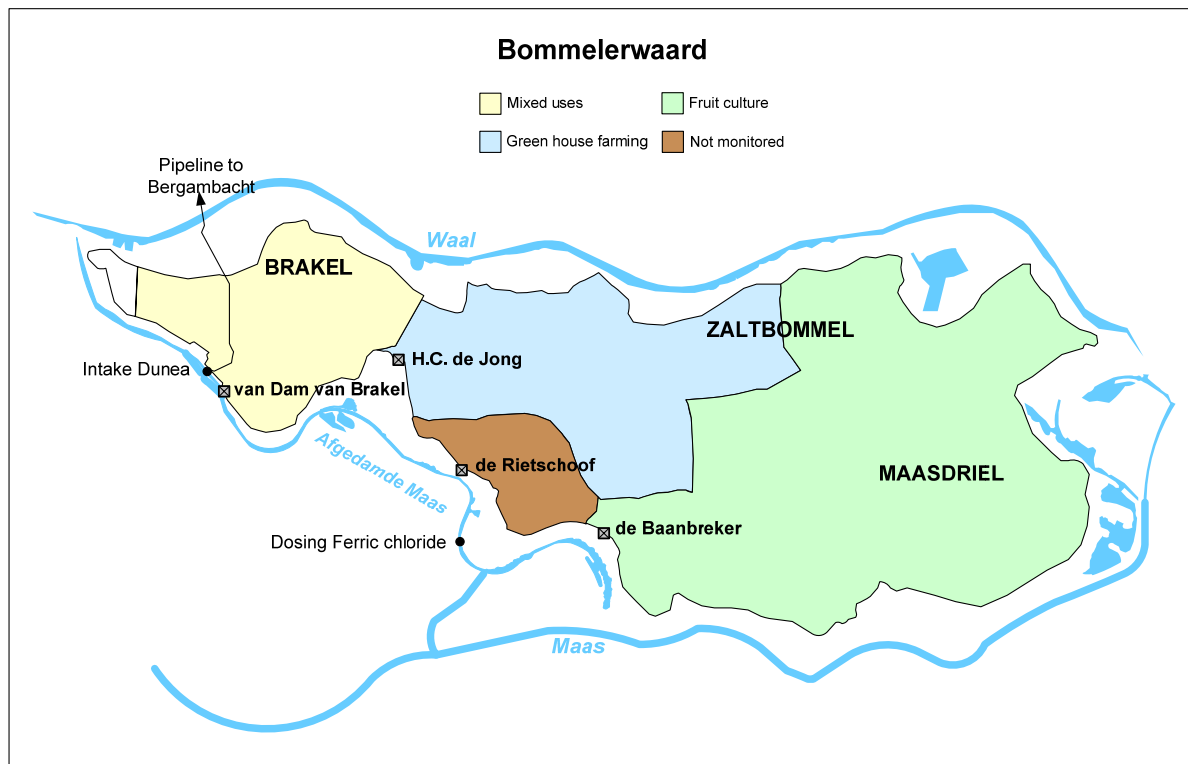


Figure 6.2: Water system Bommelerwaard

Water is released to the Afgedamde Maas whenever the water level in the Bommelerwaard too high. If the Bommelerwaard requires extra water, it is taken in from the Meuse when needed. The water quality is monitored at three pumping stations in de Bommelerwaard. This way it is possible to demonstrate which substances are used by which agricultural sector. Furthermore, samples are also taken at Dunea’s intake, and along the Meuse.

6.2.1 Motivation

The multifunctional principal applies when surface water is infiltrated in the soil. It requires that the quality of the infiltrated water should pose no threat to the other functions of infiltrated soil and the quality of the groundwater. The quality of surface water used for infiltration and abstraction in the dunes does not meet the standards set by law (Infiltratiebesluit Bodembescherming or IB). As a result, the province of South-Holland has decided to allow infiltration until 2016 under a few conditions.

The project’s main goal is to improve the surface water quality of the Afgedamde Maas, by realising an improvement in quality of the water released from the Bommelerwaard. The quality of the Bommelerwaard-water should comply with the maximum permissible risk (MTR) or with the drinking water norm when no MTR exists or when the MTR exceeds the drinking water norm. In 2010 no exceedence of the MTR and/or drinking water norm regarding plant protection products should occur.

6.2.2 Preventative measures Bommelerwaard

Several different types of measures have been designed and put into practice. Some were sector specific; others had a more general aim. The measures are categorized as:

1. reducing the use of pesticides,
2. use of alternative technologies
3. use of alternative (more eco-friendly) pesticides

An inventory of the implemented measures is given in table X, annex 11.

6.2.3 Monitoring program

The Waterboard Rivierenland conducts an extensive monitoring program in order to evaluate the progress of the project. Samples are taken at 9 locations in the Bommelerwaard. The samples are screened for the presence of relevant substances and whether the concentrations exceed the norms that are explained below.

MTR (maximaal toelaatbaar risico/ maximum allowable risk)

The MTR is the calculated concentration of a substance in the environment with no adverse effects to 95% of the present organisms. MTR values are regularly adjusted when new information regarding the consequences of a compound comes available.

Drinking water norm

The drinking water norm for plant protection products is set by the *Waterleidingbesluit*.

The concentration of individual substances cannot exceed 0,1 µg/l and the total concentration of compounds found in a sample should be <0,5 µg/l.

The number of substances included in the measuring package has increased over the years from 60 (2002) to 214 (2007). It is important to adjust for this when the results of different years are compared. Approximately 45% of the included substances are found in the samples, the rest of the substances have concentrations below the detection limit. A substance is defined as being problematic if the concentration exceeds the MTR or drinking water norm at least one time at any location.

6.2.4 Results and conclusions Bommelerwaard

The water quality is an important indicator for the success of the project, which is intensively monitored.

Speets (2005) has evaluated the outcomes of the project over the period 2002-2004 and concludes that the implementation of the measures was lagging behind the planning, despite the financial contribution and contribution of manpower. The results of the first couple of years of the project did not meet the expectations: the direct measurable effect in terms of a reduction in the emission of pesticides from the Bommelerwaard is very limited.

Several causes have been identified: measures are unpractical, too experimental, very low contribution towards emission reduction, little interest from specific sector. Only mechanic weed removal in corn fields is expected to contribute towards the emission reduction. The future must show whether the ambitious goal – no exceedence of the MTR and/or drinking water norm in 2010 – will be met. It was recommended to implement a go/no go decision in 2007.

Speets does however recognize that the project 'Zuiver-Water Bommelerwaard' provides a positive contribution towards policy making aiming at protecting surface water intended for drinking water production. The project emphasizes the need for better protection of surface water bodies used for the production of drinking water. Furthermore, the project is widely known in the region, which enlarges the support for planned measures.

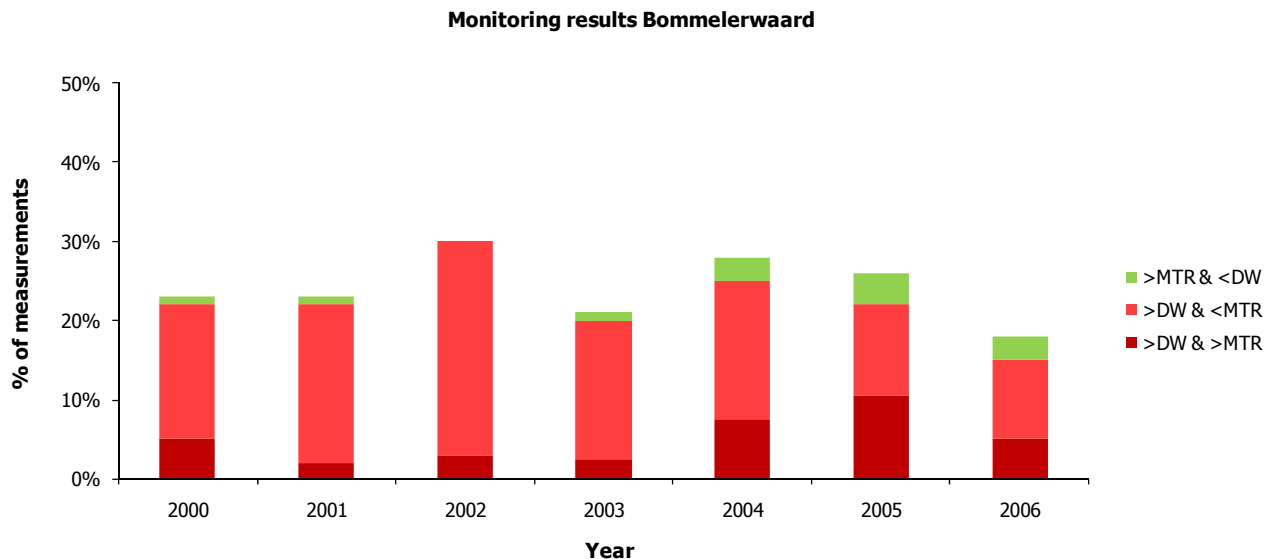


Figure 6.3: Average monitoring results all locations (adapted from Visser et al., 2007)

In 2007 the results were evaluated again (Visser et al., 2007, Speets, 2007 and Vlaar et al., 2007). The water quality at Dunea's intake has improved since the reference year 2003: a clear decrease in the percentage of norm exceeding measurements can be distinguished from 2004 and onwards. However, when the years 2005 and 2004 are compared it can be concluded that the percentage of measurements with concentrations >MTR and/or DWN has increased slightly to 10%. This remains relatively constant in the period 2005-2008.

The project has successfully introduced some measures and has achieved a reduction of usage of plant protection products in fruit culture and cattle farming. On an annual basis, 20-30% of the concentrations of monitored substances exceed the DWN and MTR for plant protection products. Some substances exceed the norms more frequently than other substances. The quality of water that Dunea infiltrates in the dune area meets the standards set by the *Infiltratiebesluit Bodembescherming* regarding the presence of organic micropollutants. This is unfortunately no guarantee that the future quality will still meet the IB-standards.

Overall, the water quality in the Bommelerwaard has improved since the project 'Zuiver water in de Bommelerwaard' commenced in 2002. It is difficult to state just how much of the improvement can be attributed fully to the project, since autonomous policy developments have their influence as well, except when the usage of certain substances is prohibited. Speets concludes his evaluation by stating that it is unlikely that the water quality goals for 2010 will be reached.

7. Measures for reduced emission of pharmaceuticals

Since 2006 The EU is trying to include some pharmaceuticals on the list of Priority Substances (Rademaker and de Lange, 2009). If a pharmaceutical is included on the list, member states have to develop emission reducing measures within 5 years. The policy making on the European level depends on a sound risk-assessment of the specific substances. The effects on soil- and aquatic organisms of some pharmaceuticals have been investigated. However, for many pharmaceuticals information regarding the environmental impact is not yet available.

Fortunately, the Dutch government had adopted a pro-active approach and is currently investigating the possible measures (see annex 13) for reducing the emission of pharmaceuticals. Actual policies and/or legislation have not been developed yet.

Two approaches to reduce the emission of pharmaceuticals were found and are elaborated in the next two paragraphs.

7.1 Separate urine collection

In paragraph 3.2 it was mentioned that urine makes up only 1% of the wastewater flow while containing almost 100% of the total amount of pharmaceuticals. When flushing a toilet the small concentrated stream of urine is diluted with drinking water. The transport of the diluted wastewater requires energy and at the end of the cycle an extra energy input is required to separate the water and waste (van den Berg, 2002). This makes little sense from an environmental, technological and economical point of view but is the result of the course of history. The costs for collecting and treating relatively small but concentrated wastewater streams are relatively low compared to large diluted conventional wastewater streams (Scheffer, 2007).

Fortunately increased awareness of this issue has resulted in increase interests for alternatives to conventional wastewater collection and treatment. Sweden is leading the development of separate urine collection: over 20.000 separation toilets have been installed. In several apartment buildings in Stockholm urine is collected separately and stored in reservoirs. Faecal matter and 'grey water' are discharged to the sewer and transported to the wastewater treatment plant.

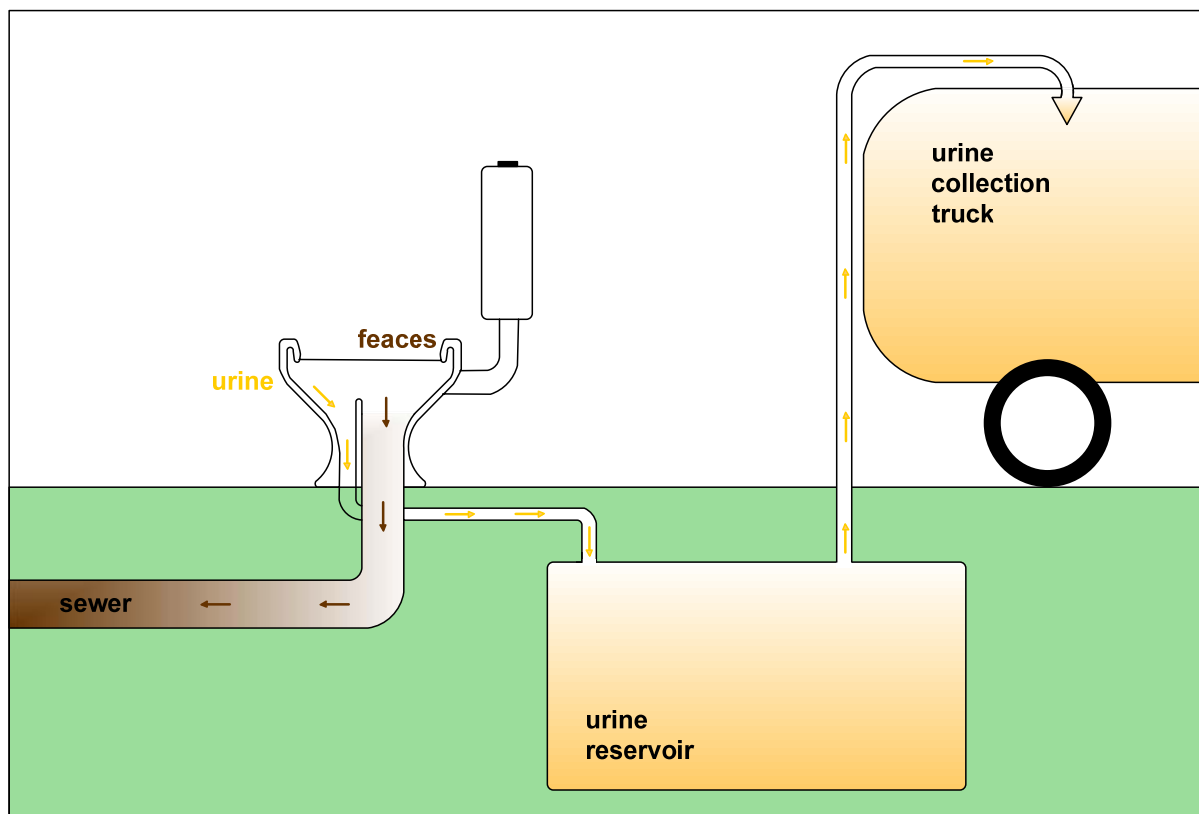


Figure 7.1: Urine separation (Scheffer, 2007)

From 2003 to 2006, a demonstration project (Sanitation Concepts for Separate Treatment) co-financed by the European Commission was carried out. Two different concepts were tested and compared: gravity separation toilets and vacuum separation toilets (see figure below), to determine the concepts are more sustainable compared to conventional sanitation systems, particularly with regard to nutrient recycling. Both systems showed an acceptable performance but substantial enhancements are required, particularly with regard to the flushing mechanisms. It was calculated that the operating costs of the new sanitation concepts are lower than those of conventional systems, due to the win of biogas from the digestion processes. The investment costs however are not lower because the installations inside and outside the houses require high effort. For more information the reader is referred to Peter-Fröhlich et al (2007).

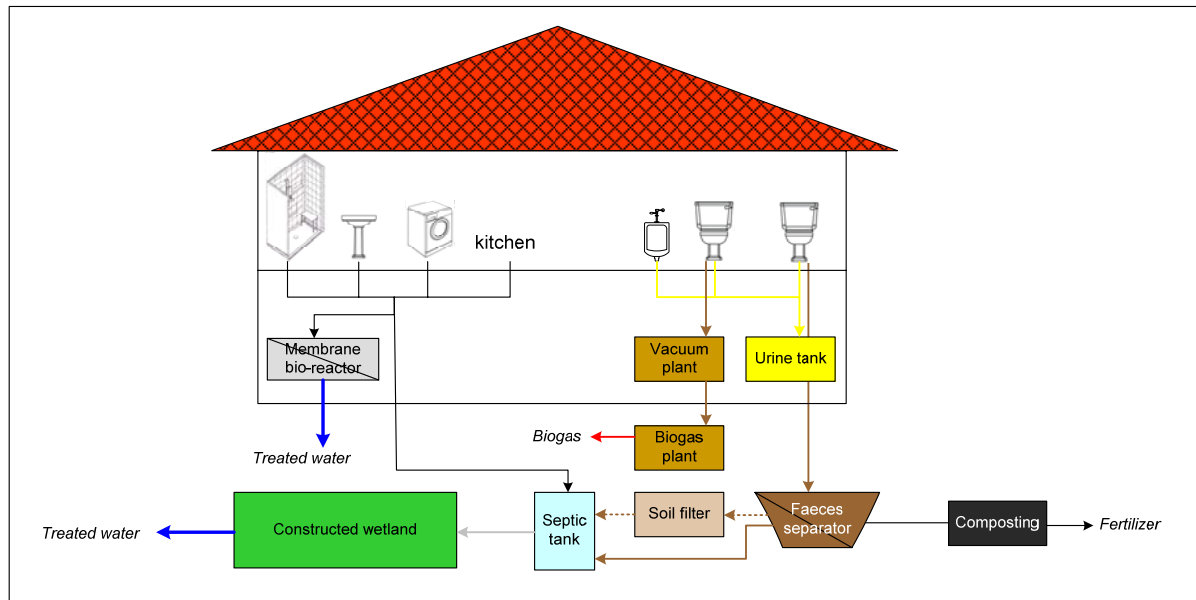


Figure 7.2: Tested sanitation concepts (adapted from Peter-Fröhlich et al., 2007)

A feasibility study realised in a Berlin hospital has demonstrated that it is possible to retain pharmaceutical residues by means of decentralised systems. The PharmaTreat project aims to develop technology for the chemical degradation of pharmaceutical residues directly at their point of origin. Preliminary tests have revealed that X-ray contrast media and antibiotics measured in the patients' urine can be transformed through the reaction with zero-valent iron (KWB, 2007).

A good Dutch example is the separate collection of urine from hospitals which is a beneficial measure for reducing the emission of X-ray contrast agents and anti-biotics. Several example and pilot projects with separation toilets have been launched (Scheffer, 2007). like for instance at the *Hogeschool Windesheim* in Zwolle, *Het Ambacht Huys* in Meppel (centre for the mentally disabled), the Watermuseum in Arnhem, office of *Waterschap Reest en Wieden* in Meppel and *De Schoel* in Sleen (new care- apartment complex). Feasibility studies of separate urine collection are currently being conducted.

7.2 Advanced post-treatment of wastewater

Instead of redefining and designing of the collection of wastewater, advanced post-treatment of wastewater could be an option. As stated before, advanced post-treatment of wastewater for removal of organic micropollutants requires multiple treatment steps: currently no technology exists that can remove all types of micropollutants.

Post-treatment of the effluent of a Swiss municipal wastewater treatment plant by ozonization followed by sand filtration, removed 40-80% of the remaining pharmaceuticals (depending on the characteristics of the specific pharmaceutical) (Hollender et al., 2009). Post-treatment using a Membrane bioreactor (MBR) can also remove pharmaceuticals, with removal efficiencies depending on the characteristics of the pharmaceuticals and the design of the MBR (Cirja et al., 2007).

A promising new concept is the *1-step filter* that is developed by the engineering company Witteveen + Bos, Norit, Delft University of Technology and Watercycle Company Waternet. The 1-step filter is a cylindrical reactor filled with activated carbon that removes nitrogen, phosphate, heavy metals and pharmaceutical residues. A coagulant (AlCl_3) is added to the pre-treated wastewater, which results in deposition of phosphate flocks that cannot pass through the filter bed. Heavy metals are also incorporated into the formed flocks. Methanol is added as a food source for denitrifying bacteria that are present in the filter bed and convert nitrate to nitrogen gas. Furthermore, pharmaceutical residues, hormones and remaining heavy metals are adsorbed onto the activated carbon (van de Sandt, 2009).

Pilot scale experiments have been performed at the wastewater treatment plant Horstermeer. The results showed a large removal of phosphate, nitrate and priority substances. A full scale reactor with a capacity of 1500 m³/hr will be taken into operation in 2012. The primary focus of the full scale reactor however, is removal of nitrate and phosphate. The granular activated carbon should be replaced every 6-12 months if removal of organic micropollutants is to be achieved. Otherwise the filter bed is expected to last as long as a conventional sand filter bed.



Figure 7.3: 1-Step filter for removal of nitrate, phosphate and organic micropollutants (van de Sandt, 2009)

8. Conclusions and recommendations

8.2 Conclusions regarding preventative measures

8.2.1 Reduction in pesticide emission

Maintaining the competitive position of the agricultural sector (benefiting the economy as a whole) and producing enough food in an efficient way requires the use of plant protection products. Policy makers are aware of the threats that organic micropollutants create for the aquatic environment and the production of drinking water. The awareness of the issues of organic micropollutants concerning environmental pollution and drinking water production is growing, amongst policymakers and society. The environmental impact of pesticides has been on the agenda of policymakers for several decades, which - in combination with or perhaps as a result of European policy – has resulted in various programs for reduced use and consequences of pesticides. The measures aim at reducing the emission to the aquatic environment by for instance reducing drift via the application of shields or different types of nozzles. Also, the application of more eco-friendly alternatives is encouraged. The quality of surface waters has been improved. However, emission of pesticides to the aquatic environment can never be fully prevented simply because pesticide use can never be abandoned.

8.2.2 Reduction in pharmaceutical emission

Consumers of pharmaceuticals and drinking water are confronted with conflicting interests. The general public requires access to safe, affordable and reliable medication and also wants access to safe, healthy and affordable drinking water containing no traces of pharmaceuticals. Often the consumption of pharmaceuticals is not a choice but a necessity: the choice for a specific type of medication is made by the physician, depending on the specifics of the medical situation of the patient. As to the consumption of non-prescriptive drugs (over the counter pain-killers); most people are not aware of the environmental impact associated with usage of pharmaceuticals. Increasing the awareness of the environmental impact via various methods (TV-commercials, information included in the drug leaflet etc) may perhaps reduce the use. However, this is not the task or responsibility of a drinking water company.

In theory, emission of pharmaceutical residues could be prevented by implementation of alternative sanitation concepts (separate urine collection) and/or advanced post-treatment of wastewater. If all urine would be collected separate from other sewerage, no pharmaceutical residues would reach the wastewater plant. Since no technology or system is completely fail-safe – like for instance the false connections in separate sewer systems for the collection of human excreta and rain (1) or the wrong connections in separate distribution nets for drinking water and an so-called grey water (2) - advanced post-treatment of wastewater would most likely be required as well. Even though advanced wastewater treatment technology such as the 1-step filter shows promising results, no guarantees can be made to the removal capacity of pharmaceuticals that do not exist yet. Future pharmaceuticals might have characteristics that impede the removal during water treatment.

Both measures require large capital investments, which combined with the extra operational costs, yield larger costs for the treatment of wastewater and consequently will increase the charges to the public. What's more, the implementation period is very long: an infrastructural change in every existing building is not realized within a short period of time. The same holds for the realization of advanced treatment steps at existing or new wastewater treatment plants. The quality of the aquatic environment will increase when less pharmaceutical residues and endocrine disrupters such as anti-conception pills are discharged. Environmental gain is however difficult to quantify in monetary values so a social cost-benefit analysis will probably not be very useful as a trade-off method. One could argue that the costs for drinking water production would perhaps be lower but advanced treatment technology is still required: even if no pharmaceuticals reach the surface waters, pesticides and other emerging substances will always be present in the water and should be removed. The author suspects however that within a not too large time span, the sanitation and wastewater treatment sector (in the Dutch case the municipalities and waterboards) will be obliged to take measures, given the increasing awareness amongst policymakers and the public.

8.2.3 Conclusions regarding preventative options for Dunea

In paragraph 1.3 was stated that the results of the network analysis - identifying parties that can help solve Dunea's problem of OMPs in the source - could perhaps help Dunea to utilize her network position in a more beneficial way. Dunea is interested in the possibilities and development of prevention oriented measures outside of the Bommelerwaard. Strong allies are the Ministries of VROM, V&W and LNV, since all three ministries have legislative power and financial resources. Moreover, V&W grants permits to waterboards for discharging WWTP effluent to 'Rijkswateren'. Reformulating the quality standards of the discharge (e.g. limit allowable concentration of pharmaceuticals) will require waterboards to invest in advanced post-treatment and or to approach parties like municipalities, housing corporations and health care facilities to implement alternative sanitation concepts. National governments usually wait until European legislation, policies and norms are passed before implementing such strict standards. However, several successful (pilot) projects for alternative sanitation concepts and advanced post-treatment of wastewater have been launched autonomously. The projects all resulted from cooperation and the sharing of knowledge and other resources between different types of stakeholders (e.g. healthcare institutions, waterboards, municipalities, housing corporations, engineering firms and knowledge institutions). Dunea can try to engage in similar projects but direct measurable effects in terms of reduced concentrations of pharmaceuticals in her source water, requires Dunea to approach a large variety and set of actors along the entire course of the river Meuse. Moreover, companies or parties responsible for production and distribution of drinking water and provision of sanitation in the Netherlands, operate on a relatively large scale while in other countries these companies often serve just one single municipality. Dunea's efforts would be fruitless from a practical point of view.

Direct options for Dunea –other than the activities in the Bommelerwaard- are limited to lobbying for her cause, perhaps together with other drinking water companies at the regional, national and international levels for policymaking and trying to influence and shape policymaking via public opinion. In fact, this is exactly what RIWA-Meuse (and its counterpart for the river Rhine for that matter) is doing.

8.3 Recommendations

Continue investing in research, development and implementation of advanced drinking water treatment technology

From the development of policies at the EU level (chemical standards set by Water Framework Directive red.), the increasing media attention to the issues of organic micropollutants in surface and drinking water and the increasing awareness of the public, can be concluded that investments in either alternative sanitation or advanced post-treatment of wastewater cannot be prolonged indefinitely. Investing in research, development and implementation of those preventative measures is not the responsibility of a typical drinking water company such as Dunea. Her responsibility lies in producing safe and reliable drinking water. Since Dunea's intake is located at the end of the Meuse river basin, this implies investing in research, development and implementation of technology for removal or degradation of OMPs from the source water. Dunea can however try to exercise its influence – and accelerate the development of prevention oriented technology - via the media or by lobbying amongst policy makers in the Netherlands - but can and should Dunea exercise her direct influence across the national border? Preventing the emission of OMPs in the Netherlands is useless as long as the whole of France, Belgium, and Germany continue to pollute the river Meuse with pharmaceutical residues and hormones. What's more, Dutch drinking water companies are conservative and afraid that lobbying for their cause might scare the public and result in reduced consumer confidence. The customers in the Netherlands have been told that Dutch drinking water is safer and of better quality than in most other countries and suddenly it is stated that the water may contain pesticides, hormones and pharmaceuticals?

Monitor progress and results Bommelerwaard

Dunea participates in the project 'Zuiver Water in de Bommelerwaard' which has resulted in a decrement of pesticide use and pesticide emission. Because Dunea's intake is located just downstream of the Bommelerwaard, it made sense to participate in the project. The quality of the Meuse water at

Dunea's intake has improved but because similar programs are implemented across the EU member states, the improvement cannot be fully attributed to the project. The ambitious objective of the project (no exceedence of drinking water or MTR norms in the Bommelerwaard in 2010) will probably not be reached.

When the project commenced Dunea took the leading role and has gradually transferred this to the Waterboard Rivierenland, which is the authority responsible with management of quantity and quality of the surface water in the Bommelerwaard region. The author recommends Dunea to continue the transfer of its responsibility to the Waterboard and monitor the progress from the sidelines.

Continuance of current approach

As to Dunea's activities in the broader field of preventative measures, the author recommends continuance of the current approach. Dunea should not take a leading role in development of prevention oriented technologies – refrain from activities outside the core-business – but should at the same time not completely turn her back towards it. Dunea should continue to utilize her central position in the network and regularly exchange knowledge and practice with regional authorities (waterboards, provinces), national authorities, knowledge institutions and drinking water companies of similar scales and practices (i.e. production from river water).

Monitor policy developments

Dunea is advised to closely monitor the development of policy (at the national but primarily EU level), the level of attention to the issue in de media and its resulting impact on the public opinion. Whenever the issue regarding traces of pesticides, pharmaceuticals and hormones found in drinking water is highlighted by the media, Dunea should response by stating that even though the found concentrations are almost undetectable and pose no threat to public health, ongoing research is performed towards the occurrence and removal of those substances during the drinking water production.

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ANNEX 1: Threats to Dunea's drinking water production

Table A1.1: Priority substances threatening drinking water production Dunea

	Application	Emission route	Characterisation
Pharmaceuticals			
Carbamazepine	Anti-epilepticum	DW	B
Diclofenac	Analgesic	DW	B
Ibuprofen	Analgesic	DW	B
Fenazon	Analgesic	DW	B
Metoprolol	Beta blocker	DW	B
Sulfamethoxazole	Anti biotic	DW	B
Bezafibrate	Cholesterol lowering	DW	B
Acetylsalicylic acid	Analgesic (aspirin component)	DW	B
Clofibrilic acid	Cholesterol lowering	DW	B
Pesticides			
2,4-D	Herbicide	AR (BW&M)	A, F
DEET	Insecticide	DW, drift (M)	A, F
Dimethenamide	Herbicide/ foliage dead plea	AR (BW&M)	A, F
Diuron	Herbicide	AR (BW&M)	A, F
Carbendazim	Fungicide	AR (BW&M)	A, F
Chloridazon	Fungicide	AR (BW&M)	A, F
Isoproturon	Herbicide	AR (M)	A, F
MCPP, MCPA	Herbicide/ growth regulator	AR (BW&M)	A, F
Nicosulfuron	Herbicide/ foliage dead plea	AR (M)	A, F
Glyphosate	Herbicide/ foliage dead plea	AR (BW&M)/ use on pavement	A, F
AMPA	Degradation product glyphosate/ zinc phosphonates cooling water	AR (BW&M)/ IW	B
Hormones and endocrine disruptors			
17β-oestradiol	Natural hormone	DW, AR	B, C, D
Oestron	Natural hormone	DW, AR	B, C, D
17α-ethinyloestradiol	Synthetic hormone, anti conception	DW	B, C, D
Bisfenol-A	Monomer for polycarbonates and epoxy resins/ PVC Stabilizer	IW	B, C, D, E
Diethylftalaat	PVC plasticizer	IW, DW	B, C, D, E
Dibutylftalaat	PVC plasticizer	IW, DW	B, C, D, E
Diethylhexylftalaat	PVC plasticizer	IW, DW	B, C, D, E
X-ray contrast media			
Amidotrizonacid	Contrast agent	DW (hospital)	B, C
Iopamidol	Contrast agent	DW (hospital)	B, C
Iomeprol	Contrast agent	DW (hospital)	B, C
Iopromide	Contrast agent	DW (hospital)	B, C
Iohexol	Contrast agent	DW (hospital)	B, C
Additional emerging substances			
PFOS	Surfactant in fat-repelling paper, textile, fire extinguishers	IW, DW	B, C
PFOA	Surfactant in fat-repelling paper, textile, fire extinguishers	IW, DW	B, C
MTBE, ETBE	Fuel additive	IW, shipping	E
NDMA	Industrial intermediate product	IW	C, D
Diglyme	Industrial solvent	IW	D,
p,p-sulfonyldifenol	Industrial intermediate product	IW	C, E
TCEP	Reducing agent	IW	C, D,
EDTA	Chelating agent, preservative	IW, DW	E
Urotropine	Fuel additive	IW	?
Tributyl phosphate	Plasticizer, solvent, anti-foaming agent,	IW, DW	?

DW =Discharge domestic WWTP

W =Discharge industrial WWTP

AR =Agricultural runoff

BM =Bommelerwaard

M =Maas

A. Possible norm exceedence, found regularly in surface water

B. Found in drinking water, undesirable, found regularly in surface water or infiltrate

C. Highly polar mobile (logKOW <3) and/or persistent (poor biodegradability) difficult to remove, found regularly in surface water

D. Carcinogenic or toxicological relevant substance found in surface water

E. Substance has high production volume and is found regularly in surface water

F. Relevant for infiltration license

Table A1.2: Maximum concentrations of pesticides (µg/l) in river Meuse near Keizersveer (RIWA, 1999-2008)

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Aldicarb-sulfoxide									0,16
Aminomethylfosfonzuur (AMPA)*	1,6	1,5	0,9	1,8	1,9	1,9	2,4	2,2	1,6
Atrazin	0,32	0,28	0,24	0,18	0,12	0,07	0,11	0,03	0,02
Bentazon	0,09	0,11		0,05	0,1	0,05	0,07	0,07	0,13
Butocarboxim-sulfoxide									0,26
Carbendazim						0,1		0,4	0,04
4-Chloor-2-methylfenoxiazijnzuur (MCPA)	0,1	0,1	0,06	0,08	0,09	0,13	0,15	0,07	0,07
Chloortoluron		0,06	0,14	0,03			0,02	0,03	0,08
Chloridazon						0,34	0,11	0,08	0,07
Dicamba							0,95	0,25	
Dichlobenil	0,02	0,02	0,05	0,12	0,1	0,04	0,03	0,02	0,02
2,4-Dichloorfenoxiazijnzuur (2,4-D)		0,05		0,03	0,05		0,11	0,2	0,14
1-(3,4-Dichloorfenyl)-3-methylureum*				0,04	0,13	0,04	0,03	0,03	0,01
Diuron	0,89	0,58	0,45	0,37	0,21	0,27	0,16	0,13	0,13
Ethofumesaat				0,1	0,11	0,07	0,08	0,06	0,11
Glyfosaat	0,17	0,13	0,14	0,25	0,38	0,45	1	0,17	0,26
Isoproturon	0,26	0,28	0,4	0,15	0,07	0,2	0,22	0,12	0,09
Mecoprop (MCPP)	0,11	0,14	0,05	0,08	0,12	0,07	0,09	0,08	0,33
Metolachloor			0,15	0,2	0,19	0,05	0,05	0,08	0,06
Metoxuron			0,11						0,02
Monuron			0,2		0,06	0,05	0,05	0,04	0,03
Nicosulfuron									0,17
Simazin	0,12	0,09	0,12	0,07	0,07	0,06	0,05	0,03	0,04
Tebuconazool							0,5		
Terbutylazin		0,05	0,08	0,11	0,1	0,07	0,07	0,06	0,06
Σ	3,68	3,39	3,09	3,66	3,80	3,96	6,25	4,15	3,90

>DWN = 0,1 µg/l

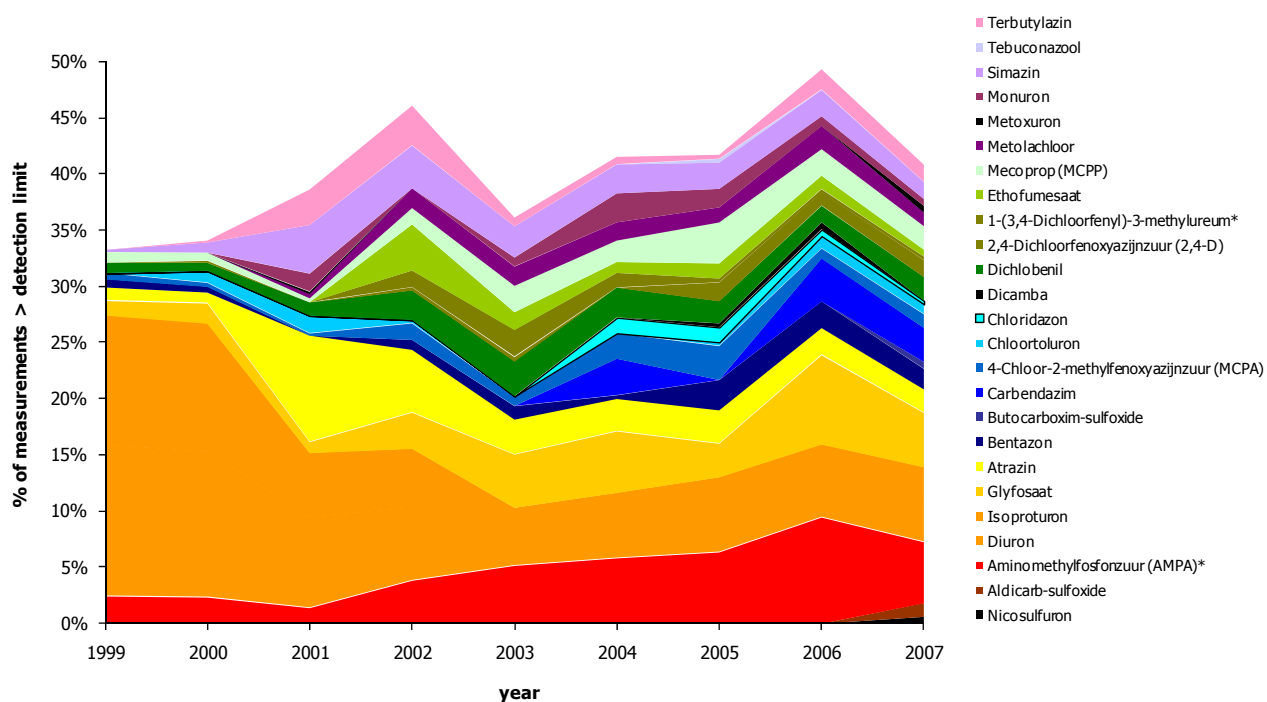


Figure A1.1: Pesticides found in Meuse near Keizersveer (RIWA, 1999-2008)

ANNEX 2: Cause and effect diagram of emissions



Figure A2.1: Cause and effect diagram

Note:

A positive relation between cause and effect is expressed by a "+" and vice versa. Factors with no incoming arrows form possibilities for intervention, with or without other stakeholders. The colors should be interpreted as follows:

- Green: factor can be influenced
- Red: factor cannot be influenced
- Orange: unsure

ANNEX 3: Analysis objectives Dunea

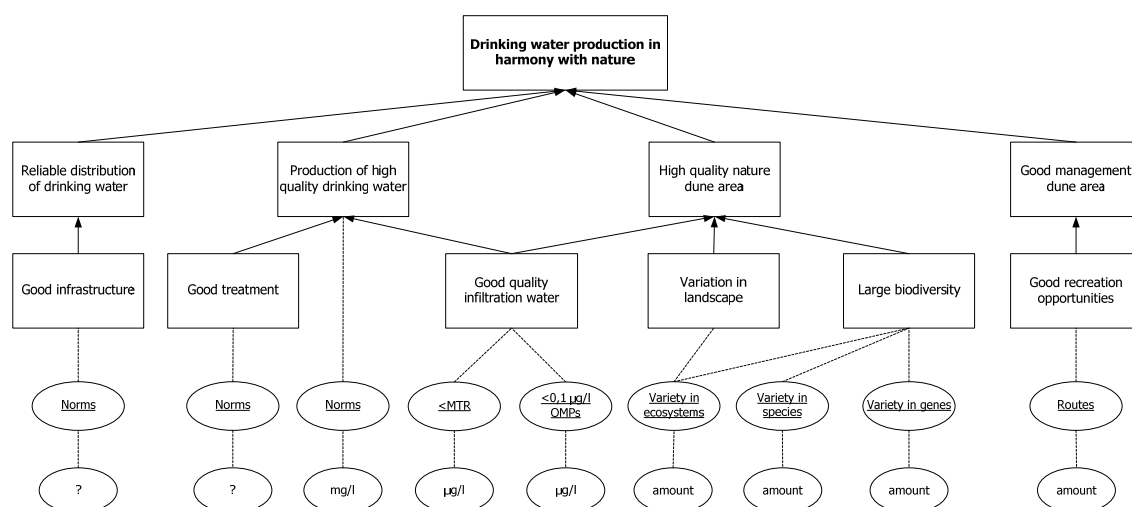


Figure A3.1: Objectives Dunea Duin en Water

Drinking water production in harmony with nature

Dunea's main objective is to *produce good and reliable drinking water in harmony with nature*. The dunes fulfil multiple functions; a combination of water abstraction, nature conservation and recreation. The slogan clean water from a clean environment describes Dunea's mission statement (Dunea, 2009). Production of good and reliable drinking water in harmony with nature includes the following aspects:

- Production of high quality drinking water (in compliance with the standards set by the Drinkwaterbesluit),
- Reliable distribution (in complying with norms regarding supply, quality and security),
- Good management of the dune areas,
- High quality of nature in the dune areas.

The quality of the infiltration water influences the quality of the produced drinking water and the quality of the nature in the dune areas. The quality of the infiltration water depends amongst others on the concentration of organic micropollutants. A large variety of landscapes and biodiversity contribute positively towards the quality of nature in the dune areas. Important indicators are the variety in ecosystems, species and genes.

Besides the quality of the infiltration water, the level treatment (pre- and post-) defines the final quality of the produced drinking water. Reliable distribution of the produced drinking water is only possible when the infrastructure is good enough en meets the norms regarding continuity of supply, quality and security.

Good management of the dune area means that sufficient recreation opportunities are available. An indicator for recreational opportunity is the amount of routes that pedestrians and/or cyclists can choose from.

Criteria regarding water quality

Because the consumers are bound to Dunea (e.g. one cannot choose another drinking water supplier), the amount of trust that they award to Dunea is very important. This is however difficult to express in a measurable unit.

Criteria for the quality of the produced drinking water are norms defined by the *Drinkwaterbesluit* (microbiological, chemical, aesthetic/organoleptic and operational) which in many cases are expressed as maximum concentrations in mg/l. The norm set for concentration organic micropollutants is as follows: the concentrations of individual substances cannot exceed 0,1 µg/l and the total concentration of compounds found in a sample should be <0,5 µg/l.

The infiltration water should meet the criterion defined by the MTR (maximum toelaatbaar risico/ maximum allowable risk): the calculated concentration of a substance in the environment with no adverse effects to 95% of the present organisms. As was mentioned previously, norms are also defined for the distribution and treatment. Those norms are not further elaborated here due to time constraints.

ANNEX 4: Exploration of drinking water networks

The Netherlands

The Ministry for Housing, Spatial Planning and the Environment (VROM) and the Ministry for Transport, Public Works and Water Management (V&W) are the national policy makers in the water sector. V&W is responsible for water resource management together with its Directorate-General for Public Works and Water Management (Rijkswaterstaat). One of the tasks of the Ministry of VROM is water supply and public health.

On the regional level 27 Water Boards are responsible for surface water management and the treatment and discharge of wastewater. The 12 Dutch provinces are in charge of groundwater management, mostly through licensing groundwater abstraction.

In the Netherlands municipalities are responsible for the construction and operation of the sewerage systems. Drinking water is provided by 10 regional drinking water companies, most of those are owned by local authorities. Although the general practice in the Netherlands was a separation of the organisations that are responsible for either the production of drinking water or the provision of sanitation, since 2006 a merger between the local water company and Water Board of the Amsterdam region established the first Dutch integral water and sanitation company.

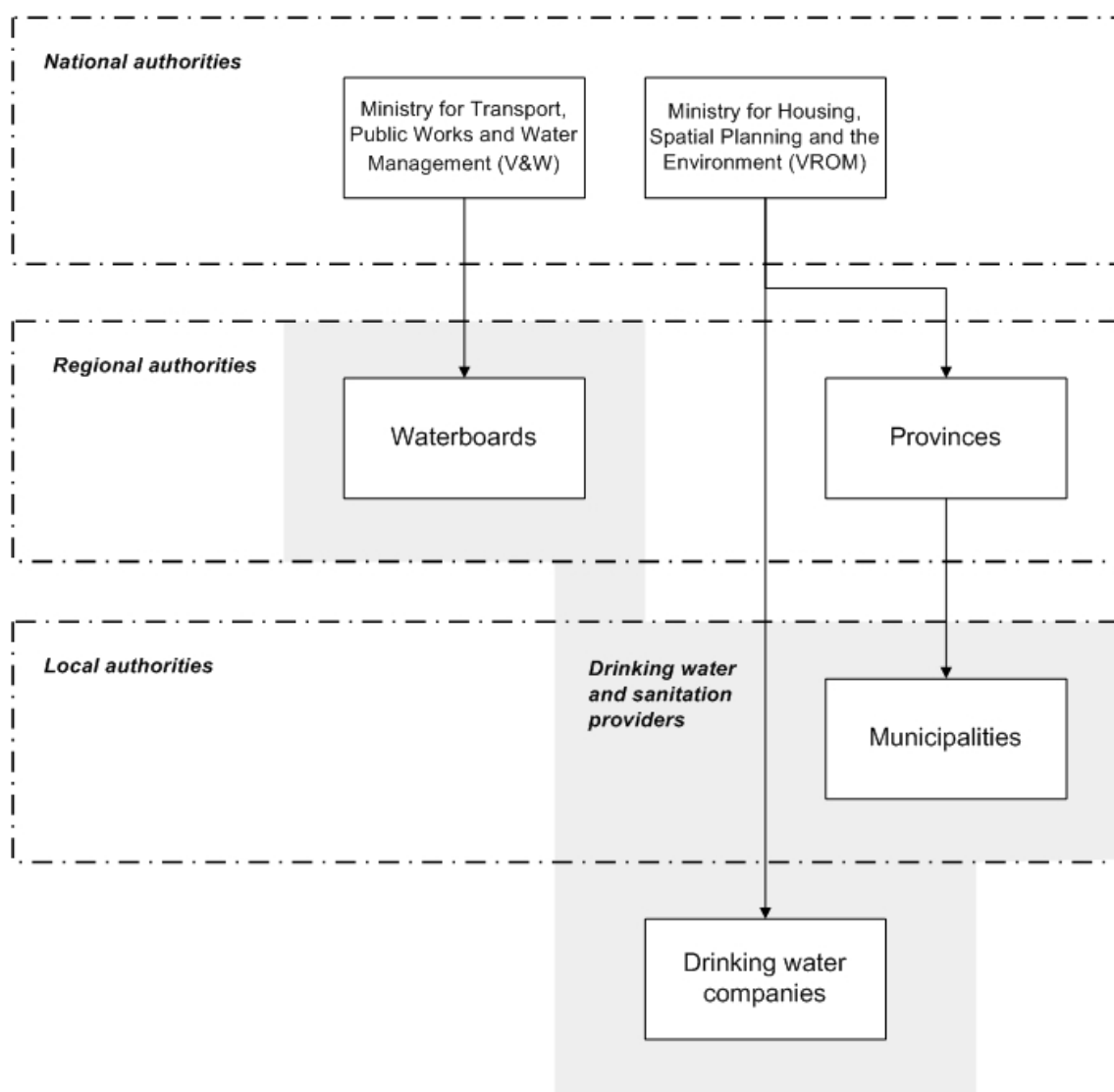


Figure A4.1: Drinking water and sanitation sector, the Netherlands

Belgium

The organization of the Belgian water sector differs significantly from the organization in the Netherlands, which can be expected since the political structure of Belgium also differs from the situation in the Netherlands.

"Belgium is a federal state, composed from the communes and the regions" (Belgian Constitution, article 1). The communities find their origin in the language spoken by the inhabitants: Dutch, French and German. The Flemish, Walloon and the Brussels-Capital Region each have their own parliament and government. Furthermore, Belgium has ten provinces belonging to either Flanders or Wallonia. The lowest levels of decentralization are the 589 Belgian municipalities. Both Flanders and Wallonia are part of the Meuse river basin district. Brussels is part of the Schelde river basin district; therefore since its wastewater is not discharged into the Meuse or its tributaries, the Brussels region is omitted from this analysis.

Flanders

The government of Flanders has appointed the *Coördinatie Commissie Integraal Waterbeleid* (CIW) as the responsible party for the preparation, planning, control and implementation of Flanders' water management. The CIW unites the different water managers and administrators that are involved in water policy-making (Belgaqua, 2001). The *Vlaamse Milieu Maatschappij* (VMM) holds the chairmanship and secretary of the CIW and is an internally independent agency with powers of jurisdiction. In essence the VMM is responsible for water resource management in the broad sense; it is responsible for monitoring the quality and quantity of ground water, surface water, wastewater and water intended for human consumption. The VMM develops policy instruments, investment plans for sewerage and wastewater treatment systems, is responsible for flood prevention, and levies taxes on industrial pollution and groundwater abstraction. As becomes apparent from this description, the VMM is responsible for tasks that in the Netherlands are decentralized to several different authorities.

In the Netherlands, the water boards are responsible for the treatment and discharge of wastewater. In Flanders however, this task is assigned to Aquafin, a company established by the regional government with the VMM as the sole shareholder. Aquafin is also responsible for the construction and operation of the main sewage system. In the Netherlands, municipalities are assigned to this task.

Belgian municipalities are responsible for smaller sewage systems and small-scale WWTPs.

The *Vlaamse Maatschappij voor Waterzuivering* (VMW), the *Antwerpse Waterwerken* (AWW) and the *Tussengemeentelijke Maatschappij der Vlaanderen voor Watervoorziening* (TMVW) are the drinking water companies of Flanders that use amongst other sources Meuse water for the production of drinking water (RIWA Maas, 2005). In total 7 drinking water companies are active in Flanders, with a total of 1.9 million connections.

Wallonia

In Wallonia, *la Division de l'Eau*, which is part of the *Direction Générale des Ressources naturelle et de L'Environnement* (D.G.R.N.E.) is the Walloon counterpart of the VMM and is responsible for water resource management and corresponding policy making in the broad sense.

Like Flanders, Wallonia has established a public company responsible for sanitation; *la Société publique de gestion de l'eau* (SGPE). The SGPE is owned by Aquawal (Association of drinking water and wastewater companies in Wallonia), Walloon Region and private investors and has more or less the same responsibilities as Aquafin (Vandelannoote, 2006).

The SGPE has contracts with seven provincially demarcated companies (intercommunales) for the design, construction and operation of wastewater treatment infrastructure. AIDE (Liège), AIVE (Luxembourg), INASEP (Namur), and IGRETEC (Hainaut) treat and discharge wastewater in the Meuse river basin but are also involved in other activities such the production of energy, drinking water and waste disposal.

The largest drinking water company in Wallonia is the *Société Wallon des eaux* (SDWE). The SDWE provides 70% of Wallonia's drinking water (SDWE, 2009). Furthermore, several intercommunale drinking water companies exist in Wallonia (BELGAQUA, 2001). VIVAQUA produces drinking water from several Meuse tributaries in the Namur province.

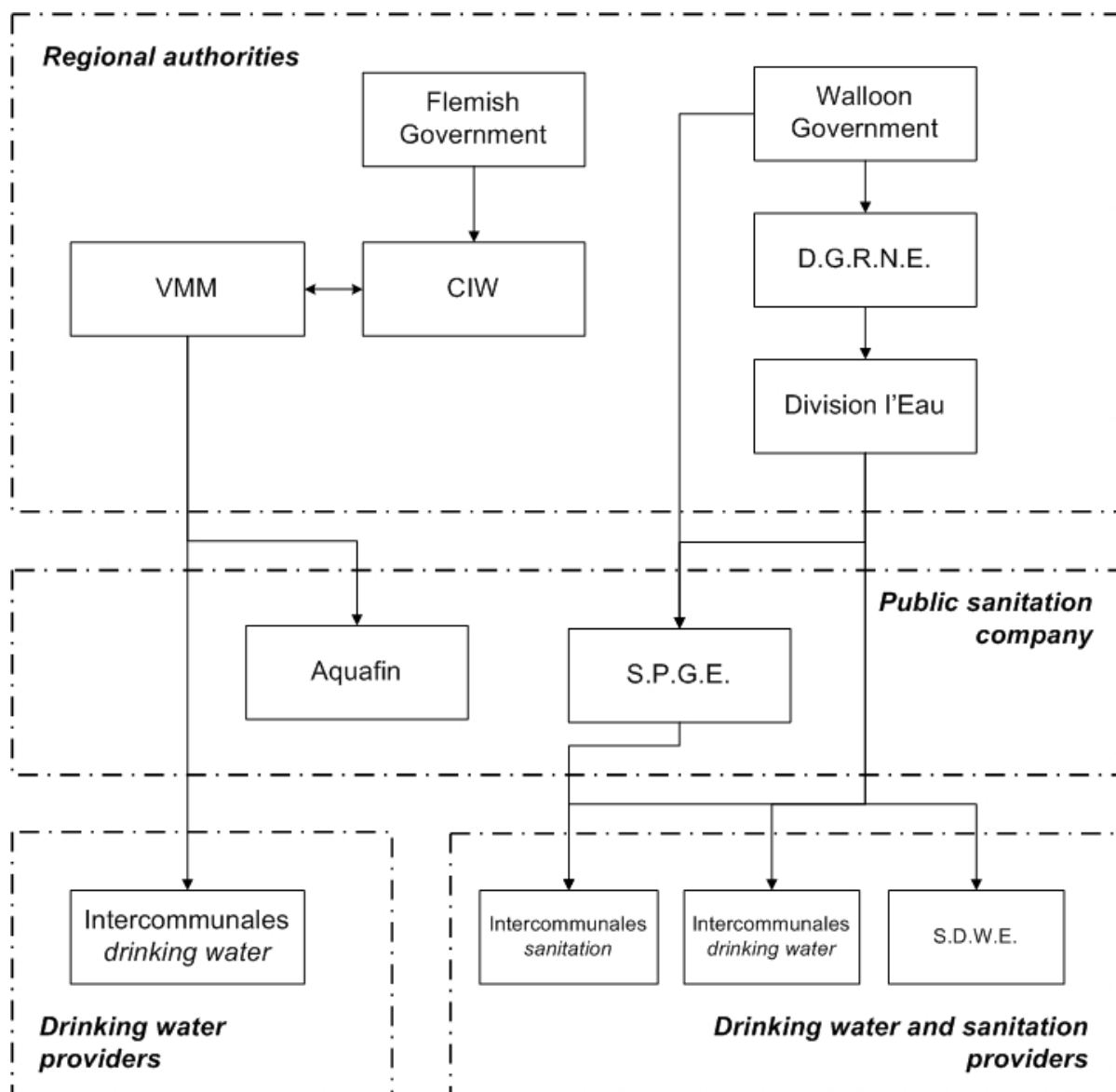


Figure A4.2: Drinking water and sanitation sector, Belgium (Flanders and Wallonia)

France

On the national level water policy making in France is similar to the Dutch model since several different ministries are involved:

- The Ministry of Ecology, Energy, Sustainable Development and Territorial Planning (supervision of Water Agencies),
- The Ministry of Health (monitoring drinking water quality),
- The Ministry of Interior (supervision of local government)
- The Ministry of Economy and Finance (supervision of Water Agencies)

Agences de l'Eau are the regional water authorities and their role is comparable to those of the Dutch water boards and provinces; the water agencies levy wastewater discharge and water abstraction fees. The proceeds of the six agencies are used to subsidize investments in drinking water supply and sanitation (les Agences de l'eau, 2009).

Drinking water supply, wastewater transport and treatment are decentralized to the municipal level in France. Municipalities appoint the parties that are responsible for the production of drinking water and the treatment of wastewater.

In 2006, 72% of the total drinking water volume was supplied by private water companies and the remainder by municipalities and utility companies. For wastewater treatment those numbers are 55% and 45% respectively (EVD, 2009). Approximately 15000 municipalities and municipal organisations are active in the French wastewater sector and 13,500 in the drinking water sector. Private companies hold approximately 5000 public tenders for drinking water production and 4000 for wastewater treatment. Most of those public tenders are held by *Veolia Eau*, *Saur* and *Lyonnaise*.

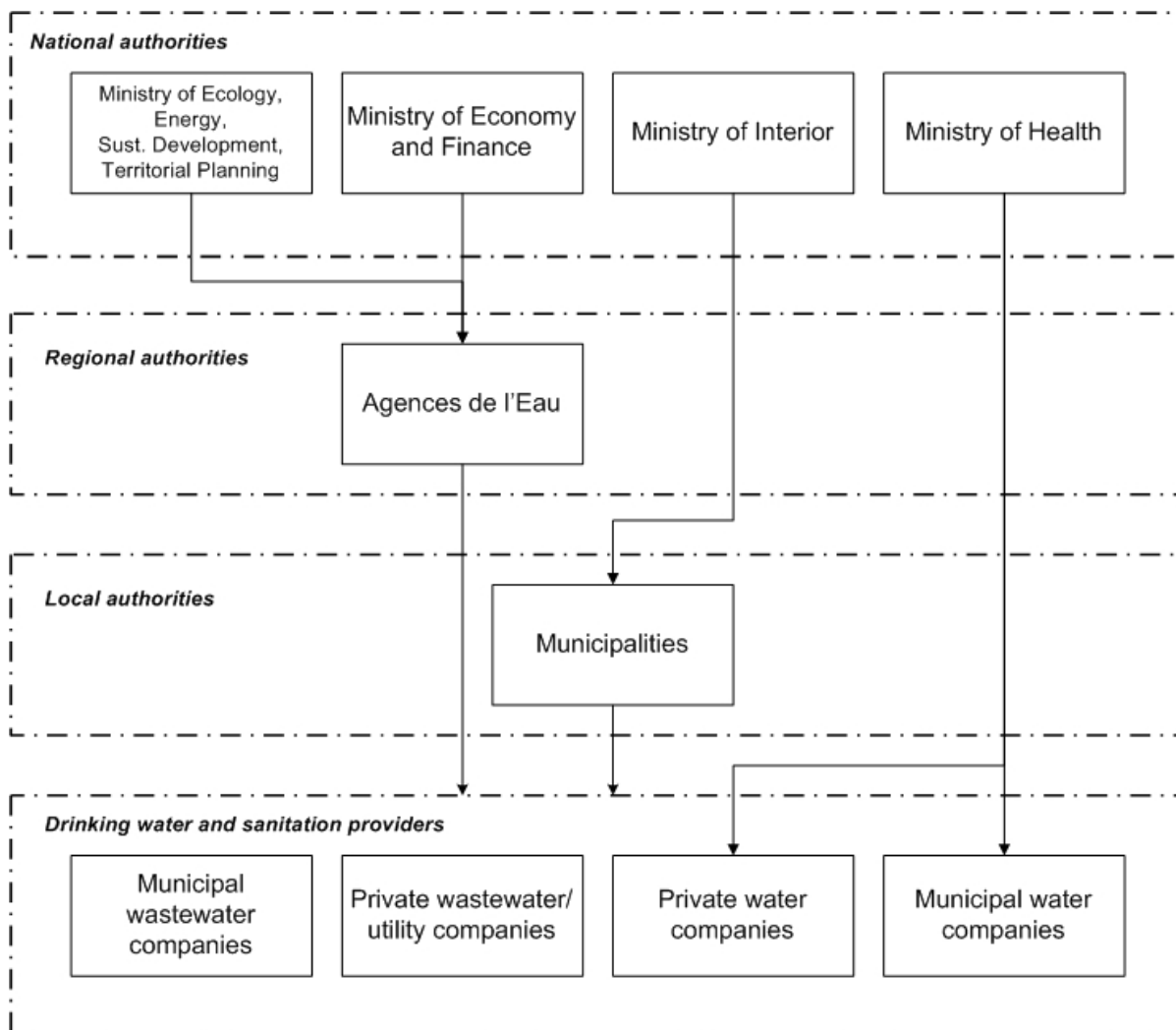


Figure A4.3: Drinking water and sanitation sector, France

Germany

The rivers Rur (not to be confused with the Ruhr) and Niers are the two German tributaries to the Meuse. Both rivers flow through the state of North-Rhine-Westfalia, just east of the Dutch border (Limburg) and the Belgian border (Liège).

In Germany the federal and state governments hold the responsibility for policy making in the field of drinking water and sanitation. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety is the ministry in charge of water management in Germany (GFMM, 2009). Their focus is primarily on maintaining the ecological balance of water bodies, guaranteeing drinking and process water supplies in combination with providing long-term safeguards for all other water uses benefiting the general public and the protection of various water bodies. The Federal Government is responsible for setting up the regulatory framework while the Länder (states) are in charge of the implementation and for the approval of tariffs (German Federal Environment Ministry, 2009).

While the Ministry for the Environment is responsible for water management in the broad sense, the Ministry of Health is responsible for policy making regarding drinking water. The Federal Environment Agency is in charge of drinking water hygiene and develops the scientific foundation and benchmarks for drinking water supply (German Federal Ministry of Health, 2009).

Supply of drinking water and the treatment of wastewater are the responsibilities of the municipalities (Rudolfph et al., 2004). Municipalities are allowed to delegate this task via concessions/operating contracts to municipal or private companies, to public-private partnerships or to inter-municipal associations known as *Wasserverbänden* (ATT et al., 2008). Gelsenwasser, a privately owned public water company, supplies 3.2 million customers in North-Rhine-Westfalia. The water company holds concessions with 39 municipalities.

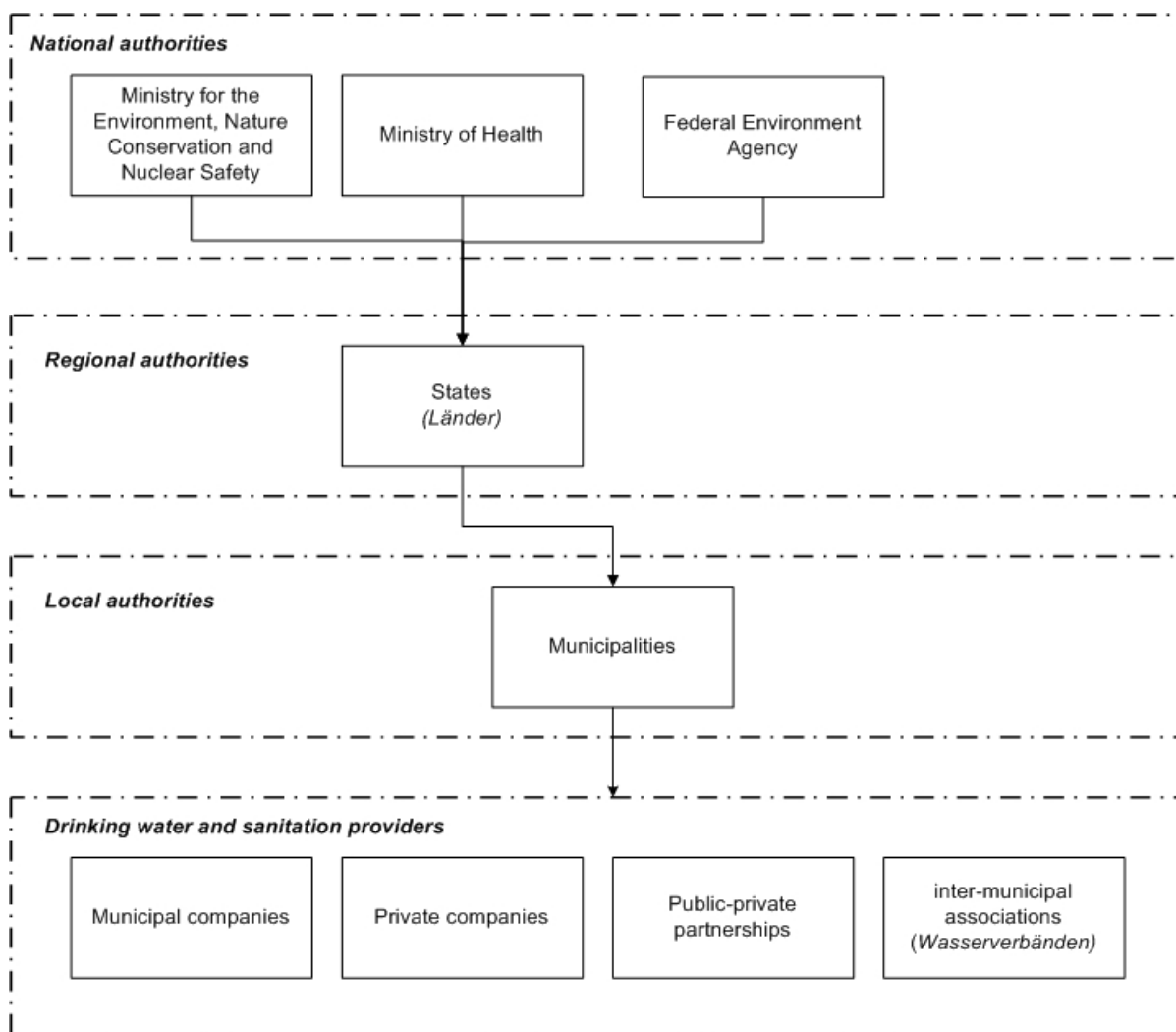


Figure A4.5: Drinking water and sanitation sector, Germany

ANNEX 5: International committees and associations

In this annex a description of international committees involved in water resource management and the corresponding policy-making issues along the Meuse river basin is given.

IMC

The International Meuse Commission (IMC) was established in 2002 with the signing of the International Meuse Treaty by the national governments of France, Luxembourg, Germany, the Netherlands, Belgium and the regional governments of Brussels, Flanders and Wallonia. The most important tasks of the IMC are (IMC, 2002):

- Coordination of implementing European Water Framework Directive.
- Construction of a Management Plan for the international Meuse river basin.
- 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.

The Meuse Treaty is an addition to the *Treaty for the protection of the Meuse* (1994) in which Germany and Luxembourg took no part.

The Commission has formulated several Programmes for achieving its goals. The general short term goal is the conservation and improvement of the Meuse quality, especially the physio-chemical quality, the ecological quality, the drinking water function and other water uses (ICPM, 1998).

Besides the 8 governments, several NGO's and intergovernmental organisations (the BeNeLuX Economical Union) have a status as observer at the Commission engage in the Commissions activities. The involved NGO's are: WWF Belgium, Bond Beter Leefmilieu Vlaanderen, RIWAMAas/Meuse, Union Wallonne des Entreprises, Stichting Reinwater, Inter-Environnement Wallonie, Union régionale du grand Est des Fédérations pour la Pêche et la Protection du Milieu aquatique (IMC, 2009).

RIWA-Meuse

RIWA-Meuse is an international association of water companies that use water from the Meuse use as a source of drinking water. RIWA-Meuse aims at drinking water production from the Meuse through simple and reliable natural treatment and is highly aware of the treats posed by OMPs in the Meuse.

By means of lobbying, extending the existing network, by giving presentations at symposia and other events, RIWA-Meuse tries to stress the importance of the Meuse's drinking water function to local, national and international authorities. Furthermore, the association is has an extensive measuring programme, is involved in scientific research, performs an intensive lobby in the media, national, regional and municipal governments, European institutions, international committees, industry and the agricultural sector (RIWA-Meuse, 2005).

Several Dutch and Belgium (all in Flanders) drinking water companies are members of the association. The publication of RIWA-Meuse report on the quality of the Meuse water (2009) resulted in a headline "*Kwaliteit Maaswater voor drinkwaterfunctie teleurstellend*" (Disappointing quality Meuse water for drinking water) in various media sources.

VNBM

The *Vlaams Nederlandse Bilaterale Maascommissie (VNBM)* is a bilateral integral discussion platform for civil servants that aims at improving the structure of Flemish-Dutch cooperation regarding the Meuse. The VNBM is installed based on the Meuse discharge treaty (1996) between the Flemish region and the Dutch national government. Its tasks include all issues regarding policy-making and management of the Meuse: high-and low-water management, water quality management, conservation and development, monitoring and research, shipping and wet infrastructure and legal affairs (VNBM, 2009).

ANNEX 6: National committees and agencies

Policy making in the water sector is scattered amongst various national and regional authorities. Therefore the Netherlands, Belgium and France have installed committees or agencies for coordinating and structuring of policy making regarding water management.

The Netherlands

Partners voor Water is an initiative of several Dutch ministries (BZ, V&W, LNV, VROM, EZ). One of the organisation's goals is to improve the coordination and tuning of policy making by various departments with a relation to water management. Coordination can be between the ministries (horizontal) and between the ministries and the water sector (vertical).

(Partners voor water, 2008)

Belgium

Geographically demarcated water systems are the basis for water management in Flanders. The most recognizable water systems are the river basins: the Yser, the Scheldt, the coastal polders and the Meuse, which are further demarcated to part river basins. This vertical demarcation has a downside however: the responsibilities regarding integral water management are fragmented among different authorities, public institutions and different levels (regions, provinces, municipalities, polders and water boards). Different degrees of organizational integration can be distinguished, varying from cooperation and coordination to actual integration, which can require a complete restructuring of the sector.

It was decided that cooperation only is not enough to reach effective integral water management in Flanders. Complete restructuring on the other hand is perhaps a step too far. Therefore the *Vlaams Integraal Wateroverleg Comité* (VIWC) was established in 1996 to shape policy making for integral water management in Flanders and to provide a platform for communication and knowledge sharing between those actors that are involved in policy making. Views and policy options can be discussed and commitments can be taken (VIWC, 2000). For instance the (part) river basin committees can order the provincial and local authorities to act on their responsibility regarding water management.

Like in Flanders, Walloon water policy-making is organised via an administration, coordination and discussion body: the *Plate-forme permanente pour la Gestion Intégrée de l'Eau* (PPGIE) (La Région Wallon, 2002).

France

The *French national agency for water and aquatic environments* (ONEMA) is a national agency active in the field of the environment and public services, operating under the supervision of the Ministry of Ecology, Energy, Sustainable Development and Territorial Planning. The activities of ONEMA are: stimulation of research and development, protection of the aquatic environment and management of the French Water Information System aiming at supporting the formulation, implementation and evaluation of public water policies (ONEMA, 2009).

ANNEX 7: Networks for policy making

Several national platforms or partnerships have been established in an attempt to organize the network in the field of water management.

The Netherlands

The *Netherlands Water Partnership* (NWP) is a public-private network organisation that operates as an independent coordination and information source for the Dutch water sector. It aims at reaching a well-organised network in the Dutch water sector by stimulating cooperation between relevant parties.

The NWP has more than 130 members among governments, knowledge institutions, companies and public institutions. One important activity of the NWP is reinforcement of the European and international network via contacts with the various international committees and agency's such as the Global Water Partnership, the World Water Council and Water Supply and Sanitation Technology Platform (NWP, 2007).

Belgium

The previously mentioned VIWC has a double role. It functions as the formal institution responsible for coordinating water policy making Flanders. Besides its formal task, it also serves as the network in which actors other than authorities can contribute in policy making.

France

The *French Water Partnership* (FWP) is the French equivalent of the NWP and consequently has very similar goals and activities: it functions as a forum concerning policy-making, governance and management of water resources. The FWP brings together the French water stakeholders active on the international stage: Ministries, NGOs, local authorities, companies, river authorities and scientific and technical organisations. The FWP maintains a political decision-making focus on water issues (FWP, 2008).

Germany

The *German Water Partnership* (GWP) is the platform for stakeholders active in the German water sector. When comparing the GWP to the Dutch and French Partnerships, it becomes apparent that the GWP has an economical focus, rather than being policy-oriented; it has no governments or other authorities amongst its members. Thus, its focus is on grouping activities, information, research and innovation in the German water sector to strengthen the competitive economic position in the international field (GWP, 2009).

ANNEX 8: Professional associations

Professionals, companies and industries operating in the field of drinking water and sanitation have organized themselves in various associations.

The Netherlands

Vewin is the association of drinking water companies in the Netherlands and every Dutch drinking water company is a member. Vewin's main task is to represent the interests of members on the national and the European level, focussed mainly on legislation and policy-making and proposals and ideas that require several years of preparation (VEWIN, 2009).

The Dutch water boards are united in *the Unie van Waterschappen*, which represents their interests on both the national and international level. The union participates in many discussion and advisory organisations and is involved in national policy making and legislation (UvW, 2008).

Aqua Nederland is an association for private companies operating in water treatment (Aqua Nederland, 2009). A relatively new association for professionals working in the Dutch water sector is the Koninklijk Nederlands *Waternetwerk*: a merger between two other associations (KVWN and NVA). The association promotes the exchange of knowledge and experience between their members (KNW, 2008).

Belgium

Belgaqua is the Belgium association for companies involved in the production and distribution of drinking water and treatment of domestic wastewater. It represents the common interests of her members at the federal, European and international level and stimulates development of knowledge (scientific, technology, economically or administrative). Following the typical Belgium practice of regional delegation, Belgaqua is actually the umbrella organisation for the regional associations *Aquawal* (Wallonia), *Aquabru* (Brussels) and *SVW* (Flanders).

France

The *Fédération professionnelle des entreprises de l'eau* (FP2E) is the association of French companies involved in drinking water and sanitation. Like its Dutch and Belgium equivalents, it represents the member companies and aims at influencing policy-making and legislation (FP2E, 2009).

Germany

A multitude of associations is active in the German water and utility sector. The associations and their activities are summarized in the table below.

Table A8.1: Associations water and utility sector Germany

Association	Description of activities.
<i>Arbeitsgemeinschaft Trinkwassertalsperren</i> (ATT)	Association of drinking water from reservoirs. Consists of companies, administrations, universities and research institutes that are involved in the production, treatment and distribution of drinking water from reservoirs.
<i>Bundesverband der Energie- und Wasserwirtschaft</i> (BDEW)	Association of energy and water industries. Representing approximately 1800 companies, from local and municipal to regional and supra-regional suppliers.
<i>Deutscher Bund verbandlicher Wasserwirtschaft</i> (DBVW)	Union of 8 regional associations. Represents the interests of water industry associations responsible for various fields in watermanagement.
<i>Deutsche Vereinigung des Gas- und Wasserfaches Technisch-wissenschaftlicher Verein</i> (DVGW)	Promotes the gas and water supply industry taking particular account of technical security, hygienic safety and environmental protection. Controls and certifies products, persons and companies, the initiates and promotes research projects and training.
<i>Deutsche Vereinigung für</i>	Politically and economically independent association of municipalities,

<i>Wasserwirtschaft, Abwasser und Abfall</i> (DWA)	universities, engineers, public authorities and companies
<i>Verband kommunaler Unternehmen</i> (VKU)	Represents the interests of the municipal utilities in the sectors of water supply and wastewater disposal as well as energy and waste management.

(ATT et al., 2008)

ANNEX 9: Stakeholder analysis

In the table A9.2 the interests, objectives, perception of problem situations and the resources/power of involved stakeholders are described. In order to avoid unnecessary repetition, similar stakeholders found in different countries like for instance the involved ministries, (inter)municipal companies and associations, are not described individually. All stakeholders are assigned a classification, described in table A9.1 below.

Table A9.1: stakeholder classification

	Dedicated actors				Non-dedicated actors			
	Critical actors		Non-critical actors		Critical Actors		Non-critical actors	
Similar supportive interests and objectives	Actors that will probably participate and are potentially strong allies.	A1	Actors that will probably participate and are potentially weak allies.	A2	Indispensable potential allies that are hard to activate.	A3	Actors that do not have to be involved initially.	A4
Conflicting interests and objectives	Potential blockers of certain changes. (biting dogs)	E1	Potential critics of certain changes. (barking dogs)	E2	Potential blockers that will not act immediately. (sleeping dogs)	E3	Actors that need little attention initially.	A4
	Position not identified							
	Ally & Enemy (internally conflicting objectives)							

Critical versus non-critical actors

The resource dependency of one actor (Dunea) in relation to a second actor (ministry of V&W for instance) depends on the importance of the resources held by the second actor (legislation, money), and the degree to which these resources can be replaced by other resources.

The problem owner (Dunea) does not only depend on actors with the resources to support problem solving, Dunea also depends on actors with resources to hinder her activities, or to preventing the successful implementation of a solution. Actors that are either important for their 'power of realization', or for their 'blocking power', are the critical actors – the actors that Dunea cannot ignore.

Dedicated versus non-dedicated actors

The dependency on other parties is not only influenced by the resources and powers that these parties have, but also by their interest in the problem and the willingness to use their resources. The importance of a problem to stakeholder will appear from his problem formulation and the extent to which his core interests are affected by the problem or by possible solutions. Furthermore, it can help to estimate a party will be confronted with clear costs or benefits. If so, the stakeholder will probably be a '*dedicated actor*', or may become one in the future.

When an actor does not experience any clear costs or benefits, or when costs and benefits seem to compensate for each other, this party will be less likely to try to influence the problem analysis and the choice and implementation of a particular solution. This means that such actors are less likely to pose a threat to the problem owner, but also that it will be more difficult for a problem owner to mobilize their active support. In such cases, we are dealing with a '*non-dedicated actor*'.

Table A9.2: Stakeholder analysis

Actor	Interests	Desired situation/ objectives	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
Dunea	Reliable production of high quality drinking water in good harmony with nature	Meet standards IB, Meet standards DWB, maintaining high level of consumer trust	Concentrations of OMPs in source expected to increase, posing a threat to the objectives	Upstream uses of river Meuse are conflicting with drinking water production	Knowledge, power to influence public opinion, financial resources, network and contacts drinking water sector	Extend drinking water treatment (pre and post), Preventative measures
Cabinet (A1 & E1)	Ensuring economy and public safety, combined with sound policy for nature, environment, water, agriculture and land use planning	Comply with EU directives			Legislation, financial resources	?
Ministry of VROM (A1)	Creation of pleasant living environment, execute development policy, safe drinking water, sustainable future	Clean and safe water, good ecological status	Quality Meuse can pose a threat to drinking water production	(conflicting) uses upstream	Legislation, financial resources	Emission prevention, Advanced treatment WW, Separate urine collection, Extend drinking water treatment
Ministry of V&W (A1)	Protection against flooding and maintaining safe water connections	Keeping the Netherlands safe, accessible, liveable and maintaining good ecology	Quality and quantity of water can be insufficient		Legislation, financial resources, grants permit for discharge effluent WWTP 'Rijkswateren'	?

Actor	Interests	Desired situation/ objectives	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
Ministry of LNV (A1 & E1)	Providing healthy food with respect to human and animal life and the environment	Appropriate balance various functions rural areas/ water courses and reinforcement competitiveness agricultural sector	Concentrations pesticides in surface waters exceed MTR norms	Pesticide use required for competitiveness agricultural sector has negative influence water quality	Legislation, financial resources	Reduced use of pesticides, development of ecofriendly pesticides,
Waterboards (A1 & E1)	Sustainable protection against water, sufficient water of sufficient quality at the correct place, serving the public and the environment	Sufficient surface water of sufficient quality in service area	Treated discharged wastewater contains pharmaceutical residues	Urine contains pharmaceutical residues that are not adequately removed at WWTP	Knowledge wastewater treatment, Ownership WWTPs	Invest in preventative measures and/or extension wastewater treatment
Provinces (A2 or E1)	Sustainable use of water and soil: good groundwater management	Transparent trade-off water needs vs. other public/social interests			Grants license for dune infiltration	Preventative measures, Improved pre-treatment, Compensate and mitigate harm to nature
Municipalities NL (A2)	Good facilities and service provision for inhabitants (IPP, 2007) Collection and transport of sewage	Adequate sewer system for collection and transport of sewerage away from urban area	?	?	Ownership sewer system	?
Municipalities France and Germany (A3 and E3)	Responsible for production and supply of drinking water and collection, transport and treatment of wastewater (amongst other tasks) when not delegated to other parties	Safe, healthy drinking water free from OMPs, Adequate sewer system for collection and transport of sewerage away from urban area. Adequate wastewater treatment				

Actor	Interests	Desired situation/ objectives	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
Drinking water companies NL (A1)	Reliable production of high quality drinking water	Meet standards DWB, maintaining high level of consumer trust	Concentrations of OMPs in source expected to increase, posing a threat to the objectives	Other uses of soil/ upstream uses river water can be conflicting with drinking water production	Knowledge, power to influence public opinion, financial resources, network and contacts drinking water sector	Extend drinking water treatment, preventative measures
(inter)municipal or private companies and PP-partnerships (A3)	Reliable production of high quality drinking water (BE, FR and GER)	Meet standards concerning quality		Other uses of soil/ upstream uses river water can be conflicting with drinking water production	?	?
Intercommunes drinking water (A3)	Drinking water production Wallonia					
Intercommunes sanitation (E3)	Collection, transport and treatment of wastewater					
Partners for water	Joining of forces to enhance international position Dutch water sector	Integrated approach for coordination of policies, cooperation, stimulation of foreign activities	?	?	?	?
Netherlands water partnership	Organizing a strong Dutch water-network	Coordination and cooperation between stakeholders Dutch water sector	?	?	Strong network position	?
<i>French Water Partnership (FWP), German Water Partnership (GWP) and VIWC</i>	idem					
VEWIN	Representing common interests drinking water companies	Maintaining and reinforcing consumer trust	Occurrence of traces OMPs may reduce consumer trust	Conflicting water uses	Knowledge, power to influence public opinion	Cooperation with stakeholders and policy makers from all relevant fields

Actor	Interests	Desired situation/ objectives	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
Unie van Waterschappen (E2)	Representing common interests waterboards /Sustainable watermanagement	Leading role in strategic discussions on regional watermanagement, in both national and international context	Regional surface waters contain OMPs	OMPs in discharged effluent WWTP, agricultural run-off	Influence on policymaking	Participate in discussion with stakeholders and policymakers
Aqua Nederland	Representing interests of its members (private water treatment industry) towards authorities and commercial sector	Strengthening competitiveness of its members			?	
Koninklijk Nederlands Waternetwerk	Building bridges between various disciplines in the water sector				?	
<i>Fédération professionnelle des entreprises de l'eau (FP2E)</i> <i>Belgaqua, Aquawal and SVW</i>	Representing common interests of members (drinking water and sanitation sector) at Federal, European and international level	Stimulating development of knowledge (scientific, technology, economically or administrative)				
<i>Prof. associations Germany</i>						
KWR (A1)	Helping the water sector identify the challenges it faces	Developing and unlocking relevant knowledge about the Watercycle			Knowledge	Separate urine collection, extended drinking water treatment, advanced post-treatment effluent WWTP (?)
Het Waterlaboratorium	Providing high-quality water research				Knowledge, equipment	?
LTO (E2)	Good economic prospects for agricultural sector combined with social water needs (LTO, 2007)	Water policies do not limit development of agriculture	Restricting use of pesticides may harm production capacity		Influence on policymaking via lobbying, strong support from agricultural sector	

Actor	Interests	Desired situation/ objectives	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
Stichting natuur en milieu (A1)	Beautiful scenery, a rich nature and a healthy environment.	Sustainable agriculture and horticulture	Continuance of pollution by pesticides	Pesticide use Dutch Agricultural sector is 2,5 times as high as EU average	Influence on public opinion via media	http://www.natuurenmilieu.nl/page.php?pageID=76&itemID=4800&themaID=6
Nederlandse Vereniging Ziekenhuizen (NVZ)	Collective representation of care-related, social and economic interests of members	Creating frameworks for alert and flexible response to changes in (demand for) care	Providing good medical care conflicts with environmental and or economical values	Increasing demand for high quality care combined with stricter financial management of hospitals and stricter environmental policies		?
<i>Coördinatie Commissie Integraal Waterbeleid (CIW)</i>	Preparation, planning, control and implementation of Flanders' water management	Cooperation between different water managers and administrators involved in water policy-making	Inadequate cooperation between policy makers	responsibilities integral water management are fragmented among different authorities, institutions and levels	Legislation, financial resources	
<i>Vlaamse Milieu Maatschappij (VMM)</i>	Water resource management and corresponding policy making in the broad sense	Good quality and quantity of ground water, surface water, wastewater and water intended for human consumption	Concentrations OMPs in source expected to increase, posing a threat to the objectives	Upstream uses of river Meuse are conflicting with drinking water production	Legislation, financial resources	
Aquafin (E2)	Treatment and discharge of wastewater, construction and operation main sewage system	Complying with EU policies	Currently, Flanders does not comply with EU policies	Discharge of untreated domestic wastewater	Ownership sewer system	Connection to sewage systems
<i>Direction Générale des Ressources naturelle et de L'Environnement (D.G.R.N.E.)</i> And <i>la Division de l'Eau (A1 and E1)</i>	Water resource management and corresponding policy making in the broad sense	Good quality and quantity of ground water, surface water, wastewater and water intended for human consumption	Concentrations of OMPs in source expected to increase, posing a threat to the objectives	Upstream uses of river Meuse are conflicting with drinking water production	<i>Direction Générale des Ressources naturelle et de L'Environnement (D.G.R.N.E.)</i> And <i>la Division de l'Eau (A1 and E1)</i>	

Actor	Interests	Desired situation/ objects	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
<i>la Société publique de gestion de l'eau</i> (SGPE) (A1 or E1)	Treatment and discharge of wastewater, construction and operation main sewage system	Complying with EU policies	Currently, Wallonia does not comply with EU policies	Discharge of untreated domestic wastewater		Connection to sewage systems
Inter-communales Water (A2)	Production of drinking water	Safe and healthy drinking water	OMPs may pose a threat to drinking water production			
Intercommunales sanitation (E2)	Collection and treatment of waste water		Treated and discharges wastewater contains pharmaceutical residues	Urine contains pharmaceutical residues that are not adequately removed at WWTP		
<i>Société Wallon des eaux</i> (SDWE) (A1)						
<i>Plate-forme permanente pour la Gestion Intégrée de l'Eau</i> (PPGIE)	Effective integral water management	Providing platform for communication and knowledge sharing	Inadequate cooperation between policy makers	Responsibilities regarding integral water management are fragmented among different authorities, public institutions and different levels		
<i>French national agency for water and aquatic environments</i> (ONEMA)	protection of the aquatic environment , supporting formulation, implementation and evaluation of public water policies	?	?	?	?	?
<i>European Commission and European Parliament</i> (A1)	Good ecological status and biodiversity combined with good agricultural policies.	protection of quality and quantity of ground and surface waters, maintaining/improving habitats, flora and fauna	Water in the E.U. is under increasing pressure: conflicting interests/uses.	Increasing demand of sufficient water quantities of high quality for numerous purposes.	Legislation, financial resources	
<i>International Meuse Commission (IMC)</i> (A1)	Durable and integral watermanagement of the international Meuse river basin.	Good physio-chemical and ecological quality river Meuse, preserving the drinking water function and other water uses.	Water in the E.U. is under increasing pressure: conflicting interests/uses.	Increasing demand of sufficient water quantities of high quality for numerous purposes.	Knowledge, network position,	International coordination and cooperation.

Actor	Interests	Desired situation/ objects	Expected or existing situation and gap	Causes	Resources and power	Possible solutions
RIWA-Meuse (A1)	Simple natural treatment for reliable drinking water production from Meuse water.	Restoration of natural balance River Meuse by preventing discharge of harmful substances.	Surface water intended for drinking water production should meet strict norms. In Meuse river basin these norms are exceeded.	Use and run-off of plant protection products, inadequate removal of pharmaceuticals and hormones during wastewater treatment	Knowledge, power to influence public opinion, network and contacts drinking water sector	Engage in dialogues with polluters
<i>Vlaams Nederlandse Bilaterale Maascommissie (VNBM)</i>	Execution of 'Maasafvoeroverdrag' (article 4)	Improvement of coordination structure between Belgium and the Netherlands concerning the river Meuse	?	?	?	?
European Federation of Pharmaceutical Industries and Associations (EFPIA) (E1)	Representing of pharmaceutical industry operating in Europe	Promote pharmaceutical research and development	Favourable economic, regulatory and political environment, enabling to meet the growing healthcare needs and expectations of patients.	Pharmaceuticals included on EU priority list and strict legislation/regulation may harm image and profits	Financial resources and power to influence health care sector	?
Hospitals* (A2 & E2, depending on influence pharm.indus)	Providing medical care of high quality	Large patient trust and desirable work environment for medical personnel.	Providing good medical care conflicts with environmental and or economical values	Increasing demand for high quality care combined with stricter financial management of hospitals and stricter environmental policies		?
Consumers of pharmaceuticals/ patients (E2)	Access to affordable, safe and reliable medication	No relation between consumption of pharmaceuticals and quality of drinking water	Consumption of pharmaceuticals influences drinking water quality	?	?	?
Consumers of drinking water (A1)	Access to affordable, safe and reliable drinking water	No traces of organic micropollutants in drinking water	Possible health risks of consuming drinking water containing residues of medication, pesticides etc.	?	?	?
European Crop Protection Agency (ECPA) (E1)	Representing crop protection industry in Europe	Promote agricultural technology in the context of sustainable development	Pesticide production/use viewed as conflicting with environmental values	Lack of understanding on why pesticides are needed		Listen and learn from stakeholders the public, and seek to understand their interests, views and perspectives
Distributors of pharmaceuticals (E1)						
Agricultural sector** (E1)						

* the term hospitals refers to all types of health facilities: hospitals, elderly homes, nursing homes and mental institutions

** the term agricultural sector refers to all types of agricultural activities: growing of crops, livestock, fruit, horticulture and greenhouse farming

ANNEX 10: Legal framework - Legislation and policies

European Water Framework Directive

Regarding the prevention of the emission of organic micropollutants to surface waters, reducing the environmental consequences and combating threats to drinking water production, a multitude of European policies and legislation are relevant. Based on the WFD, (inter)national river basin management plans should be formulated that incorporate measures to achieve the environmental targets, taking not only the WFD into account but also the Integrated Pollution Prevention Control Directive, the Plant Protection Products Directive, the Biocidal Products Directive (98/8/EC) and the Directive on Priority Substances.

This paragraph summarizes the relevant European directives.

Introduction

The European Parliament and the Council have adopted the Directive 2000/60/EC, also known as the EU Water Framework Directive (WFD). The Directive aims at maintaining and improving the aquatic environment in the Community.

The purpose of the Directive is to establish a framework for the protection of surface waters, transitional waters, coastal waters and groundwater that should (article 1, 2000/60/EC):

- Prevent further deterioration, protects and enhances the state of aquatic ecosystems, terrestrial ecosystems and wetlands that depend directly on aquatic ecosystems.
- Promote sustainable water use.
- Enhance the protection and improvement of aquatic ecosystems through specific measures.
- Reduce and prevent further groundwater pollution.
- Contribute to mitigation of effects of floods and droughts.

The WFD incorporates several different water directives into one orderly arrangement, like for instance the 'old' Framework Directive of 1976 (76/464/EEC), several directives aimed at control of water pollution by hazardous substances (76/464/EEC), directives for water quality of waters with a specific use like drinking water (75/440/EEC) of fish water (78/659/EEC) and a directive aimed at groundwater protection (80/68/EEC).

Objectives

Specific environmental objectives are the central importance of the Directive. A *good water status* should be achieved by 2015 and deterioration of the water status and pollution should be prevented. For surface waters this implies a *good chemical status* and *good ecological status* and for groundwater this means a *good chemical status* and a *good quantitative status*.

The chemical status of surface water bodies is good if the European standards from the daughter directives of the dangerous substances directive (Annex IX WFD) are met. Surface waters have a good ecological status if the quality deviates only slightly from natural conditions.

In the Netherlands assigned functions of drinking water, shellfish water and fishing water to specific surface waters, will be cancelled. If the environmental objective of a 'good chemical status' should fail to provide sufficient protections against threats to those purposes, it may be necessary to formulate additional national policies.

Important aspects of the WFD are the river basin management plans (RBMPs) that have to be developed for all river basin districts. The RBMPs include a specification of the environmental objectives, an assessment of the current situation and a prediction of the future situation if no measures are taken and the development and implementation of a programme of measures to achieve the environmental objectives (Mostert, 2008). Where international basins are concerned, the Framework Directive requires the development of an international plan. For the Netherlands this means that a national management plan is drawn up for each of the four international river basins (Rhine, Scheldt, Ems and Meuse), which is part of the international plans.

Besides the WFD, several Directives that do not have a direct focus on protection of water quality are relevant: the Integrated Pollution Prevention Control Directive (2008/1/EC), the Plant Protection Products Directive (91/414/EEC) and the Biocidal Products Directive (98/8/EC)

Relation to pollution by organic micropollutants

Article 16 of the WFD outlines a strategy against the pollution of water. The strategy includes the establishment of a list of priority substances, a procedure for the identification of priority substances/priority hazardous substances and the adoption of specific measures against pollution with these substances. In 2001 a list of 33 priority substances, including 11 priority hazardous substances was adopted (Decision 2455/2001/EC) as part of the WFD (annex X WFD). The discharge, emission and losses of these substances should be within 20 years.

In 2008 the Directive on Priority Substances (2008/105/EC) was adopted to replace annex X of the WFD. This directive set limits to allowable concentrations of these substances in surface waters by defining annual average environmental and maximum allowable concentration quality standards (AA-EQS and MAC-EQS). The average concentration of atrazine in inland surface waters for instance cannot exceed 0,6 µg/l.

Conclusion

According to article 16, European Parliament and the Council should adopt specific measures against the pollution of water, aimed at progressive reduction in discharge, emission and losses of priority substances and cessation of phasing out priority substances. At the European level limits to allowable concentrations in surface water are defined and the placing of new plant protection products and herbicides on the market is only allowed after EU approval. However, no measures for reduced discharge, emission or losses have been proposed on the European level so far. In absence of action at the European level, member states themselves are required to take action (Mostert, 2008).

National legislation

The Netherlands

The Netherlands have adopted an integral *Waterwet* (Water law, 2009) that replaces all legislation concerning water resource management. Regarding drinking water, the production and distribution is regulated by the *Waterleidingwet* (to be replaced in 2010 by the *Drinkwaterwet*), the quality standards are defined by the *Waterleidingbesluit* (to be replaced in 2010 by the *Drinkwaterbesluit*). The admission, sales and use of plant protection products and biocides is regulated by the *Wet gewasbeschermingsmiddelen en biociden* (2007). The '*Besluit glastuinbouw*' (2002) limits the maximum use of pesticides in green house farming and the *Lozingenbesluit open teelt en veehouderij*' (2005): 90% reduction of emission caused by drift (compared to 1995).

Belgium

No national legislation with a specific aim towards water exists in Belgium. Legislation is formulated by the regional governments. On the federal level, so-called product norms regarding water, soil and air are formulated. This includes norms for drinking water quality (inspectie V&W, 2004).

In Flanders the following legislation is relevant:

- *Decreet integraal waterbeleid* (Decree on integral water policy), transposition of WFD
- *Vlaams Reglement betreffende de Milieuvergunning* (VLAREM, Flemish regulation regarding Environmental permits), defines basic quality standards for surface waters.

The following legislation is relevant for the Walloon region:

- Het Waterwetboek (WBB),

Germany

Germany has a federal framework regarding surface water, groundwater and coastal waters: the *Wasserhaushaltsgesetz* (The Water Management Act) that is transposed into the legislation of states via the *Landeswassergesetze*. Details concerning drinking water, groundwater and wastewater are defined by several ordinances.

The use, sale, monitoring and authorisation of plant protection products are regulated by the *Pflanzenschutzgesetz* (Plant Protection Act, 2004). The Plant Protection Act also governs the authorities' competencies for authorising and monitoring plant protection products. The details are stipulated in various ordinances.

France

National French legislation regarding water management in the broad sense is defined by two laws:

- The *Loi sur l'eau* (Water Law, 1992),
- *Loi sur l'eau et les milieux aquatiques* (Water and Aquatic Environment Law, 2006)

The Water Law concerns water issues on all fields: drinking water, drainage, floods, agriculture, industry, production of energy, transport etc. The Water and Aquatic Environment Law forms the national transposition of the WFD. Both laws are effectuated via numerous decrees.

Legislation regarding industries, public health and agriculture contain regulation for the protection of the aquatic environment as well. Furthermore, legislation regarding waste, air and soil also contain regulations for the protection of water.

In order to reduce the complex legislation system, an integral Environmental Law was adopted (2000).

ANNEX 11: Zuiver water in de Bommelerwaard

Introduction

Approximately 40% of the total water volume in the Afgedamde Maas – Dunea's source for drinking water - consists of Bommelerwaard-water the rest originates directly from the Meuse. It therefore makes sense to aim at reducing the emission of pesticides from the Bommelerwaard. The project *Zuiver-Water Bommelerwaard* aims at improvement of the surface water quality via preventative measures. This chapter describes the relevant aspects and outcomes of this initiative.

Motivation

The multifunctional principal applies when surface water is infiltrated in the soil. It requires that the quality of the infiltrated water should pose no threat to the other functions of infiltrated soil and the quality of the groundwater. The quality of surface water used for infiltration and abstraction in the dunes does not meet the standards set by law (Infiltratiebesluit Bodembescherming or IB). As a result, the province of South-Holland has decided to allow infiltration until 2016 under a few conditions. Those conditions require DZH to execute several projects and activities (Speets, 2005):

- Improvement of surface water quality via preventative measures.
- Improvement of pre-treatment.
- Aiming at reduced agricultural run-off.
- Mapping of the dispersion of substances that are foreign and of high concentrations of substances known to be used in the area.
- Compensate/mitigate harm to nature/environment caused by infiltration of undesirable substances.

Formal framework and goals

The project is an initiative of DZH, water board Rivierenland (WSRL) and Rijkswaterstaat Direction South-Holland (RWS-DZH) and aims at reaching agreements with stakeholders towards reduced usage of pesticides. In 2002 a 'intention agreement' has been signed by the involved actors: the province of Gelderland, the municipalities of Maasdriel and Zaltbommel, representatives of region's farmers/horticulturists (GLTO) and drinking water company Vitens.

The project's main goal is to improve the surface water quality of the Afgedamde Maas, by realising an improvement in quality of the water released from the Bommelerwaard. The quality of the Bommelerwaard-water should comply with the maximum permissible risk (MTR) or with the drinking water norm when no MTR exists or when the MTR exceeds the drinking water norm. In 2010 no exceedence of the MTR and/or drinking water norm regarding plant protection products should occur.

Within the project three tracks have been formulated:

1. Realisation of *memoranda of agreement*, containing agreements on reaching environmental targets and associated terms (time, budget)
2. Development of knowledge thru projects and demonstrations
3. Informing, advising and broadening of support

Relation to autonomous policy development

Autonomous policy is developed as well, which has become stricter over the years. The following policies are relevant when aiming at further reduction of the emission of pesticides:

- '*Lozingenbesluit open teelt en veehouderij*' (2005): 90% reduction of emission caused by drift (compared to 1995)
- '*Besluit glastuinbouw*' (2002): limits maximum use of pesticides in green house farming
- The Commissie Toelating Gewasbeschermingsmiddelen (Commission for Admittance of Pesticides) tests nowadays for harmful effects to water.
- '*Convenant Gewasbescherming*': aims at a 95% reduction of pesticides in 2010 compared to 1998
- European Water Framework Directive
- '*Gelders Milieuplan-3*' and '*Gelders Waterhuishoudingsplan-3*': Environmental and watermanagement plan province of Gelderland

Water system

Water is released to the Afgedamde Maas from four pumping locations whenever the water level in the Bommelerwaard too high. If the Bommelerwaard requires extra water, it is taken in from the Meuse when needed. The water quality is monitored at three pumping stations in de Bommelerwaard. This way it is possible to demonstrate which substances are used by which agricultural sector. Furthermore, samples are also taken at Dunea's intake, and along the Meuse. In total samples are taken at 12 locations.

On average 40% of the total water volume in the Afgedamde Maas consists of Bommelerwaard-water (see also figure below), the rest originates directly from the Meuse. It therefore makes sense to aim at reducing the emissions from the Bommelerwaard with location specific measures.

In the polder discharging to de Baanbreker mostly fruit culturists can be found. H.C. de Jong discharges water from an area dominated by green house farming. Just near de intake of Dunea, pumping location van Dam van Brakel is located, which discharges water from an area with various uses. De water quality at de Rietschoof is not monitored.

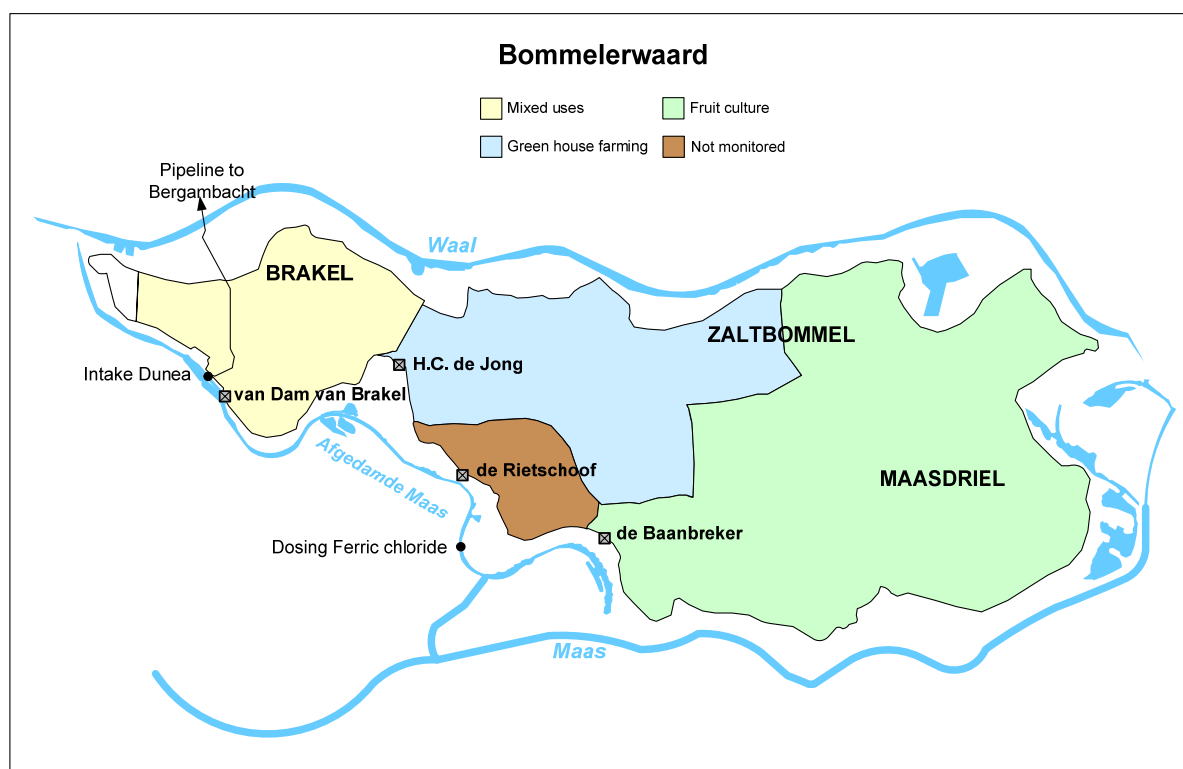


Figure A11.1: Water system Bommelerwaard

Preventative measures

Several different types of measures have been designed and put into practice. Some were sector specific; others had a more general aim. The measures are categorized as reducing the use of pesticides (1), use of alternative technologies (2) or use of alternative (more eco-friendly) pesticides (3). In table 3.1 a summary of the measures can be found. For a more detailed description the reader is referred to Speets (2005), Hoekstra et al (2002) and Vlaar et al (2007).

Table A11.1: Preventative measures Bommelerwaard

General		
Financial contribution to investments in emission-reduction (mainly fruit culture)		
Advising on pesticide usage		
Prevention at source: reduced usage as 1 st step		
Altering pumping regime Bommelerwaard		
Communication		
Fruit culture		
Category	Measure	Comment
Reduction of usage	Application of AseptaColl	Improves the effect of glyphosate and thus reduces the need
	Usage of models and weather station information to optimise usage fungicides in scab control	
	Smaller 'black strip' (zwarte strook)	Smaller black strips around trees require less pesticide use
	Vegetation black strip	Vegetation on black strips significantly limits pesticides use
	Manual grubbing	
	Biological control	Use of assassin-bugs
Alternative technologies	Windshields on ditch sides	
	Sprayer filler machine	Central, mobile filler for sprayers, meeting all latest requirements
	Alternative nozzles ('tunnelspuit')	
	Using lime against fruit tree cancer	
	Use of 'Wannerspuit'	Sprayer with emission shields, might be recognized as 'emissie bep. Maatr' (WVO)
Other	Cost/Benefit analysis of emission reducing measures	
	Informing about new policy (1/1/2006)	
Green house farming (chrysanthemum)		
Category	Measure	Comment
Reduction of usage	Increase steaming frequency	Steam used to heat the ground controls several diseases and pests
	Improved steaming efficiency	
Usage alternative substances	Use of Mycotal	A mould preparation, capable of replacing several chemical pesticides
	Use of Nemasys	An eel preparation, capable of replacing several chemical pesticides
	Biological control	One type of millipedes preys on another type of millipedes
Alternative technologies	Recirculation of irrigation water	
	Optimising usage fertilizer by a software tool that calculates evaporation from plants	
Other	Monitoring development of reconstruction/expansion green house farming in Bommelerwaard	

Table A11.1: Preventative measures Bommelerwaard, continued

Green house farming (chrysanthemum)		
Category	Measure	Comment
Reduction of usage	Increase steaming frequency	Steam used to heat the ground controls several diseases and pests
	Improved steaming efficiency	
Usage alternative substances	Use of Mycotal	A mould preparation, capable of replacing several chemical pesticides
	Use of Nemasys	An eel preparation, capable of replacing several chemical pesticides
	Biological control	One type of millipedes preys on another type of millipedes
Alternative technologies	Recirculation of irrigation water	
	Optimising usage fertilizer by a software tool that calculates evaporation from plants	
Other	Monitoring development of reconstruction/expansion green house farming in Bommelerwaard	
Agriculture and grasslands		
Category	Measure	Comment
Reduction of usage	Mechanical grubbing in combination with row spraying	Combined usage reduces required volume pesticides
	Increase area of no-spray zones alongside waterways	
	Grassland management	Farms with good grassland management have less problems with weeds
Other	Stimulating crop rotation	
Municipalities/ private sector		
Category	Measure	Comment
Reduction of usage	Project toxin-free in municipalities of Maasdriel and Zaltbommel	No measures executed until 2007: municipalities will participated in provincial pilot toxin-free management Bommelerwaard

Monitoring program

The Waterboard Rivierenland conducts an extensive monitoring program in order to evaluate the progress of the project. Samples are taken at 9 locations in the Bommelerwaard. The samples are screened for the presence of relevant substances and whether the concentrations exceed the norms that are explained below.

MTR (maximaal toelaatbaar risico/ maximum allowable risk)

The MTR is the calculated concentration of a substance in the environment with no adverse effects to 95% of the present organisms. MTR values are regularly adjusted when new information regarding the consequences of a compound comes available.

Drinking water norm

The drinking water norm for plant protection products is set by the *Waterleidingbesluit*.

The concentration of individual substances cannot exceed 0,1 µg/l and the total concentration of compounds found in a sample should be <0,5 µg/l.

The number of substances included in the measuring package has increased over the years from 60 (2002) to 214 (2007). It is important to adjust for this when the results of different years are compared. Approximately 45% of the included substances are found in the samples, the rest of the substances have concentrations below the detection limit. A substance is defined as being problematic if the concentration exceeds the MTR or drinking water norm at least one time at any location.

Results preventative measures

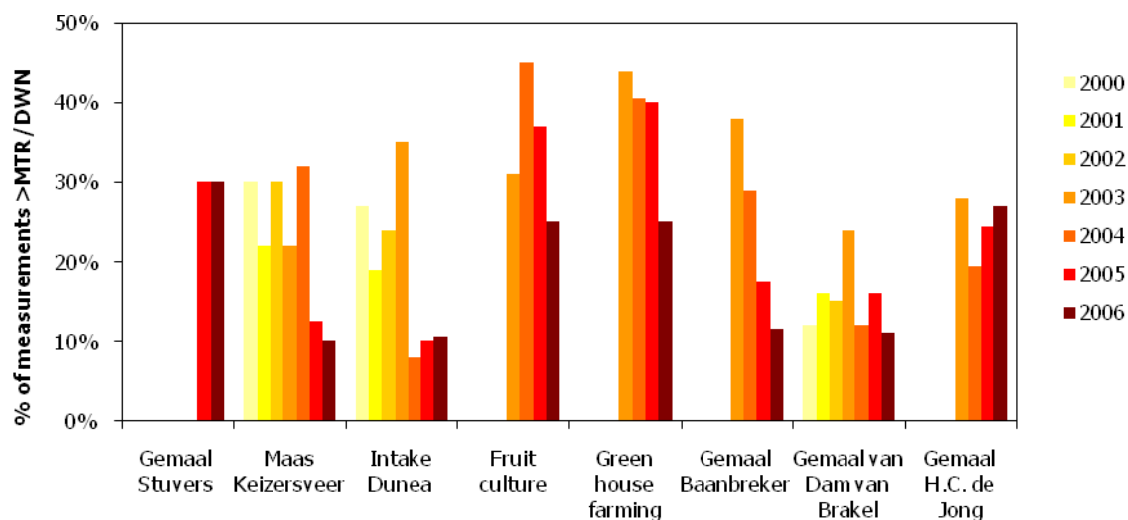


Figure A11.2: Monitoring results Bommelerwaard (adapted from Visser et al., 2007)

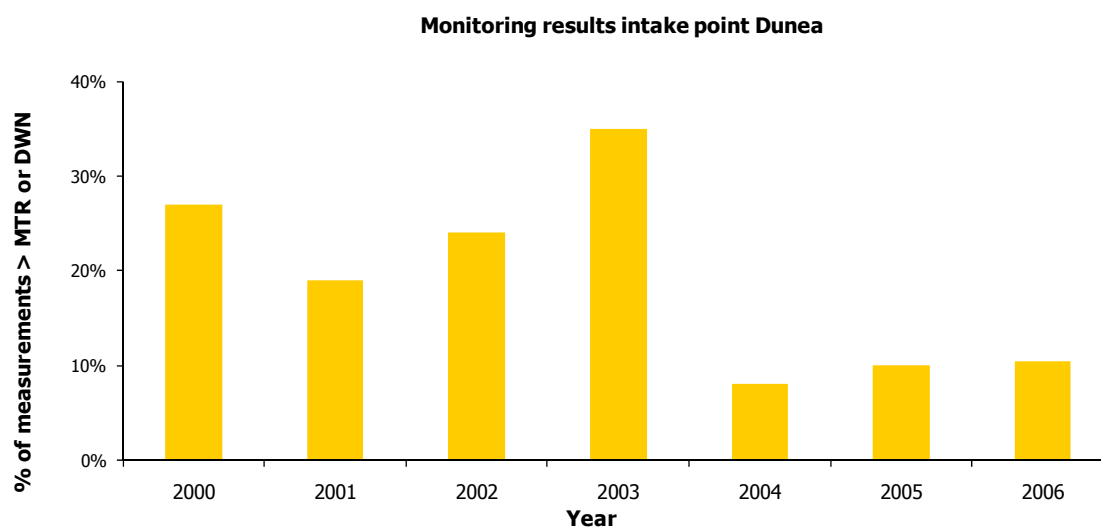


Figure A11.3: Monitoring results intake Dunea (adapted from Visser et al., 2007 and HWL 2008/2009)

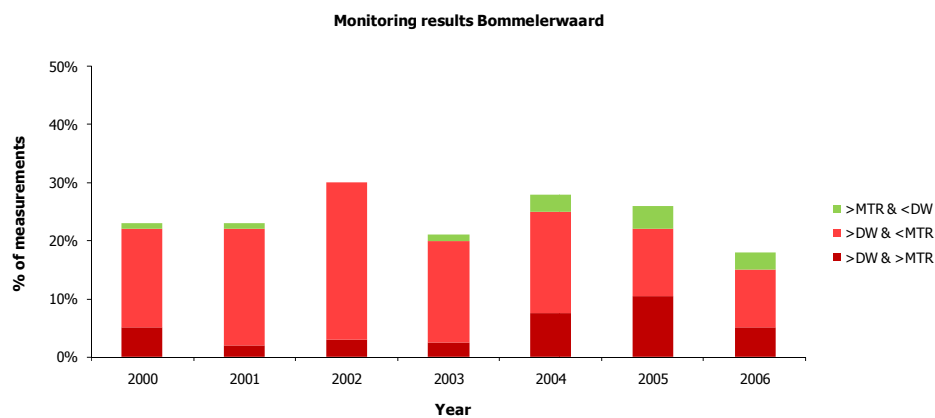


Figure A11.4: Average monitoring results all locations (adapted from Visser et al., 2007)

The water quality is an important indicator for the success of the project, which is intensively monitored. Speets (2005) has evaluated the outcomes of the project over the period 2002-2004 and concludes that the implementation of the measures was lagging behind the planning, despite the financial contribution and contribution of manpower. The results of the first couple of years of the project did not meet the expectations: the direct measurable effect in terms of a reduction in the emission of pesticides from the Bommelerwaard is very limited.

Several causes have been identified: measures are unpractical, too experimental, very low contribution towards emission reduction, little interest from specific sector. Only mechanic weed removal in corn fields is expected to contribute towards the emission reduction. The future must show whether the ambitious goal – no exceedence of the MTR and/or drinking water norm in 2010 – will be met. It was recommended to implement a go/no go decision in 2007.

Speets does however recognize that the project 'Zuiver-Water Bommelerwaard' provides a positive contribution towards policy making aiming at protecting surface water intended for drinking water production. The project emphasizes the need for better protection of surface water bodies used for the production of drinking water. Furthermore, the project is widely known in the region, which enlarges the support for planned measures.

In 2007 the results were evaluated again (Visser et al., 2007, Speets, 2007 and Vlaar et al., 2007). The water quality at Dunea's intake has improved since the reference year 2003: a clear decrease in the percentage of norm exceeding measurements can be distinguished from 2004 and onwards. However, when the years 2005 and 2004 are compared it can be concluded that the percentage of measurements with concentrations >MTR and/or DWN has increased slightly to 10%. This remains relatively constant in the period 2005-2008.

The project has successfully introduced some measures and has achieved a reduction of usage of plant protection products in fruit culture and cattle farming. On an annual basis, 20-30% of the concentrations of monitored substances exceed the DWN and MTR for plant protection products. Some substances exceed the norms more frequently than other substances. The quality of water that Dunea infiltrates in the dune area meets the standards set by the *Infiltratiebesluit Bodembescherming* regarding the presence of organic micropollutants. This is unfortunately no guarantee that the future quality will still meet the IB-standards.

Overall, the water quality in the Bommelerwaard has improved since the project 'Zuiver water in de Bommelerwaard' commenced in 2002. It is difficult to state just how much of the improvement can be attributed fully to the project, since autonomous policy developments have their influence as well, except when the usage of certain substances is prohibited. Speets concludes his evaluation by stating that is unlikely that the water quality goals for 2010 will be reached.

ANNEX 12: Preventative measures – pesticides

Reducing the contamination of surface waters is one of the main objectives of the European Water Framework Directive, which is implemented via national legislation of the member states. The Netherlands, Belgium, Germany and France have implemented policies and programs aiming at a reduction of pesticide use and emission to the natural environment. A summary of the different policies and the effectiveness is given below.

The Netherlands

The Dutch Ministry of Agriculture, Nature and Food Quality has formulated a target concerning the environment and the protection of crops: a 95% reduction of the environmental impact to surface waters in 2010 compared to 1998, in an economically sound way (maintaining the competitive position).

In order to reach this target the Ministry has formulated a memorandum (Nota Duurzame Gewasbescherming) with a dual approach: the implementation of admission and environmental policies in line with European policies and joint efforts of involved parties. The latter is realized via a formal agreement with 7 other relevant parties (Overeenkomst Duurzame Gewasbescherming, 2003):

- Ministry of Housing, Spatial Planning and the Environment (VROM)
- Association of drinking water companies (VEWIN)
- Association of water boards (Unie van Waterschappen)
- Association of agriculture and horticulture (LTO Nederland)
- The Netherlands Society for Nature and Environment (Stichting Natuur & Milieu)
- Association of pesticide producers (Nefyto)
- Association of pesticide distributors (Agrodis)

The effectiveness of the policy and the agreement in terms of reduced emission of pesticides has been monitored and it can be concluded that crop protection has become more environmental friendly. In 2005 an 86% reduction was reached: mainly via measures aimed directly at reduced emission (Lozingenbesluit Open Teelt en Veehouderij) such as no-crop zones along surface water en emission reducing equipment (MNP, 2006). Also, changes have been made to the package of authorised pesticides (90 substances were taken of the market). The intermediate goal was set at 75% which has been sufficiently realized. The reduction in 2006 compared to 2005 was 10% (MNP, 2008).

The quality of surface waters used for the production of drinking water has improved, but the intermediate target of 50% reduction in the number of drinking water problems – exceedance of the drinking water standard at site of abstraction - has not been achieved. In 2005 a reduction of 18% has been reached. The reduction can be fully attributed to the prohibition of three types of pesticides in the Netherlands: atrazine, diuron and simazin. Illegal use in the Netherlands cannot be ruled out completely, however when the Meuse crosses the Dutch border, atrazine and diuron are already present. It is suspected that 27% of the problems concerning drinking water have an origin outside the Netherlands.

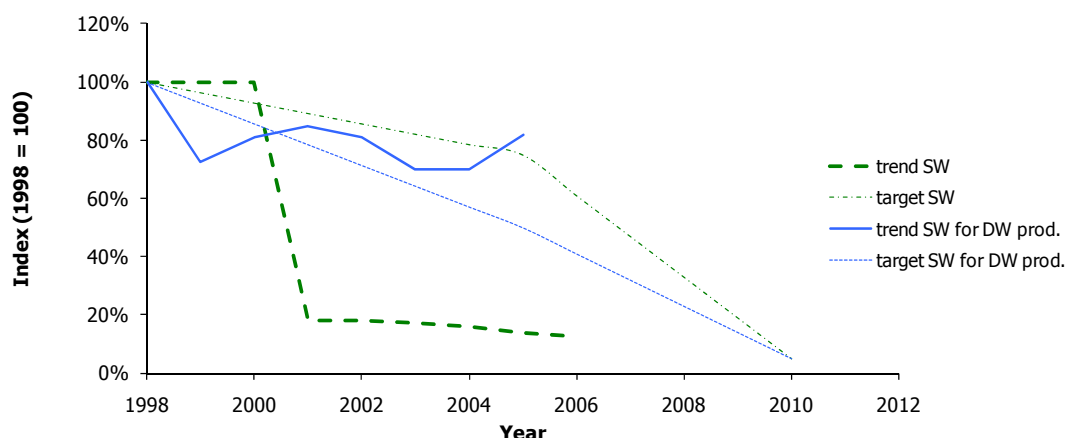


Figure A12.1: Reduction environmental impact of pesticides to Dutch surface water (exceedence norms)

Germany

The Germany Ministry Food, Agriculture and Consumer Protection has formulated a policy that is very similar: the *Reduction Program Chemical Plant Protection* (2004) and the *National Action Plan on Sustainable Use of Plant Protection Products* (2008). The focus is on risk reduction rather than formulating specific targets on quantity reduction: it takes the relation between risk level and applied volumes of chemicals into account. Germany's plant protection policies have reduced to risk to the natural environment by more than 50% - in some cases by as much as 90% - since 1987 (BMVEL, 2008). Specific policies regarding pesticide use in relation to the drinking water function of surface waters and the corresponding monitoring data could not be found.

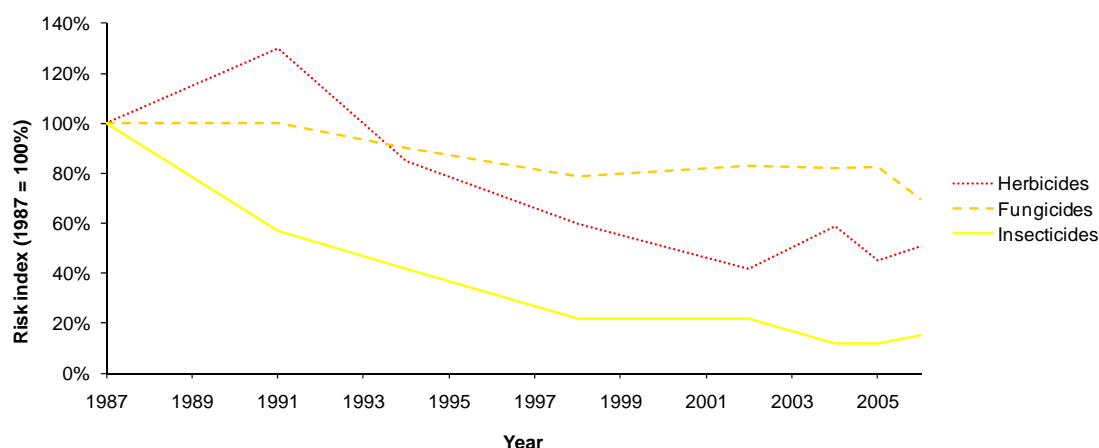


Figure A12.2: Trends in risk for aquatic environment (adapted from BMVEL, 2008)

Belgium

Until 2005 no national plan toward reduced pesticide use existed in Belgium. Therefore the Federal Government has formulated the *Program for Reduction of Pesticides and Biocides* (FOV, 2005), which aims at a 50% reduction of the impact of pesticides to the environment.

Besides specific measures aimed at reducing the professional use and consequences of pesticides, the Federal government has also launched a campaign to reduce the home-use of pesticides by the general public.

In Flanders the spreading equivalent (Seq) is used, which is a measure for the emission of pesticides corrected for differences in eco-toxicity and *verblijftijd*. The year 1990 is used as reference level. In 2005 the achieved reduction was 47% (or index level of 53%) so the formulated target has not been reached (FOV, 2006).

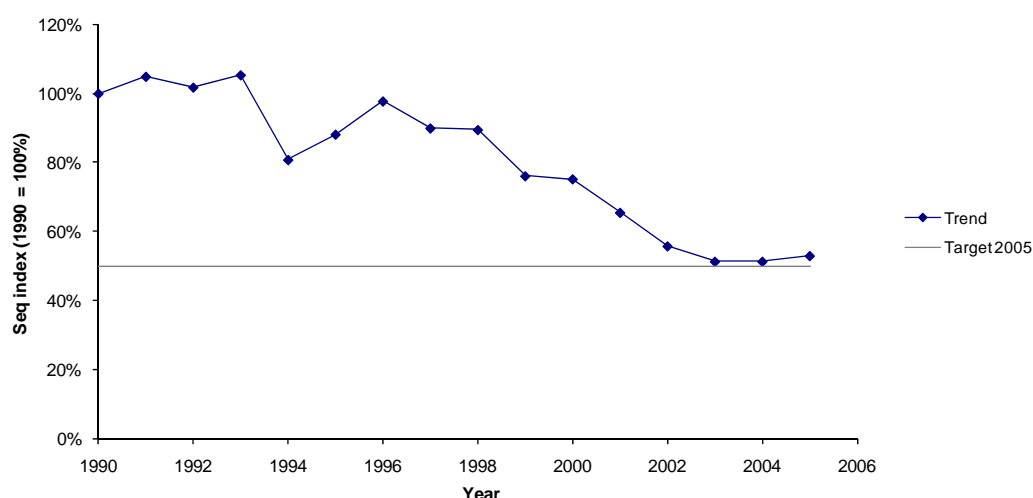


Figure A12.3: Spreading equivalent pesticides Flanders (adapted from de Smet et al., 2002 and Verbank 2006)

Information regarding trends in the spreading and/or risks associated with pesticide use in Walloon was not found. The only practical indicator available is the number of measurements exceeding the norm for concentrations of specific pesticides in surface waters. A reduction in the number of measurements exceeding the norms can be distinguished, which yields the conclusion that the emission of pesticides to surface waters is reduced. However, this yields no information regarding the achievement of targets set by the federal reduction program.

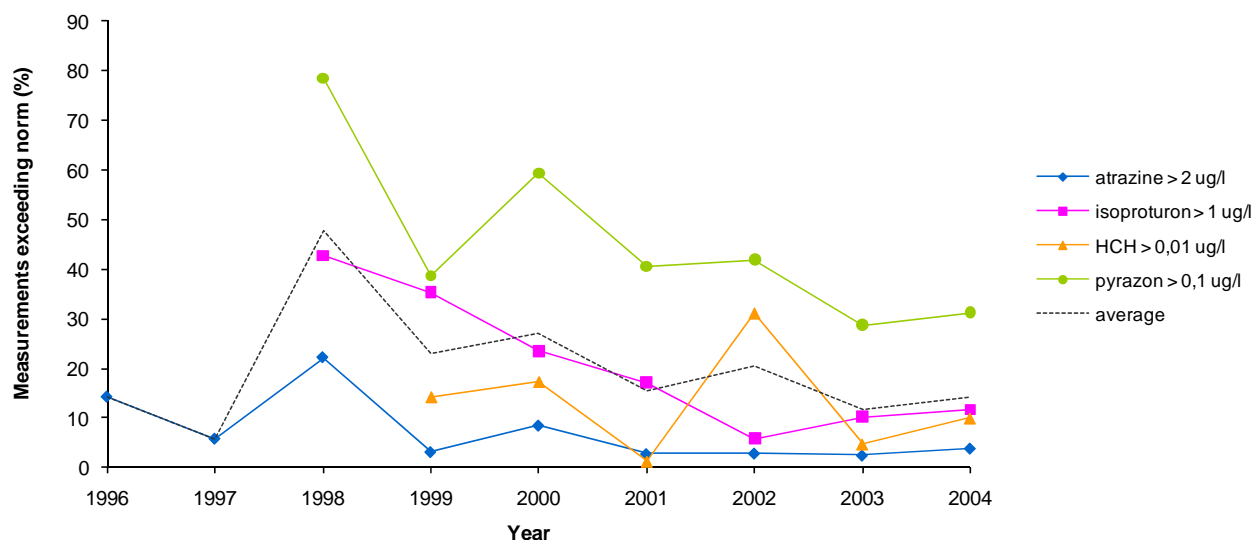


Figure A12.4: percentage of Walloon surface water samples exceeding the norms for pesticides (adapted from Chalon et al., 2006).

France

France is the top user of pesticides in Europe (Scheuer, 2006). Pesticides are found in 80% of the surface water measuring stations and in 57% of ground water measuring stations. Plan Ecophyto 2018, an interministerial plan was launched to reduce the use and risks associated with pesticides by 50% in 2018 compared to 2008 (la Ministère de L'agriculture, 2008).

From 1998 France has monitored the occurrence of pesticides in waters. Based on the found concentrations the water body receives a quality label that can vary from very good (<0,1 µg/l) to very poor (>2,0 µg/l). A positive trend in water quality regarding pesticides can be distinguished.

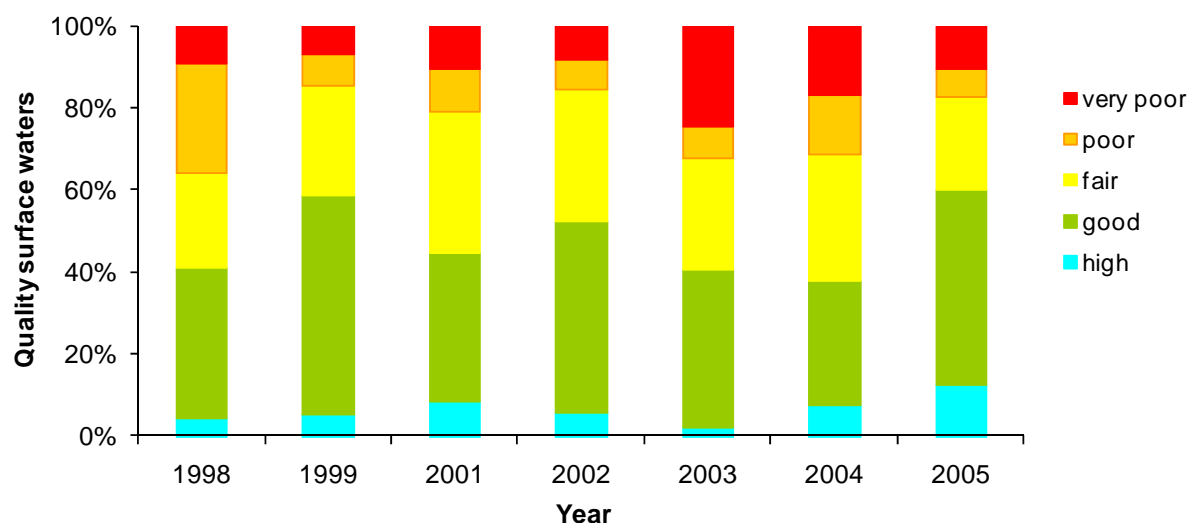


Figure A12.6: Quality French surface water regarding pesticides (adapted from Ifen, 2000/2003/2006/2007)

ANNEX 13: Preventative measures – pharmaceuticals

Since 2006 The EU is trying to include some pharmaceuticals on the list of Priority Substances (Rademaker en de Lange, 2009). If a pharmaceutical is included on the list, member states have to develop emission reducing measures within 5 years. The policy making on the European level depends on a sound risk-assessment of the specific substances. The effects on soil- and aquatic organisms of some pharmaceuticals have been investigated. However, for many pharmaceuticals information regarding the environmental impact is not yet available.

Fortunately, the Dutch government had adopted a pro-active approach and is currently investigating the possible measures for reducing the emission of pharmaceuticals. Actual policies and/or legislation have not been developed yet.

The Netherlands

In 2002 Kiwa WR, RIWA and RIVM have monitored the presence of pharmaceuticals in surface water, ground water and drinking water in relation to possible risks for public health. The RIVM considers it unlikely that the concentrations found in drinking water affect public health. The ministry of VROM shares this opinion; however in 2004 a commission was installed and assigned with the task of investigating the emission routes to the aquatic environment (TK, 2007). The commission has proposed several measures to reduce the emission of human and veterinary pharmaceuticals to surface and groundwater, mostly of an exploring character. In general the measures aim at:

- restricting the use and the stopping of unnecessary use of pharmaceuticals,
- increasing the awareness for environmental friendly disposal of unused medication,
- production and consumption of pharmaceuticals with reduced environmental impact (Green Pharmacy),
- improved access to information regarding the environmental impact of admitted pharmaceuticals,
- advanced and alternative wastewater treatment approaches.

Agreements will be made with drinking water companies, health and social services sector and the pharmaceutical industry in order to reduce the environmental impact of emitted pharmaceuticals.

The Green Pharmacy concept focuses on an environmental-friendly production of pharmaceuticals. According to the pharmaceutical industry, the design of pharmaceuticals increasingly incorporates environmental aspects such as the degradability. Unfortunately no information regarding Green Pharmacy, plans, pilot projects or outcomes was found.

Increasing the public awareness about the negative impact of pharmaceuticals to the environment might lead to a more eco-friendly disposal of unused medication. Unused pharmaceuticals can be returned to the pharmacist instead of being flushed through the toilet. Furthermore, encouraging the public to be conservative in usage of pharmaceuticals, or promote the use of more eco friendly alternatives will have a positive contribution in reducing the emission.

The reduction of the emission of human pharmaceuticals at the source is very complex. Since the majority of the emission is caused by the discharge of treated municipal wastewater, it makes sense to investigate the possibilities for advanced treatment. However, advanced treatment capable of removing pharmaceuticals requires large investments: several extra treatment steps are required. Furthermore, does it make sense from an economical point of view to treat the wastewater to such a level that it contains no pharmaceuticals? In fact, one could state that the discharged water has a quality that is comparable to drinking water.

In table A13.1 below a complete overview of the proposed measures can be found.

Table A13.1: proposed measures for emission reduction pesticides

Humane geneesmiddelen	
Stimuleren restrictief gebruik humane geneesmiddelen	Uitvoeren project "Doelmatig geneesmiddelengebruik" door het – Vragen Nederlands Instituut voor Verantwoord Geneesmiddelengebruik (DGV) – advies aan Stichting Werkgroep AntibioticaBeleid over emissiereducerende Het milieu maatregelen van antibiotica naar milieu en voorlichting daarover. – als extra criterium laten meeliften bij voorlichtingsprogramma's ter vermindering van het geneesmiddelengebruik.
Stimuleren afweging milieu bij voorschrijven	Evaluëren van Zweeds milieuclassificatiesysteem voor toepassing in NL.
Emissiereductie uit zorginstellingen	Uitvoeren van haalbaarheidstudie en pilots naar – emissiereducerende maatregelen in ziekenhuizen en zorginstellingen.
Kortdurende kuurspecifieke inzameling van urine.	Uitvoeren van haalbaarheidstudie en pilots naar inzameling van – urine van patiënten die een kortdurende kuurspecifieke behandeling ondergaan.
Extra zuiverings-stap rioolwater-zuiveringen	Uitvoeren van pilots naar vergaande zuivering van geneesmiddelen – in rioolwaterzuiveringen door mee te liften met maatregelenpakket van Kaderrichtlijn Water.
Humane en diergeneesmiddelen	
"Green Pharmacy"	Inventarisatie van kansrijke verbeterpunten op milieu binnen – "Green Pharmacy" samen met farmaceutische industrie.
Milieubewuste afgifte van niet-gebruikte medicijnen	Uitvoeren van voorlichtingscampagne om de mogelijkheden – voor milieubewuste afgifte van niet-gebruikte humane en diergeneesmiddelen Uitvoeren van onder de aandacht van de verschillende sectoren te brengen. – haalbaarheidstudie naar (wettelijke) mogelijkheden om zogenaamd "uitponden" van diergeneesmiddelen mogelijk te maken en kleine hoeveelheden restmedicijnen milieubewust te laten afvoeren via chemobox of dierenarts.
Milieubeoordelingen (dier)geneesmiddelen	Het nastreven van harmonisatie bij de milieubeoordeling in de – lidstaten door het bepleiten van harde afwijscriteria bij de Europese Commissie. Nederland deed dit al in 2006 en zal dit nogmaals bepleiten in 2007.
Diergeneesmiddelen	
Stimuleren restrictief gebruik diergeneesmiddelen	Uitvoeren van voorlichtingscampagne om ondoelmatig – Uitvoeren van antibioticagebruik in de veehouderij te voorkomen. – haalbaarheidsstudie en pilots naar kosteneffectieve maatregelen ter verdere optimalisering van dosering/wijze van toediening
Duurzame ontwikkeling in veehouderij.	Stimuleren van preventie van ziekten en duurzame ontwikkeling – van ziektevirje

	productieketens
Duurzame ontwikkeling in consumptievis en siervisteelt.	Het optimaal benutten van de wettelijke kaders om noodzakelijk – Het middelen bij het kweken van consumptie- en siervis op de markt te brengen. – ontwikkelen van een gedragscode voor duurzaam kweken/verhandelen van siervis.
Acties voor geneesmiddelen met aantoonbare milieuhygiënische gevolgen	
Emissiereductie van de joodhoudende röntgencontrastmiddelen (jopamidol en amidotrizoiënezuur) en anti-epilepticum (carbamazepine)	Convenant tussen overheid, farmaceutische industrie, zorgsector – en drinkwaterbedrijven dat gericht is op het stimuleren van een betere milieuverdienste van geneesmiddelen die de bereiding van schoon drinkwater verstoren.
Emissiereductie van actieve stof (17 α -ethinyloestradiol) in anti-conceptiepil	Convenant tussen overheid, farmaceutische industrie en – waterschappen dat gericht is op het stimuleren van een verdere emissiereductie naar het watermilieu van de synthetische hormonen bij anticonceptie.

Separate urine collection

Urine makes up only 1% of the wastewater flow while containing almost 100% of the total amount of pharmaceuticals. When flushing a toilet the small concentrated stream of urine is diluted with drinking water. The transport of the diluted wastewater requires energy and at the end of the cycle an extra energy input is required to separate the water and waste (van den Berg, 2002). This makes little sense from an environmental, technological and economical point of view but is the result of the course of history. The costs for collecting and treating relatively small but concentrated wastewater streams are relatively low compared to large diluted conventional wastewater streams (Scheffer, 2007).

Fortunately increased awareness of this issue has resulted in increase interests for alternatives to conventional wastewater collection and treatment. Sweden is leading the development of separate urine collection: over 20.000 separation toilets have been installed. In several apartment buildings in Stockholm urine is collected separately and stored in reservoirs. Faecal matter and 'grey water' are discharged to the sewer and transported to the wastewater treatment plant.

From 2003 to 2006, a demonstration project (Sanitation Concepts for Separate Treatment) co-financed by the European Commission was carried out. Two different concepts were tested and compared: gravity separation toilets and vacuum separation toilets (see figure below), to determine the concepts are more sustainable compared to conventional sanitation systems, particularly with regard to nutrient recycling. Both systems showed an acceptable performance but substantial enhancements are required, particularly with regard to the flushing mechanisms. It was calculated that the operating costs of the new sanitation concepts are lower than those of conventional systems, due to the win of biogas from the digestion processes. The investment costs however are not lower because the installations inside and outside the houses require high effort. For more information the reader is referred to Peter-Fröhlich et al (2007).

Advanced post-treatment of wastewater

Instead of redefining and designing of the collection of wastewater, advanced post-treatment of wastewater could be an option. As stated before, advanced post-treatment of wastewater for removal of organic micropollutants requires multiple treatment steps: currently no technology exists that can remove all types of micropollutants.

Post-treatment of the effluent of a Swiss municipal wastewater treatment plant by ozonization followed by sand filtration, removed 40-80% of the remaining pharmaceuticals (depending on the characteristics of the specific pharmaceutical) (Hollender et al., 2009). Post-treatment using a Membrane bioreactor (MBR) can also remove pharmaceuticals, with removal efficiencies depending on the characteristics of the pharmaceuticals and the design of the MBR (Cirja et al., 2007).

A promising new concept is the *1-step filter* that is developed by the engineering company Witteveen + Bos, Norit, Delft University of Technology and Watercycle Company Waternet. The 1-step filter is a cylindrical reactor filled with activated carbon that removes nitrogen, phosphate, heavy metals and pharmaceutical residues. A coagulant (AlCl_3) is added to the pre-treated wastewater, which results in deposition of phosphate flocks that cannot pass through the filter bed. Heavy metals are also incorporated into the formed flocks. Methanol is added as a food source for denitrifying bacteria that are present in the filter bed and convert nitrate to nitrogen gas. Furthermore, pharmaceutical residues, hormones and remaining heavy metals are adsorbed onto the activated carbon (van de Sandt, 2009).

Pilot scale experiments have been performed at the wastewater treatment plant Horstermeer. The results showed a large removal of phosphate, nitrate and priority substances. A full scale reactor with a capacity of 1500 m³/hr will be taken into operation in 2012. The primary focus of the full scale reactor however, is removal of nitrate and phosphate. The granular activated carbon should be replaced every 6-12 months if removal of organic micropollutants is to be achieved. Otherwise the filter bed is expected to last as long as a conventional sand filter bed.

