Living with water: not without Water Statistics[1]

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1. Introduction

Since the beginning of the seventies of the previous century Water Statistics in the Netherlands has established itself as an important and increasing source of information for Dutch water policies. This paper provides a review of the management of water along the main water related issues within the country. It will deal with the organization and policies in water and water management. Moreover, use and application of Water Statistics and Water Accounts currently compiled by Statistics Netherlands, the resulting indicators, and its uses for policy making and research will be discussed.

The outline of this paper is as follows: After this introduction, chapter 2 continues with a brief description and categorization of water management activities in the Netherlands including the past and current issues and problems related to water management, the water governance, the main national and international rules and legislation being applied in water management, and Integrated Water Resource Management (IWRM). Chapter 3 continues with a description of Water Statistics and Water Accounts in the Netherlands, the policy cycle and its subsequent stages and the relation between water policy and Water Statistics. In particular it looks in detail after the different stages in the policy cycle and the connected data and statistics. Chapter 4 presents examples of statistics and statistical indicators in use for water policy making and policy evaluation. In chapter 5 the direct and more indirect application of statistical indices in water management, research and policy is described. Finally, chapter 6 finishes the paper and draws major conclusions and some recommendations for future work.

2. Water Management in the Netherlands

2.1 Water related problems and issues

The Netherlands has a long experience in managing water. It is a low-lying, densely populated country in the delta of four European rivers: the Rhine, the Meuse, The Scheldt and the Ems, all flow into the North Sea catchment area (Warmer & van Dokkum, 2002). Of its total surface (41,000 km2), one third lies below mean sea level and two third of the country would regularly be flooded if there were no dikes (Huisman, 2004, Warmer & van Dokkum, 2002). For centuries, the Dutchmen had to learn to live with water. Regularly the Netherlands is confronted with problems related to water. Generally these problems can be divided into five main issues or tasks, as is[2]:

[1] Acknowledgements: we would like to thank our colleagues Kees Olsthoorn, Sjoerd Schenau, Bram Edens and Maarten van Rossum for their contribution and helpful comments to this paper.

[2] The 26 water boards in the country play major role in these tasks (UvW, 2010).

1. Safety, protection against flooding;
2. Water management, Excess of water,
3. Water management, lack of water, water resources and water use;
4. Water pollution;
5. Water quality.

Flooding can threaten a large part of the population, or can either cause major damage to the economy in the Netherlands (Klijn et al, 2007). Therefore protection against high water from the sea or from the rivers has been and will always be priority number one. After the flood of 1953 along the coast of the North sea, the government decided to improve the 'water defense system' in order to prevent such huge flood to happen never again, and as a result initiated the Delta plan and the Delta Act (Min. V&W, 1958) with a number of huge projects for establishment of large preventive structures. The floods of the Rhine and Meuse in 1993 and 1995 resulted in a new Delta Plan and the Delta Act on Large Rivers (Min V&W, 1995). Due to changing climate, with enhanced weather extremes, 'water storage facilitation' and 'room for water' along the rivers, has gained attention in policy. From 2000 onwards, several policy documents and protection programs were issued. Among those the findings of the Second Delta committee ('Veerman') of 2008. This Delta Committee expressed its opinion and formulated a list of detailed recommendations on how to protect against water and to ensure fresh water supply for the country in the long run (Delta Committee, 2008).

Excess of water (major flooding excluded) is often a local and temporal problem. This concerns the strive to keep the water levels as close as possible to the preferred and agreed water level among the different stakeholders. Because that is a condition to keep 'dry feet' in order to live, work, and enjoy life. The water boards are mainly responsible for maintaining the agreed water level.

Sometimes local flooding occurs caused by short but extreme rainfall or long lasting rainfall and saturated soils. In lower areas the vulnerability for flooding increases by ongoing subsidence of the soil. (Min. V&W, VROM and LNV, 2009).

On the other hand water shortages, with lacking water resources in the Netherlands can be a problem too. Currently, water shortages especially are observed in summer periods. Agriculture potentially suffers the largest economic losses annually. But also in inland shipping and to a lesser extent in electricity production damage occurs. Nature also experienced damage. As a result of climate change situations with water shortage may become more frequent in which case the government must take action more often in order to distribute the available fresh water to different sectors (agriculture, drinking water, energy, industry/cooling, and shipping) and regions. During periods with droughts and water shortage the salt water intrusion will go further inland, affecting ecosystems and agriculture (Min. V&W, VROM and LNV, 2009; Delta Committee, 2008).

Water pollution means the water is contaminated with (toxic) substances particularly from human origin. This can cause serious damage to aquatic life. Polluted water can also affect and contaminate the sediment underwater. During the last four decades the pollution from point sources like industries and Urban Waste Water Treatment Plants (UWWTP's) has decreased significantly due to many measures. As a result, water quality now has been substantially improved. However, diffuse sources of pollution, like agriculture, corrosion processes and/or atmospheric deposition increasingly dominate the load to surface waters and cause breaches of water quality objectives (Min. V&W, VROM and LNV, 2009).

The quality of surface water and groundwater is important for the functioning of eco-systems and functions like resource for preparation of drinking water, recreation, irrigation and fishing. In most waters, quality depends on the load of pollutants discharged due to human activities and the import of (foreign) pollution from upstream discharges in the River Basin. Fluxes of pollutants from sediments to water play a major role in deteriorating water quality. In coastal areas, salt intrusion endangers freshwater eco-systems as well as the use of water for irrigation and preparation of drinking water. Another problem is that as a result of radical changes in the morphology of water breaches, like canalization, the diversity in habitats and related species already has decreased (Min. V&W, VROM and LNV, 2009).

2.2 Developments in Water Governance in the Netherlands

In response to national and international water related problems, including disasters like the 1953 flooding, the government issued a succession of policy documents and water acts. In these policies and acts the five main themes or issues as mentioned above can be distinguished. Not being an exhaustive enumeration, table 1 gives an overview of the most important policy documents and legislation, with its major features.

Table 1 Overview of water policy announcements and water legislation in the last four decades.

Year	Title	Major features
1900	Act on Public Water Works	Regulates management of public water works and tasks of the State Water Authority.
1904	Act on land reclamation and polders	Regulates the procedures for- and management of reclaimed land and polders.
1958	Delta Act	Regulates the building of major flood defense structures
1968	1st National Policy document on Water Management	Ensuring the quantitative availability of freshwater; drainage of catchments
1969	Pollution of Surface Water Act	Regulates discharges; introduction of Pollution Levy
1975	Pollution of Sea water Act	Regulates discharges to the marine environment
1975	Indicative multi-year program Water 1975-1979	Measures for combating water pollution 1975-1979
1981	Indicative multi-year program Water 1980-1984	Measures for combating water pollution 1980-1984; setting standards for water quality in order to protect ecological and human functions
1981	Ground water Act	Regulates abstraction of ground water and infiltration
1984	2nd National Policy document on Water Management (NW2)	Ensuring availability of water of good quality for all uses; some relations with nature and environment included.
1985	Living with Water: towards integral water policy	Introduction of IWRM
1985	Indicative Multi-year Program Water 1985-1989	Meaures for good functioning of the whole water system
1987	Rhine Action Program	Reduction of pollution from sources in the Rhine river basin
1989	Water Management Act	Regulates quantative water management
1989	3rd National Policy Document on Water Management (NW3)	Implementation of IWRM
1991	Northsea Action Program	Reduction of pollution loads to the Northsea
1994	Evalution report 3rd National Policy Document on Water Management	Partial Revision of NW3; strong focus on reduction of emissions and recovery of natural values of water systems
1995	Delta act on large rivers	Regulates measures to reduce the risk of floodings along the large rivers.
1996	Act on primary water defence structures	Regulates the building and maintenance of the primary dams and dikes
1997	4th National Policy Document on Water Management (NW4)	Strengthening of NW3; focus on safety; regional water shortages; diffuse pollution; polluted sediments
1999	Action program on Diffuse Sources of Water Pollution	Formulating measures to reduce diffuse pollution
2003	National Government Agreement on Water	Treaty between all national and regional governments, formulating a common approach for managing water systems.
2007	Implementation Program On Diffuse Sources of Water Pollution	Strengthening of 1999 Action Program
2009	Water Act	Integrated act covering all water aspects
2009	National Waterplan	Planning and implementation of water policy for period 2009-2015; includes River Basin Management Plans

Source: www.helpdeskwater.nl.

Most of the policy documents and Acts are partially a result of the implementation of EU Directives, like the Dangerous Substances Directive, the Urban Waste Water Treatment Directive (UWWTD), the Nitrates Directive, the Integrated Pollution Prevention and Control Directive (IPPC) and the Water Framework Directive (WFD) (Eurostat, 2010) Also many measures are a response to international agreements, e.g. in the framework of Oslo Paris Commission (North sea), Helsinki Commission (HELCOM), the MARPOL convention or the International Commission for Protection of the River Rhine.

2.3 Integrated Water Resource Management (IWRM) in the Netherlands

While until the eighties, water policies and management mainly focused on just one theme, step by step water management became more integrated, finally resulting in a real integrated approach[3]. With the publication of the Third National Policy Document on Water Management in 1989 (Min. V&W, 1989), IWRM became an official part of Dutch Water Policy. Central in the IWRM-approach in the Netherlands is the recognition that ecologically healthy and sound functioning water systems are the basis for sustainable use of the available water; the so-called water system approach (Mostert, 2006). From 2000 onwards, water management and policies increasingly oriented themselves on the Water Framework Directive (EC, 2000). This directive requires the EU Member States to prepare river basin management plans and to reach a "good water status" of all its waters by 2015. In 2009, all existing national legislation on water, put down in nine separate acts, was integrated in the new Water Act (Min. V&W, 2009a). Parallel to the implementation of the new Water Act, the government issued the National Water plan, a document in which the water policies for the period 2009-2015 are described. The National Water plan includes also the River Basin Management Plans, formulated as a result of the implementation of the Water Framework Directive (Min. V&W, VROM and LNV, 2009).

3. Water Statistics & Accounts, Water policy and the Policy cycle

3.1 Introduction

Water Statistics and Water Accounts are compiled not only for general purposes or the public. Usually, there is a sense of urgency to start making inventory of certain data, here water relevant data. This need for statistical data will be determined by different stakeholders. The statistical community with the statistical commission in particular identifies and defines the need for certain specific Water Statistics. Policy makers either national or international (European) can have a need for such statistics in context of new policies being put in place. In this chapter the interdependencies between water related problems, policies, and compiling of relevant Water Statistics and Water Accounts are explored.

3.2 Statistics and Accounts

The (physical) Water Statistics in the Netherlands have developed gradually along the main themes/ policies in water management in the last forty years. The first major Water Statistics were the 5 yearly inventory of industrial water abstraction and water use. During the seventies, Statistics Netherlands also started with statistics on organic water pollution and Urban Waste Water Treatment (UWWT), in order to provide information on the progress of the pollution abatement policies. Later on, the focus of these statistics was broadened to other substances like nutrients and heavy metals. Also data on the costs and expenditures related to water pollution and water use were inventoried. During the nineties, Statistics Netherlands joined the 'water-part' of the Dutch Emission Inventory (PRTR, Pollutant Release and Transfer register) and methods were developed for additional estimates on industrial point source emissions to water and the sewer system, for all relevant pollutants. In the past ten years, efforts were increased to compile yearly - instead of 5 yearly - data on water abstraction and water use by the various economic sectors.

In the beginning of the 1990s, Statistics Netherlands extended their National Accounts (NA) with a 'satellite account' that includes environmental pressures from the production of goods and services and the consumption by households. This has led to the National Accounting Matrix including Environmental

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[3] According tot the Global Water Partnership (2004) IWRM calls for a sustainable management of water resources to ensure that there is enough water for future generations and that water meets appropriate quality standards. An IWRM approach promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Accounts (NAMEA), which deals with a number of environmental issues with both inputs from the environment as well as emissions to the environment. Due to integration of environmental accounts with similar concepts, definition and classification as from the national accounts (2008 SNA (SNA; UN et al, 2009; referred to as 2008 SNA), developments in the field of the environment and macro-economic developments can directly be compared. From both accounts integrated key indicators can be derived that provide insight in the environmental effects of the nation's macro-economic development (see Statline; CBS 2010b). The integrated nature of both systems allows quantifying and analyzing underlying causes of changes in environmental indicators.

Part of the development of Environmental Accounts, was the set up of a dedicated account for water, the NAMWA, the National Accounting Matrix including Water Accounts (Brouwer, et al., 2005). These Water Accounts consist of quantity and quality aspects and combine physical and monetary aspects, in an integrated manner.

One difference between Environmental Statistics including Water Statistics and Environmental Accounts including Water Accounts is that the accounts follow the residence concept that underlies the NA. An institutional unit is denominated resident within the economic territory of a country if it maintains a centre of predominant economic interest in that territory. GDP is an aggregate measure of production by all resident units. However, some of this production may occur abroad and as a result GDP differs from the sum of all production that takes place within the geographic boundaries of the national economy. Likewise, the Environmental Accounts record, for instance, air emissions as a result of activities of residents. These emissions differ from the emissions occurring on Dutch territory and recorded normally in Environment Statistics. Differences therefore primarily arise as a result of international transport and tourism (CBS, 2010a).

International context of Water Statistics and Water Accounts (kort houden)

The international demand for Water Statistics and Water Accounts generally has lead to several standard formats and frameworks for compilation of data. For physical water data, the OECD/Eurostat Joint Questionnaire plays a leading role and its formats and definitions are used also in the Netherlands. Completion of this questionnaire is not legally obliged but is regulated via a Gentleman's Agreement.

For Water Accounts standardised reporting is done by request of the United Nations (UN) according to the standard reporting tables. This is a joint UNSD/UNEP biennial questionnaire. In context of the Water Framework Directive (WFD), progress for the Netherlands on the agreed objectives is reported by Rijkswaterstaat Centre for watermanagement (Waterdienst) of the Dutch Ministry of Infrastructure and the Environment. For this purpose Statistics Netherlands provide detailed data derived from the Water Accounts, at an annual basis. At an Ad Hoc basis requests are communicated from international partners (UN, Eurostat, EEA) for data derived from Water Accounts for analysis and reporting purposes.

An important recent development is the adoption of the International Recommendations for Water Statistics (IRWS), reflecting a multi-purpose framework for (further) "establishment and strengthening of an information system for water in support of integrated water resource management" (UNSD, 2010). More specific, the recommendations: "(a) support the collection, compilation and dissemination of internationally comparable water statistics in countries; (b) support the implementation of the SEEAW; (c) provide the necessary information for deriving coherent and consistent indicators, enabling comparisons over time and between countries from an agreed list of data items" (UNSD, 2010). Concepts and definition of international data collection formats are largely applied already in Dutch Water Statistics and Water Accounts today. Implementation of the recommendations wouldn't affect current practice so much and is preferred.

In 2009 the Ministerial Council Meeting of the Organisation for Economic Co-operation and

Development (OECD) committed itself to a green growth strategy (OECD, CBS 2011). According to the OECD, green growth is about: "foster[s] economic growth and development while ensuring that the quality and quantity of natural assets can continue to provide the environmental services on which our well-being relies. It is also about fostering investment, competition and innovation which will underpin sustained growth and give rise to new economic opportunities (OECD, 2011). The Green growth strategy provides both a policy strategy for implementing this economic transformation and a monitoring framework with a proposed set of indicators. In a recent report made by Statistics Netherlands (CBS, 2011), a first attempt has been made to present a selection of these indicators for the Netherlands. The report contains also an indicator on the water use intensity of tap water in industry (see also chapter 4.3).

3.3 The regional component of Water Statistics and Water Accounts

Traditionally most of the Water Statistics provided national and regional (NUTS-2) data. With the coming into force of the Water Framework Directive, the challenge was to compile statistics at the level of (sub)-River Basins so data could be used for the River Basin Management Plans. For UWWTP statistics and industrial emissions this was established by making use of the GIS layers of the Emission Inventory/PRTR database. Recently also methods were developed to compile the data on the abstraction and use of water at the level of (sub-)River Basins (Baas & Graveland, 2011). In 2011, Statistics Netherlands has started a project to compile a physical water balance per River Basin.

Figure 1 The Dutch main river basins

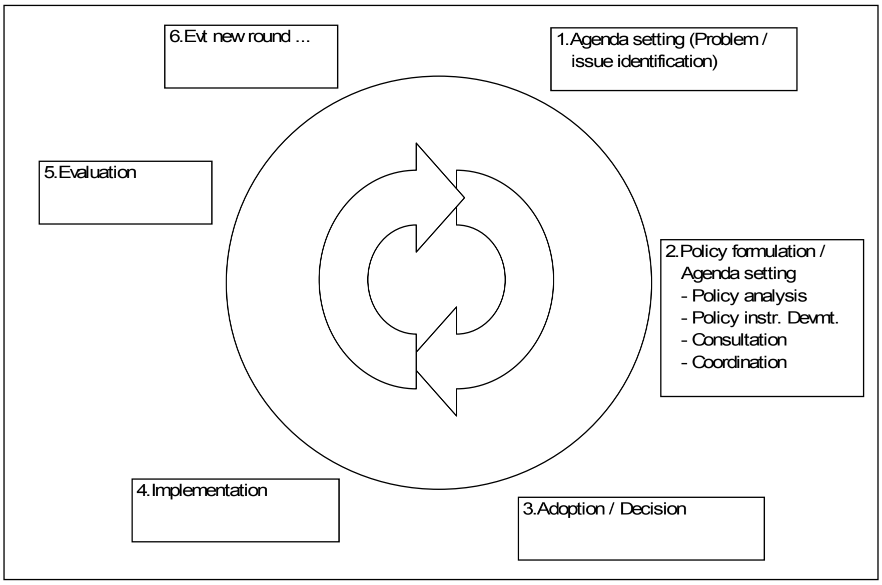
In addition, NAMWARIB, 'National Accounting Matrix including Water Accounts for River Basins', is developed. It provides economic information as well as information on water pollution at the level of the seven (sub-)river basin districts in the Netherlands with Rhine, Meuse, Scheldt and Ems (Brouwer, et al., 2005). Because the Rhine basin covers approximately 70 percent of the entire Dutch territory, this basin is split into four sub river basin districts (figure 1). The NAMWARIB is compiled by Statistics Netherlands in cooperation with and by order of the National Water Authority (Rijkswaterstaat) and is used for economic analysis per River Basin in the framework of the WFD (CBS, 2009).

3.4 Policy cycle

In the process of identifying water related problems and developing and analyzing forthcoming policies often the concept of the 'policy cycle' is applied. The 'policy cycle' concept provides a general framework that supports policy making and analysis, without the prescription of a rigid format. A variety of representations of the 'policy cycle' exists. Here we choose to combine a few in order to find a suitable format for water and water policies. In general the 'policy cycle' consists of a number of stages (figure 2), starting with identification of the observed problem(s) and issues, via formulation of the policy that will be needed in order to come up with ideas and possible solution for the observed problems. The next steps are subsequently the selection of the proposed policy and policy instruments and the adoption of those instruments, via implementation of the policy measures. Finally after a while, when the policy has run for some time, the evaluation of the policy and measures closes the cycle. Eventually, the described cycle of events can get a follow-up, when problems/issues remain or new problems were identified that do require additional response by policymakers or from society. Running a new policy cycle not necessarily means that existing policies cannot be continued. However there may be reasons to just somehow adjust the policies already in place.

Principally for each of the five main water issues a separate cycle can be designed and run. However as activities related to water issues increasingly are based on the IWRM philosophy, it is presumably better to apply for an integrated policy cycle in which policies can be analyzed in an integrated manner. Integrated in the sense that policies taking care for one or few of the five relevant issues can and should be dealt with in conjunction.

Figure 2 Policy cycle application to the (five) water related main issues



Source: adapted from 'public policy theory' incl..Althaus, et al. (2007); Koundouraki, (2007).

Generally, for describing and analyzing environmental problems use is made of the Driving forces Pressure State Impact Response (DPSIR) framework. With the Water Accounts, driving forces for the environmental pressures to the water system, as economic activities by industry and households are determined. The driving forces exert a variety of pressures to the water system, such as water extraction from - and emissions of pollutants to - ground and surface water. NAMWA also contains a water balance that shows the quantitative inputs and outputs. The driver and pressures data are also made available at the level of water bodies and river basin districts (RBDs), allowing a more detailed and dedicated analysis as required for the newest policies and regulations like the WFD.

With regard to the response part of the DPSIR framework, the water related revenues by the different governments, as by the central government, provinces, regional water boards and municipalities are relevant.

These consist of water related revenues by provinces via dividend from water supply companies. Other water related revenues are the water pollution levy, levy for water quantity management (water boards), sewer tax and other environmental taxes (municipalities).

Use of Water Statistics and Water Accounts in water main issues and related policies

We attempt to show the application and use of Water Statistics and Water Accounts and other statistics and accounts connected to water, in the broad area of water related issues and water related policies. Table 2 shows the five main issues and tasks that do relate to water in the Netherlands, and the connection with relevant (Water) Statistics and (Water) Accounts with a primary physical nature or economical nature. These are supposed to be relevant or eventually potentially relevant for water policies. The statistics are assigned to one or eventually more than one of the relevant water issues with details being added on statistical coverage of sector and/or area/region. Also information is added for the stage in the policy cycle the statistical information is used, or can be used. The reasoning behind the five main issues / tasks was explained previously. The table shows the extensive set of statistics that has been developed or either is under development. In particular valuation and ecosystem services aspects were developed right now. Also aspects of the water balance are under development. From this table it can be concluded that most statistics and accounts are used in the stages 1.Agenda setting and stage 5.Evaluation. Although statistical data may probably be used in stage 2 in a more indirect manner, being less transparent to the statisticians.

In the next chapter, the role of Water Statistics in providing relevant information for policy-making and research is discussed.

Table 2 Water related problems / issues, Water Statistics, water policy cycle aspects

Issues / problems:	Waterstatistics / Water Accounts*: Physical; Statistics / Accounts related to water issues: Physical	Waterstatistics / Water Accounts *: Economical; Statistics / Accounts related to water issues: Economical	Major sectors included / industry breakdown	Regional breakdown 1)	Use in policy cycle, stage (agenda, formulation) 2)
Safety against major flooding (risk / damage from water):					
Risk of Flooding;	No stats; Population at risk during major flooding;	Effected population; NA, economic loss in situation of flood;	All	N; P	1. / 2. / 5.
(potential) Damage from flooding; Costs of flooding;	No statistics	(Regional) economic stats; economic performance of area under threat;	All	N; P	1. / 2. / 5.
Prevention against flooding; Costs of preventive measures;	No statistics	Investments / Public expenditures to dams, dikes, barriers, etc.	Public sector	N	4.
Flooding related to Climate Change (CC);	No statistics	Env. Expenditures for mitigation CC / adaptation CC;	Public Sector	N	4.
Excess of water					
Local floodings caused by	Spatial distribution of the population effected;				
Heavy rainfall ;	No statistics	Regional economic statistics;	Agric; transp; tourism; recreation,	N	1. / 2. / 5.
Soil Subsidence;	No statistics	Economic damage / effect on production / value added;	All; individual;	N	1. / 2. / 5.
High groundwater levels due to decrease in abstractions;	No statistics	Value of property over time; (public) costs of continued abstractions;	Public sector	N	2. / 5.
Transport affected by extreme water situation;	Water, rail / road transport, volume of transport, development, by modality;	Production value, intermediary use, productivity, development;	Agriculture; transport	N	2. / 5.
Decoupling of paved area from rainwater sewer system;	No statistics	Investments / Public expenditures for modifying sewer systems;		N; P	4.
Lack of water resources; Water use					
Water use; Water supply;	Statistics on use / supply of tapwater;	Value use / supply tapwater, production value, value of use;	Whole economy;	N; RBD; PWS	2. / 4. / 5.
		Tapwater use per capita; use efficiency;	Indust; Agric; Households	N; RBD	4. / 5.
	Statistics on use / supply of groundwater / surface water;	Value use/supply tapwater, production value, value of use;	Whole economy;	N; RBD	2. / 4. / 5.
		Water use efficiency; use intensity of production; water productivity;	Industry, agriculture	N; RBD	4. / 5.
	Total water consumption**, Physical water trade balance;	Water trade balance; water embodied in products; Virtual water;		N; RBD	1. / 2 / 5.
Water 'use' ('in-situ') in thermoelectric plants;	Use of cooling water; Energy statistics (production);	Production value / value added; Ecosystem service of cooling water;	Energy sector; Industry;	N; RBD	4. / 5.
Water 'use' (in-situ) in hydroelectric plants;	Renewable Energy statistics (production);	Production value of hydro in Renewable Energy;	Energy sector	N	4. / 5.
Depletion of waterresource / stock, groundwater;	Freshwater resource (groundwater); recharge of groundwater;	Value of the groundwater stock and various groundwater flows;	Not specific;	N	1. / 5.
Depletion of waterresource / stock, surface water;	Freshwater resource (surface water); surface water balance;	Costs of research; costs of innovation;	Not specific;	N	1. / 5.
Abstraction of water;	Abstraction of fresh groundwater and surface water; by sector;	Ecosystem service from water; Economic value generated with water;	Agriculture.; Industry; Energy;	N; RBD	4. / 5.
		Investments, costs, subsidies; taxes related to water abstraction;	Agriculture; Industry; Energy;	N; RBD	1. / 2. / 4. / 5.
	Abstraction of marine water;	NA/PS: Investments; costs;	Energy sector; Industry;	N; RBD	4. / 5.
Overexploitatation of waterresources;	Physical balance of freshwater resources;	NA/PS: transfers between private and public actors;	Not specific;	N	1. / 2. / 5.
		Investments, cost, subsidies, taxes related to water infrastructure;	Building; public sector	N	4. / 5.
		Value of exports and imports of water; value of losses;	Whole economy	N	1. / 5.
	Waterbalance: Total return of water to the environment ***;	Waterbalance: Total return of water to the environment ***;	Not specific;	N	1. / ?
Irrigation/ water use in agriculture and horticulture;	Area irrigated / non-irrigated; Abstraction for irrigation;	Costs of irrigation, production irrigated / non-irrigated agriculture;	Agriculture;	RBD	1. / 4. / 5.
Desiccation of nature conservation areas;	Abstraction; resource (stocks); internal flow; water exploitation;	Values, valuation;	Nature;	N	4. / 5.
Low water levels in rivers hampers water transportation;	No statistics, influence on barge kilometers;	Economic impact of less barge kilometers	Transport;	N	2. / 5.
Heat / cold storage and geo-energy via abstraction/injection;	Renewable energy statistics;	Production value; production costs, value added;	Not specific;	N	2. / 4. / 5.
Ecosystem services derived from water;	Services generated at North Sea, coastal area, rivers, etc.;	Value generated at North Sea, coastal area, rivers, etc.		N	1. / 2. / 5.
Development of quality of life connected to water;	Various statistics / accounts ie on leisure;	Various statistics / accounts ie on spending;		N	1. / 5.
Water pollution:					
Contamination of ground and/or surface water with substances by					
- point sources;	Urban WW collecting systems; connection rates resident population;	Supply of WW to sewer system; WW supply to other economic units;	Industry; households	N; WB; P	1. / 4. / 5.
	WW collecting and treatment systems; type of treatment;	Investments, costs, subsidies; taxes related to NACE 37	UWWTP's	N; WB; P	1. / 4. / 5.
	UWWTP statistics;	NA: Sewer tax; Levies on water pollution; WW treatment g.ment;	Industry; UWWTP's	N; RBD; WB; P	1. / 4. / 5.
	Industry PRTR point sources plus additional estimates;	EA - EGSS: wastewater treatment services; NA: Environmental taxes;	Industry; households	N: RBD; P	1. / 4. / 5.
		NA: economics; compensation of empl, production value, value added;	Industry	N	1. / 4. / 5.
- diffuse sources;	No statistics; PRTR uses activity data;	No statistics; NA: Polder-board levies;	Transport; corrrosion processes	N; RBD; WB; P	1. / 4. / 5.
- transfers from air or soil to water;	No statistics; via other insititutes (PRTR cooperation);	No statistics;	Agriculture; Industry	N; RBD; WB; P	1. / 4. / 5.
Release of heat (cooling water);	Abstraction of surface water; Energy Statistics;	NA: Levies on water pollution; Monetary Energy Statistics;	Power plants; industry	N: RBD	1. / 4. / 5.
Biological contamination;	No statistics;	No statistics; NA: Sewerage charges; Levies on water pollution;	UWWTP's; Sewer overflows	N	1. / 4. / 5.
Spatial: Regional pollution; Pollution by River Basin;	Regional Water accounts, NAMWARIB;	Regional Water accounts, NAMWARIB;	Whole economy	N; RBD	1. / 4. / 5.
Water quality					
Salt intrusion;	Abstraction & recharge of groundwater;	Payment of groundwatertax, provincial groundwaterlevies, economic impact	Agriculture; recreation; nature		1. / 5.
Water pollution induced human / animal health problems;	No statistics;	NA: Sewerage charges; Levies on water pollution;	Healthcare		1.
Recreational Water Quality / Swimming (bathing) Water Quality;	No statistics;	No;			
Aquaculture / fish farming / fishery;	Production value;	Production value;	Agriculture; recreation; nature		1.
Polluted sediments;	No statistics;	No statistics;			
Changes in morphology; canalization of water breaches;	No statistics;	No statistics;			

1) Abbreviations: RBD = River Basin District; WB = Waterboard; P = Provinces (NUTS-2); PWS = Public Water Supply companies.
2) Abbreviations: 1. = Agenda setting; 2 = Policy formulaition; 3 = Adoption / decision; 4 = Implementation of measures; 5. = Evalution.
NA = National Accounts; EGSS = Environmental Goods and services Sector (part of satelite Accounts: Environmental Accounts); EA = Environmental Accounts;
NO = Not available; WW = Wastewater; WVO (Dutch acronym for Wet verontreiniging oppervlaktewater = Pollution of Surface Waters Act;PS: Production statistics;
* Can be a problem / issue itself or on related Drivers, Pressures, State, Impact Respons from DPSIR - framework;
** Total water consumption: difference between total water supply & total water use.
*** Total net return of water / returned water: is water before or without use.

Source: CBS.

4. Statistical indicators used in water management and -policy

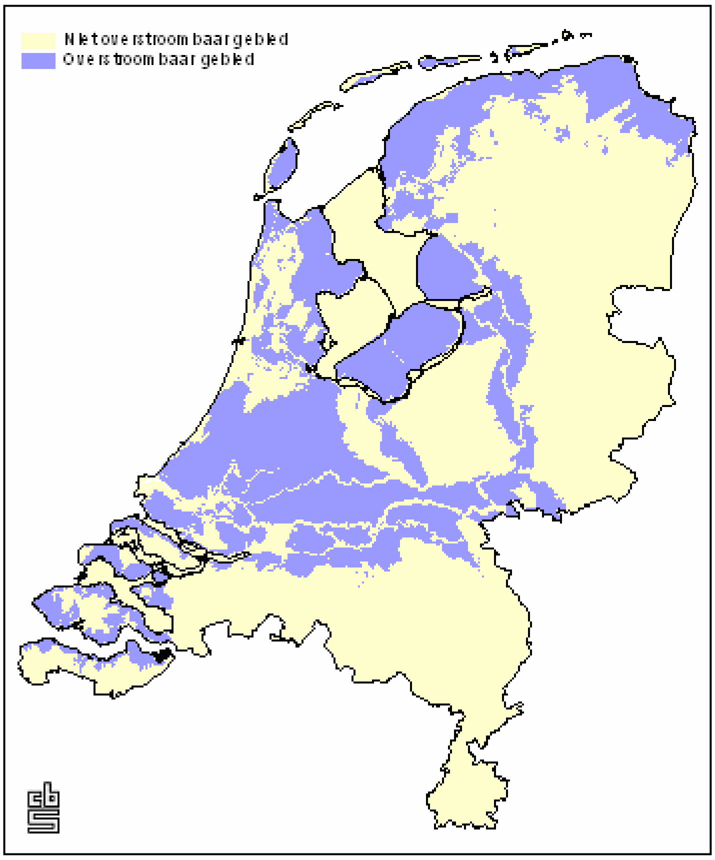
4.1 Introduction

In this chapter, examples are given of indicators compiled by Statistics Netherlands. Depending on the nature of the issues addressed, the complexity of the indicators can vary from very concise, focusing on just one parameter, to composite, covering more then just a single aspect. Often, the indicators can be found in national and international reports in which the progress of water policies is evaluated. The indicators are presented along three of the five main themes as mentioned in chapter 2: Safety (paragraph 4.2), Water shortage including water use (paragraph 4.3) and water pollution (paragraph 4.4).

4.2 Safety: The economic potential of flood risk areas

As the Netherlands is vulnerable to flooding from the North Sea and the rivers the potential economic harm is assessed. In the analysis done, the aim was to identify the economic potential of the area at risk. The risk map, represented in figure 3, is based upon flooding simulations, using the most current information available, created by hydraulic experts, hydrologists and other water experts. It is actually a map with maximum water depths, composed of hundreds of independent flooding calculations. The areas at risk were projected against (sub-) regional statistics on population, housing and real estate, employment, economic activities and GDP.

Figure 3 Risk map of areas prone to flooding



Source: 'Environmental Accounts of the Netherlands 2008', 2009 (In Dutch: Milieurekeningen 2008, 2009). 'National Management Organization Risk Map' of the Association Provincial Authorities, processed by Statistics Netherlands. (Landelijk Beheer Organisatie Risicokaart van het Interprovinciaal Overleg, bewerking CBS).

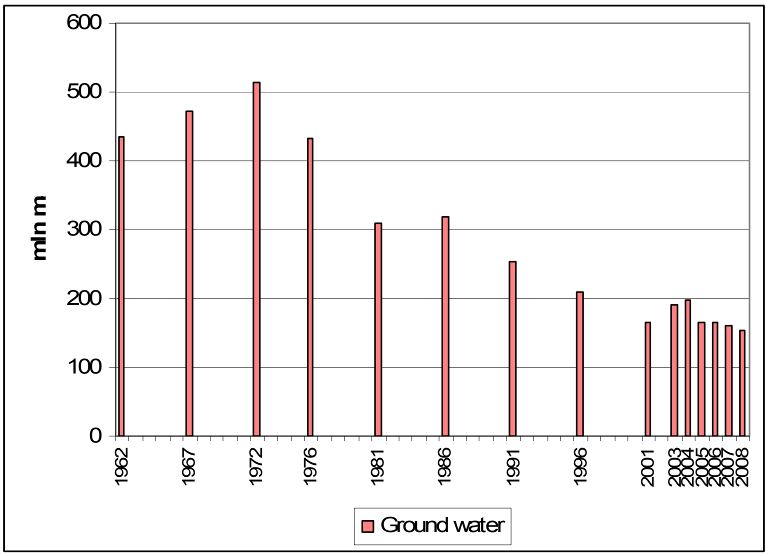
Following the risk map, about one third of the Dutch territory, carry the risk of flooding. The endangered area consists of coastal areas and large areas along the main rivers. In 2008, about six million people, 36 percent of the total population, lived in the identified risk areas. Approximately one third of the Dutch GDP is generated in areas identified to carry the risk of being flooded. In particular, large parts of horticulture, energy and construction companies are located in the flood-prone area. The houses situated in the flood-prone areas, with a value of around 525 billion euros, represent one third of the total value of all houses. Other property such as offices and premises, carry a value of another 120 billion euros.

4.3 Water shortage and water use

Groundwater abstraction by the manufacturing industry

The manufacturing industry extracts significant amounts of groundwater. Figure 4 shows a time series of total extracted volumes. Because of its high quality, groundwater can be used in a wide range of industrial processes. With a share between 30 and 40%, the food and beverage industry is and was by far the largest user of groundwater. Also the chemical industry, the paper and cardboard industry as well as the basic metal industry extract large amounts.

Figure 4 Groundwater abstractions by industry, 1962-2008



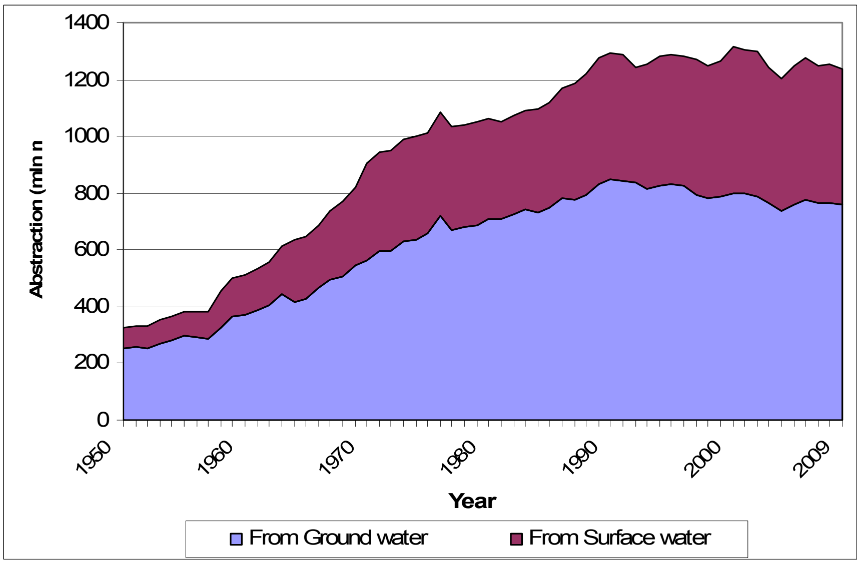
Source: CBS 2010a; 2010b; 2004; 1998.

Abstraction of groundwater and surface water for Public Water Supply

Today around 8 percent of total abstracted water is turned into tap water as supplied by the water supply industry. Total tap water production in 2009 amounted to 1.2 billion m3. Figure 5 illustrates that the share of groundwater abstraction needed for tap water production has been reduced from 78 percent in 1950 to 62 percent in 2009. Nevertheless the volume of groundwater abstraction for tap water production tripled in almost sixty years and peaked in 1990. Since the nineteen nineties, disincentives are established and implemented by policy and policymakers to deviate from groundwater abstraction.

Households today do use nearly two third of the available tap water in the Netherlands. The production of tap water has increased by 280 percent since the nineteen fifties. Since 1990 the use and production of tap water remained fairly stable notwithstanding population and continued economic growth. Through efficiency measures the use per capita and in industry has been reduced.

Figure 5 Abstractions of ground- and surface water for tap water preparation



Source: CBS 2010a; 2004; 1998; VEWIN 2010.

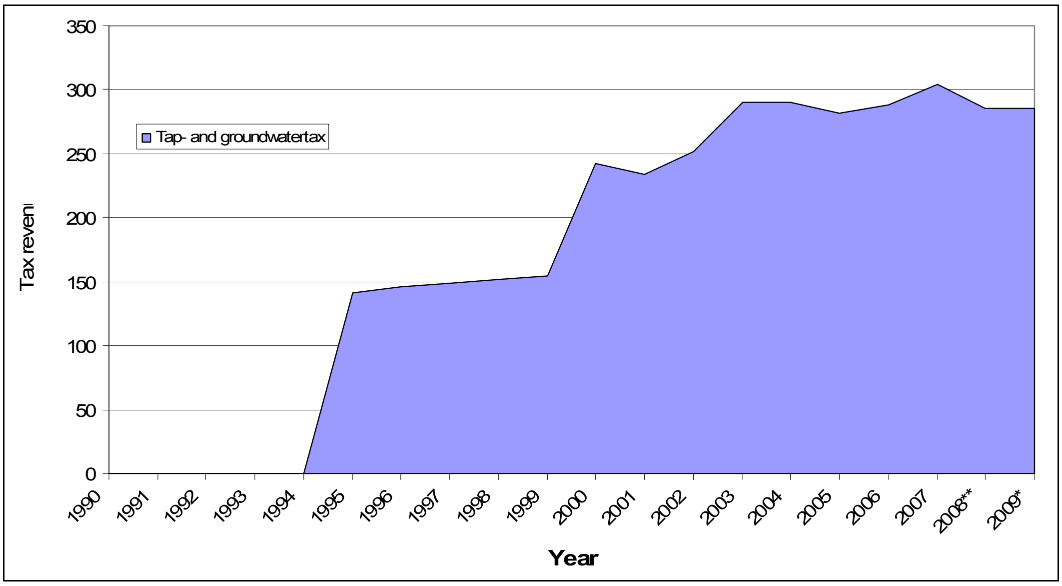
Tap water and groundwater tax

In the Netherlands since 1995 a tax is levied on tap water. The tax has to be paid by both businesses as well as households that use tap water. The tax aims to reduce water use.

The groundwater tax, also levied since 1995, was introduced by the government to discourage groundwater abstraction. It aims to promote the efficient use of a resource under pressure within the country. This tax is paid by water companies, farmers and manufacturers for example, as well as by individuals and users of well-point drainage that abstract large quantities of groundwater.

Both taxes are product-specific and part of the category Environmental Taxes as imposed by the central government. Figure 6 shows the total revenues from these taxes.

Figure 6 Revenues by government from tap- and groundwater tax



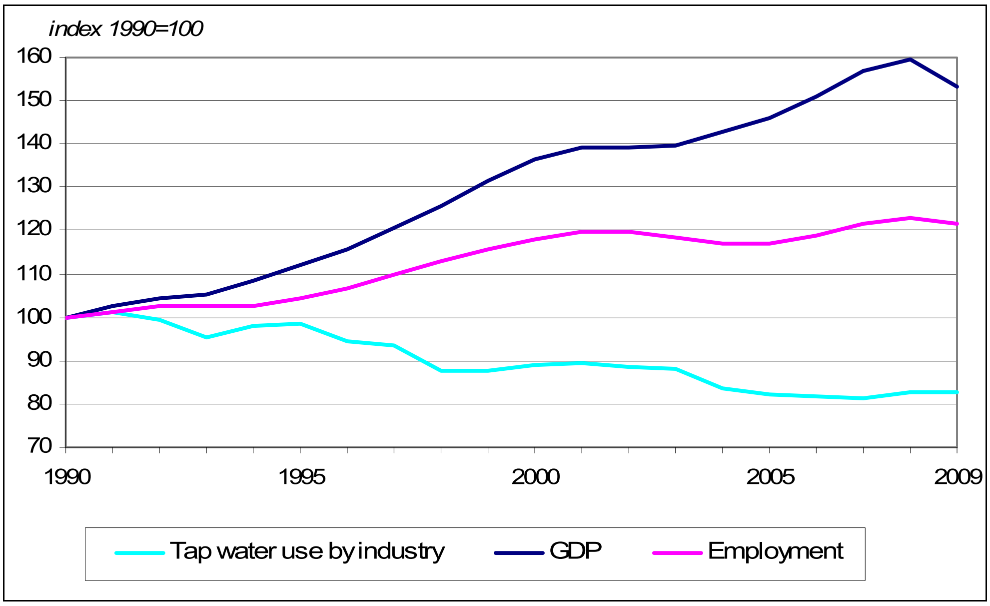
Source: CBS 2010b.

Decoupling of tap water use for production

The chemical industry, food and beverage manufacturers and agriculture are extensive users of tap water. Industries in general have used 1 percent less tap water per year since 1990 on average. At the same time their production, profits and employment have grown substantially (see figure 7). This is known as absolute decoupling. Absolute decoupling occurs when the emission of a pollutant or use of an environmental input / resource, in this case water, is stable or decreases while the economic driving force (e.g. GDP) shows growth. Decoupling can be either absolute or relative. Relative decoupling happens when the growth rate of the environmental theme, or in this case a resource input, is positive but less than the growth rate of the economic variable. Absolute decoupling thus is preferred above relative decoupling.

Notwithstanding the long term absolute decoupling, the reduction of the use of tap water by the industry came to an end in 2005 and remained fairly constant since. Somewhat surprisingly the water use by companies didn't fall in 2009, in spite of the economic recession. It will be interesting to see what will happen in the near future. This indicator is used recently in a report on Green Growth in the Netherlands (CBS, 2011).

Figure 7 Volume change GDP, employment and tap water used for production



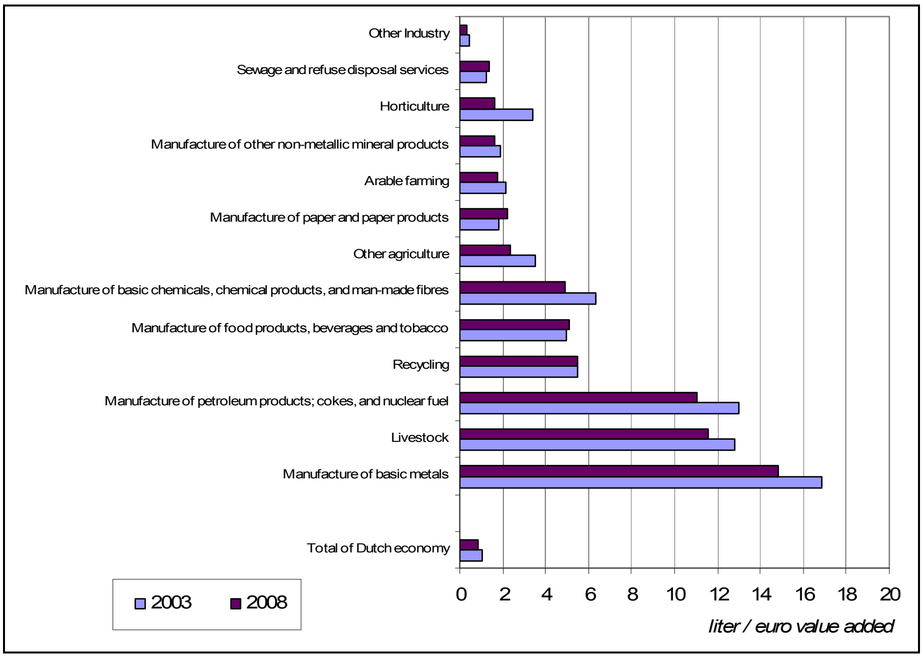
Source: CBS 2010a, CBS 2011 (adapted)

Water use intensity shows a downward trend

Water use intensity for an industry is defined as the use of water, either surface, ground or tap water, in litres divided by its value added[4]. This may depend on the objective of analysis. Figure 8 shows the water use intensities of tap water for a selection of industries for 2003 and 2008. On average, nearly one litre of tap water is used for every euro of added value generated by the Dutch economy. This water use decreased from 1.04 litres in 2003 to 0.85 litres in 2008. In 1990 even 1.64 litre of tap water was used per euro of value added. The manufacturing of basic metals has the highest water use intensity rate for tap water, followed by livestock breeding and manufacturing of petroleum products, cokes, and nuclear fuel. These three water intensive industries however, did manage to reduce their tap water use intensity rates significantly since 2003, namely with at least 10 percent.

[4] Value added is expressed in constant prices (prices of 2000).

Figure 8 Industries with the highest water use intensities for tap water



Source: CBS 2010a.

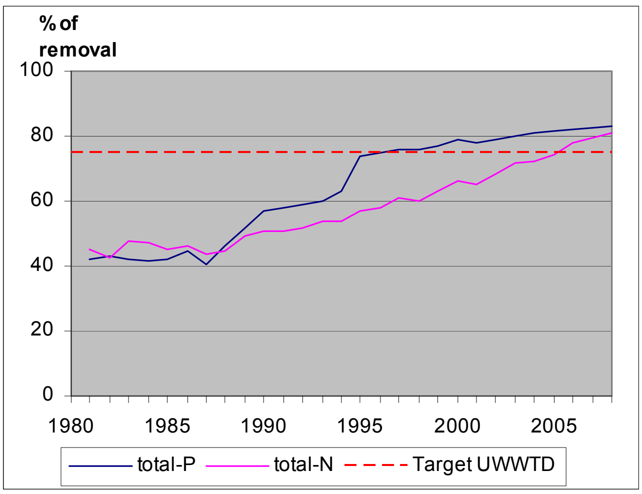
4.4 Water pollution

The Urban Waste Water Treatment Directive

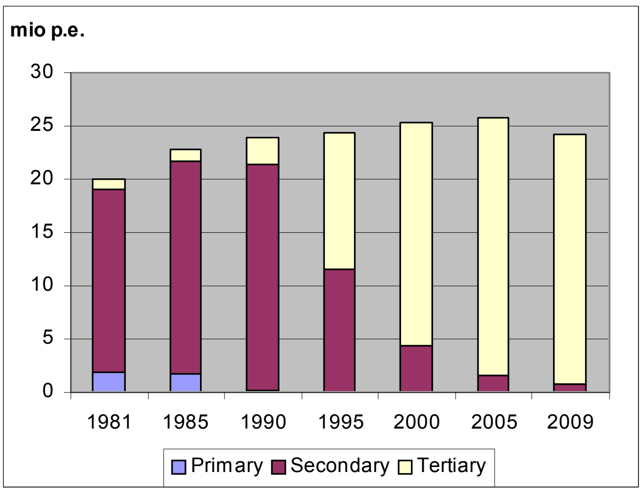
In 1991 the Urban Waste Water Treatment Directive (UWWT Directive) (CEC, 1991), came into force. For the Netherlands territory it was chosen to comply with article 5.4 and 5.8 of the UWWT Directive, implying that total removal of both Phosphorus and Nitrogen in UWWTP's must be at least 75% for the whole territory (Min.VROM/ Min.V&W, 1996). This target had to be met by 31-12-1998. Figure 9a reflects the progress in overall removal of Nitrogen and Phosphorus in the UWWTP's compared to the target of 75% (Min. V&W and Min. VROM (2010)). Figure 9b visualizes the penetration degree of Nitrogen and Phosphorus removal facilities (tertiary treatment) at the UWWTP's (PBL et al, 2011, adapted).

Figure 9a Treatment efficiency of UWWTP's: nitrogen and phosphorus
Figure 9b Treatment capacity (p.e., population equivalents) of UWWTP's, by type of treatment

9a.



9b.



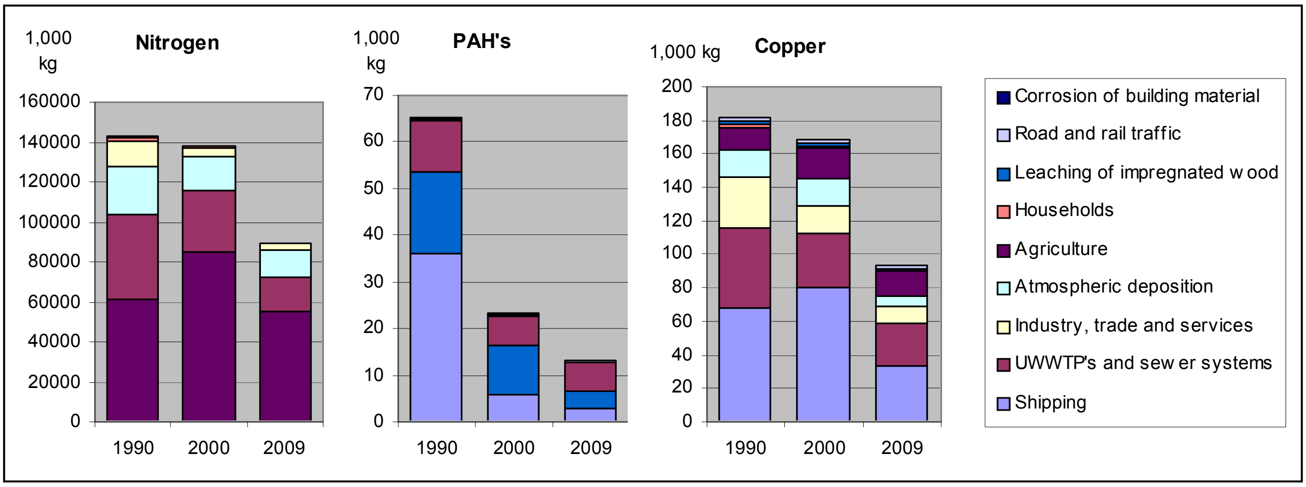
Source: Min. V&W 2009; Min V&W, VROM 2010; adapted from PBL et al 2011.

For Phosphorus the target as set of 75% removal was already met in 1996. After a period of large investments, including the modernization of existing UWWTP's and construction of new UWWTP's, the target for Nitrogen was met in 2006.

Emission Inventory (PRTR): trends and sources of water pollution

Data on the load of pollutants to surface waters provide a solid basis for the evaluation of trends and policies and the identification of new problem substances. As an example, the graphs in figure 10 show the different sources of a selection of pollutants for the years 1990, 2000 and 2009 (PBL et al, 2011). The graphs illustrate that in general the load to surface water has decreased during the last two decades. This is predominantly caused by reduction measures in industry and shipping as well as lower atmospheric deposition, which is a result of a decrease in air emissions. Nevertheless it can be noticed that both diffuse loads from agriculture as well as point discharges of UWWTP effluents still have a significant part in total loads to surface water.

Figure 10 Trends in total yearly load to surface water, by main source

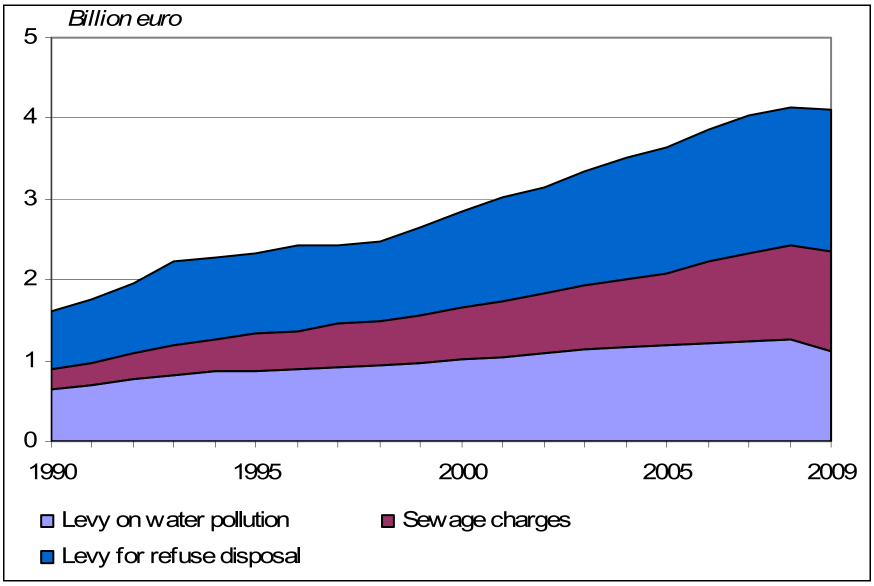


Source: PBL 2011; Min. V&W 2009.

Economic instruments related to pollution

Revenues from environmental taxes remained virtually unchanged in 2009 compared to 2008, at 4.2 billion euro (see figure 11). The sewage charge, imposed by municipalities, has shown a strong growth in nineteen years, in 2009 it was fivefold the 1990 level, an average annual growth of almost 9 percent. The sewage charge rose all the way up to 1.24 billion euro in 2009. The continued high growth in recent years is explained by the fact that sewage charges are systematically increased by municipalities in order to achieve full coverage of costs for exploitation and expansion of the sewer system in the end. Particularly decoupling of the rainwater drains from the regular system with grey water required substantial investments.

Figure 11 Levies and charges related to water treatment and water pollution by government

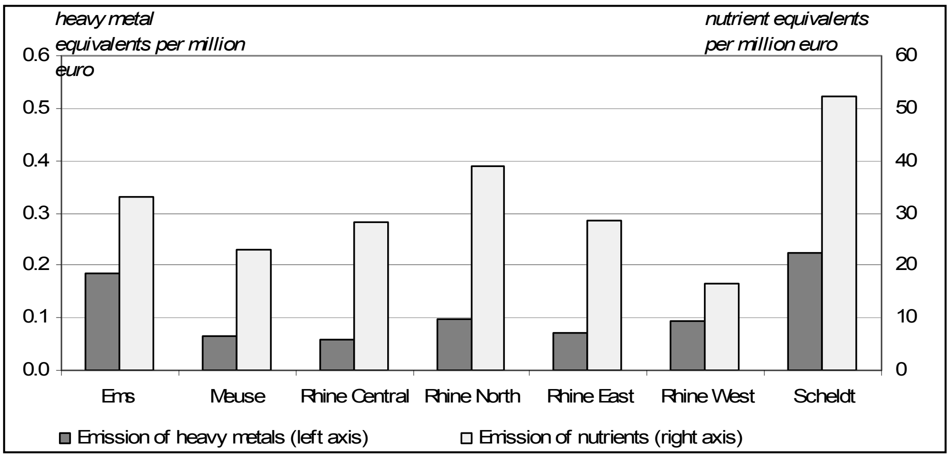


Source: CBS 2010a.

Emission intensities per River Basin

In NAMWARIB (National Accounting Matrix including Water Accounts for River Basins), the emission of nutrients and heavy metals to the water environment are allocated to the economic activities causing these emissions. Key economic indicators (value added, production, employment, and others) for the different economic activities (58 industries) are compiled for the seven different river basins. Figure 12 plots the emission intensities for heavy metals and nutrients (aggregated as equivalents) per river basin.

Figure 12 Emission intensity by (sub-) River Basin in 2006



Source: CBS 2010a; van Rossum, 2009.

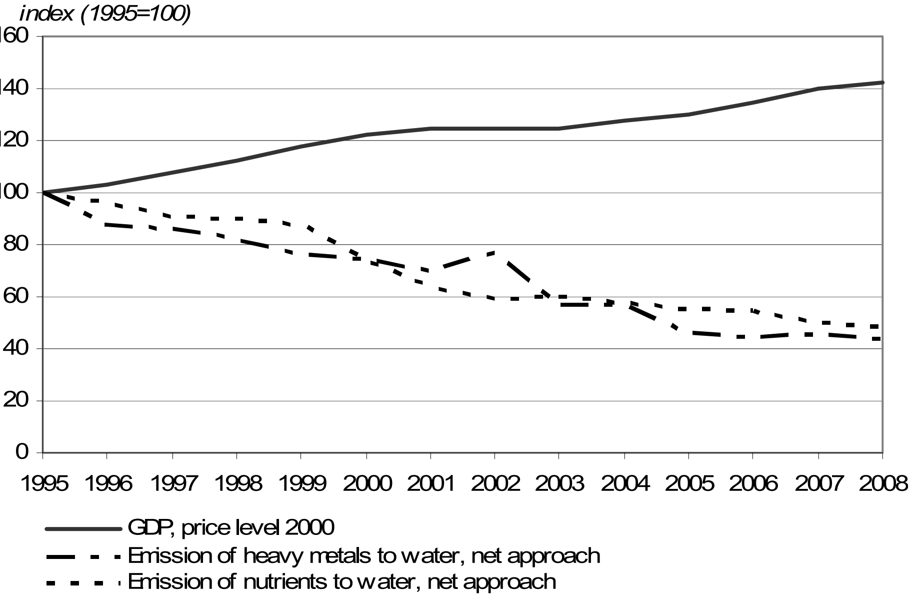
Figure 12 shows that water pollution (measured in equivalents) per euro value added is relatively high in the river basins Scheldt and Ems. This low environmental efficiency is explained by the more flexible environmental regulations for discharges on marine waters. Because of the high degree of dilution, the aquatic system in marine waters is less vulnerable than small river aquatic systems (van Rossum and van de Grift, 2009).

In the Meuse basin, livestock is an important activity generating value added. As manure contains a lot of heavy metals, the Meuse region is responsible for the emission of relatively many heavy metal equivalents. However, the realized emission intensity of agriculture is relatively low because much of the manure produced is transported to areas other than the Meuse basin. This is triggered by the relatively strict environmental regulation related to manure treatment in the Meuse area. It means that the manure intensive livestock industry transports its environmental problems related to manure production to other regions.

Decoupling of economic growth and emissions to water

In 2008 the Dutch economy grew by 1.9 percent compared to 2007, where emissions of nutrients and heavy metals to surface water and sewer systems decreased. Accordingly, there is absolute decoupling between these emissions to water and the economic growth for 2008. This is a continuation of the decreasing trend that has been observed since 1995. In the period 1995-2008 economic growth equaled 43 percent (figure 13). Emissions were reduced by more than half in this period: heavy metals by 56 percent and nutrients by 52 percent. This reduction is mainly caused by a reduction in the emission intensity by producers and reduced emissions by other domestic sources. The environmental performance of companies and institutions thus has improved substantially in the period 1995-2008.

Figure 13 Economic growth and contribution of the Dutch economy to water emissions, net approach



Source: CBS 2010a.

5. Application of indicators in water management, research and policy

Policy makers increasingly rely on quantification, modeling and modeling exercises. As part of ex ante evaluations or assessments of policy instruments that are proposed to achieve the policy goals being set, quantified models are used. These models are used to assess the effects of individual instruments or sets of instruments. In such ex ante assessments and sometimes ex post assessments one looks after effectiveness to achieve the predefined objective, as well as after cost-effectiveness and adoption of the proposed measures. For a good assessment these models do rely on sound and detailed Water Statistics and on other statistical data like detailed (regional) economical statistics. Such a policy process making use of quantifications and modeling based upon sound statistics clearly is used for the WFD. In there the economic consequences as well as the achievement of the different objectives for improvement of water quality in the future as well as its cost-effectiveness are assessed.

Water Accounts and WFD

Increasingly the use of economics in water policy and management gains importance. One of the first examples of this development was the Water Framework Directive (WFD). In here economic driving forces behind the different pressures as denominated by the Directive, were explicitly addressed. The other part of the spectrum, the policies and measures, was analyzed in detail by a large number of studies. These address the measures, the effects, revenues, effectiveness, cost-effectiveness as well as economic impact on the different measures. As the policy goals were ambitious, the expected economic impacts for particular sectors and/or regions could be large. For that purpose the integrated system of Water Accounts has been used extensively. The integration of physical and economic information allows for the construction of integrated indicators. For instance, water use by various economic sectors can be related to the economic interests involved. In conjunction, the focus from policy and research being put to the regional level or river basin level is a recent phenomenon. The WFD requires that river basins across Europe are described in both physical and economic terms. As a result more data on the disaggregated level is required. Integrated river basin accounting supports this development.

Application in Cost – benefit analysis

Cost-benefit analysis (CBA) or BCA (Benefit-Cost Analysis) is often used by various governments to evaluate the desirability of a given intervention. CBA or Social CBA (SCBA) is an analysis of the cost effectiveness of different policy alternatives in order to see whether the benefits outweigh the costs. For preparation and policymaking / decision making regarding water related issues, SCBA is often applied for assessment of future costs and benefits as for decisions on water extraction, dikes, water retention plans, environmental remediation, or ecological compensation. Statistical data is used for the compilation of the required analysis.

In CBA in principal the effects for all stakeholders like governments, businesses or citizens are assessed. Benefits and costs are mostly expressed in monetary terms, and adjusted for the time value of money, in order to enable comparison over time. Within Social CBAs, costs and benefits related to environmental quality can be in- or excluded. When included, positive and negative impacts as well as other environmental qualities of a project on nature and environment are expressed monetarily, including an estimation of the socio-economic value of nature. In case the benefits or advantages outweigh the costs it is supposed to be a socially responsible project. It can also indicate which project alternative is the best. A CBA helps to prevent that economically inefficient choices are made, or that taxpayers' money is wasted. SCBAs generally are used by actors responsible for choices to be made on spatial interventions as for example by central government, provinces, municipalities, water boards, all kinds of interest groups, etc (Delta Committee, 2008; Brouwer, 2005).

For that purpose establishment of an integrated set of model instrumentation covering physical and economic aspects of the water system is most wanted. That will facilitate the need for assessments of costs and benefits of water policy and management. One can think of a model that estimates crop damage and its dependence on various groundwater levels, or of a transport model that includes vessels and that assesses the influence of harmful water depths. In there dose-effect relationships can be assessed for the resulting economic losses. Information from statistics is used to fill such information systems (Brouwer, 2005).

Valuation of water at (Sub-)River Basin level.

A project called 'Water Economic Modelling for Policy Analysis' (WEMPA, see Brouwer, 2005) aimed to develop an integrated hydro-economic model for the Netherlands. The model predicts the direct and indirect economic impacts of policy measures and instruments at national and river basin level. The results provide the basis for a cost-benefit analysis of the implementation of the Water Framework Directive (WFD) in the Netherlands. Potential relevant models, both economic and integral hydrologic-economic models, has been reviewed on their suitability to be incorporated in the water economics model.

Relevant interactions between agriculture and water are analysed and the existing Dutch Regionalized Agricultural Model (DRAM) is adapted to incorporate the relation between WFD measures, the water quality on the one hand and the economic effects on the other hand. This has been done between 2005 and 2009 (Brouwer, 2005).

Assessment of cost recovery

To promote sustainable water use, the WFD applies the principle of recovery of costs for water services. This is derived from the polluter / user pays principle. The Directive aims to achieve a reasonable degree of cost recovery for water services. This means that sectors (like households, agriculture and industry) which use water services are to be charged in a reasonable way.

Although water services can be defined in different manner, in the Netherlands at least as water services were distinguished: 1.the production and supply of water; 2. collection and disposal/discharge of water from precipitation and wastewater; 3.Waste Water Treatment; 4.Management of groundwater and extraction; 5.Management of Regional and local Water Systems. (Van der Veeren R. et al, 2005). This includes water services delivered to parties themselves even without payment. The degree of cost recovery thus is about the contribution of the users, of the water services, to the costs of the water services. This can be expressed through cost recovery rates. The cost recovery rates are calculated as revenue from water services (minus any subsidies) divided by the charges made. For the costs, in addition to direct costs, the monetary value of the impact for the environment and natural Resources is determined. For these calculations extensive use has been made of Water Statistics and Water Accounts (including from NAMWA) and other statistics. The financing of water services in the Netherlands already for decades has been based on the principles ‘the polluter pays’ and ‘the user pays’. Therefore calculation of cost recovery rates do show percentages close to hundred. Practically all the costs of water services are recovered.

Micro data on Urban Waste Water Treatment Plants

One major advantage of the detailed statistics on UWWTP’s was that from its inception in the late seventies, micro data could be used by third parties. The water boards, being responsible for the operation of the UWWTP’s, provided official dispensation for statistic confidentiality. Likewise, the micro data could and still can be used by a number of governmental bodies and research institutes, for example in research projects carried out under the umbrella of the STOWA (Dutch acronym for the Foundation for Applied Water Research). Moreover, the National Water Service is allowed to use the micro data for official reporting obligations in the framework of the Urban Waste Water Treatment Directive. Finally it is noteworthy to mention that each year a large data file with individual data is delivered to the National Emission Inventory (PRTR) database.

6. Conclusions and recommendations

In the Netherlands, five main issues with regard to water are relevant. These are: 1.protection against flooding; 2.water management dealing with excess of water or; 3.shortage of water (incl..water use); 4.water pollution, and; 5.water quality / health.

In the last four decades water related issues have got more and more attention This is also illustrated by the abundance of national and international legislation and regulation that have been developed and applied. Every subsequent year water gains attention from society and by policy makers. In this regard Water Statistics and Water Accounts have strongly been developed and have been implemented. The resulting statistical data and indicators are widely used in the policy making process by several stakeholders and within society in general.

Statistics and accounts are either directly or indirectly used by research in policy making, by politicians, civil servants. This use takes place for the different governmental levels including the water boards as well as by policy and academic researchers, and for educational purposes in schools and in universities.

With respect to the five main themes mentioned above, the scope of the Water Statistics and Water Accounts in particular lies within the themes water shortage (incl. water use) and water pollution. Moreover, within the themes Protection against flooding and Excess of water some supporting economic statistics are available, while physical data on these themes is inventoried mainly by other parties in the Netherlands. The theme water quality/ health has the least involvement of official national statistics. The monitoring of, reporting on and evaluation of chemical and biological water quality is an activity for which specific and local knowledge is required. The regional and national water authorities are clearly the most suited organizations to execute these tasks.

Regarding the use of Water Statistics and –accounts in the different stages of the Policy Cycle, it can be concluded that Policy Evaluation is the most common use of Water Statistics and Water Accounts. To a lesser extent, statistics are also used within the stages Agenda setting and Policy formulation. In particular the use of indicators on water abstraction and water stocks is still very much restricted because of the lack of sub-annual data, like monthly or seasonal data. Extension of the data to a better coverage of phenomena that occur primarily within shorter periods, as for example drought during the summer months, would be advisable.

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