Households and recreation: use and value of water
Households and recreation: use and value of water

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Contents

Summary iii

1. Introduction 5
   1.1 Scope and aim of project 5
   1.2 Use of water, costs and values 5
   1.3 Outline of report 6

2. Extractive use 7
   2.1 Public water supply 7
      2.1.1 Sources of water and production 7
      2.1.2 Use of drinking water in households 7
      2.1.3 Costs and prices of drinking water 8
      2.1.4 Economic data on the public water sector 10
      2.1.5 Quality of produced drinking water 10
      2.1.6 Costs related to changes in surface water quality 11
   2.2 Fish catch and consumption 12

3. Non-extractive use 13
   3.1 Water recreation 13
      3.1.1 Introduction 13
      3.1.2 Intensity and expenditures 13
      3.1.3 Effects of changes in water quality 14
   3.2 Experiencing quietness and nature 14

4. Indirect use, optional use and non-use 17
   4.1 Waste water discharge 17
      4.1.1 Sources of waste loads entering sewer system 17
      4.1.2 Waste loads entering sewer system and discharges into surface water 18
      4.1.3 Costs of communal waste water collection and treatment 20
      4.1.4 Costs related to changes of emission standards 20
   4.2 Effect of the presence of water on house prices 22
   4.3 Optional use and non-use 22

5. Costs and benefits of improving water quality and possibilities of modelling 23
   5.1 Costs 23
   5.2 Benefits 23
   5.3 Modelling of costs and expenses 24
      5.3.1 Costs of emission reduction 24
      5.3.2 Recreation expenses and expenditures 25
   5.4 Modelling of benefits 26

6. Conclusions and recommendations 27
Summary

The aim of the project Water Economic Models for Policy Analysis (WEMPA) is to develop an integrated and operational water and economy model framework for the Netherlands that will enable us to determine the economic effects of measures to improve the water quality and as a result the ecological quality of rivers, regional and local waters. It must be shaped in such a way that it will be suitable for applying cost benefit analysis of implementing the EU Water Framework Directive (WFD) in the Netherlands.

The underlying document addresses the use and value of water for households and recreation. A distinction is made between extractive use (public water supply), non-extractive use (recreation values), optional use (possible future use), and non-use (altruism values).

Implementing the WFD has consequences for households and recreation. On one hand measures are needed of which households have to bear their share of the costs. It is estimated that the costs to households of additional treatment at communal treatment plants may accrue to € 0.2 to 0.5 billion per year depending on the degree of additional treatment needed. On the other hand households benefit from the improved water quality as a result of implementing the WFD. Drinking water might become cheaper and water recreation might become more attractive. These benefits are estimated at roughly about € 1 billion per year, but with respect to cost savings on public water supply (benefits of € 0.3 billion per year) it is not sure that these benefits can be realized actually.

It proves to be complex and very difficult to determine the costs, expenses and benefits of water quality improvement accruing to households accurately and reliable. Simplifying assumptions are needed that differ between the cost items and between the benefit items.
1. Introduction

1.1 Scope and aim of project

The aim of the project ‘Water Economic Modelling for Policy Analysis’ (WEMPA) is to develop an integrated and operational water and economy model framework for the Netherlands. This model will enable us to determine the economic effects of measures to improve the water quality and as a result the ecological quality of rivers, regional and local waters. An important requisite of this model framework is that it must be shaped in such a way that it will be suitable for applying cost benefit analysis of implementing the EU Water Framework Directive (WFD) in the Netherlands.

The model framework must allow an interchange of information between model components of the economic and hydrological realms. In the future an interchange between these two realms and the ecological realm is also foreseen. Initially, the focus will be restricted to surface water. The WFD also addresses groundwater issues, but for the moment models dealing with groundwater are not included in the model framework. The groundwater part of the water system may be added in a later stage.

In the Netherlands about 1000 water bodies can be distinguished. The WFD requires that the water and ecological quality is determined that can be realized in each of these water bodies and at what costs. Regional and local water and economy analyses are needed for this. However, the complexity of the model framework needed for these analyses increases when narrowing the geographical scale. Therefore, it is decided to focus first on the national scale, and add on in a later stage regional details.

This document addresses the water use of households and recreation and costs and values of that use related to the quality of surface water in the Netherlands. This information is needed for making economic analysis of water quality improvement as required by the WFD and for determining possibilities to model ‘water and economy’ for these two sectors and to incorporate that into the model framework.

1.2 Use of water, costs and values

When considering households and recreation a distinction is useful in the following water uses (e.g. Pearce and Turner, 1990; Turner et al., 2001):

- **Extractive use**, which comprises: (a) withdrawal of water from water bodies and use in households; and (b) fish catch and consumption.

- **Non-extractive use**, which includes: (a) leisure activities in water and on banks like swimming, boating, angling, walking and cycling; and (b) aesthetic experience and enjoyment with the presence of water.

- **Indirect use**, which covers: (a) discharge of waste and waste water into water bodies therewith affecting the water quality; and (b) hedonic price effects of the presence of water on houses.

- **Optional use**: the possibility to use the water in the future (option value).
• Non-use, which encompasses values people assign to the presence of water: (a) just of being there without the intention to use it (existence value); and (b) in a more philanthropic sense meaning to preserve it for future generations (bequest value).

Using water in general means that costs must be made for enabling people actually to use it. The cost items vary from investment costs (for water treatment facilities, angling equipment, and so on) to operation and maintenance costs, to travel costs.

A total economic value can be assigned to these uses. Related to the distinction in uses, a distinction in values can be made (see Figure 1). Other terms are used as well. For instance values related to leisure activities are often called recreation values.

![Table of economic values]

Source: adapted from Brouwer (2004)

**Figure 1:** Scheme of economic values and coherence between these values

Apart from the total economic value, also socio-cultural and nature values can be assigned to the presence of high quality water and related to that a high ecological quality. Nature values are often called intrinsic values. As these values are not related to any anthropogenic welfare considerations, nature values are not considered here (see Ruijgrok et al., 2004).

1.3 Outline of report

In Chapter 2 the extractive use of water is discussed as well as the costs and values of this use related to the water quality. Chapter 3 describes the non-extractive use of water (water recreation and experiencing nature) and the costs and values of this use related to water quality improvement. Chapter 4 is dedicated to the indirect use of surface water in the Netherlands, the optional use and non-use. The indirect use comprises waste water discharge by households and effects of the presence of water on house prices. Costs and values of these uses related to the quality of surface water are dealt with. In Chapter 5, an overview is given of both the costs and benefits of improving water quality for households and recreation and the possibilities to model these. Conclusions are drawn and recommendations are made in Chapter 6.
2. Extractive use

This chapter is dedicated to the extractive use of water. This concerns public water supply and consumption of fish caught by anglers.

2.1 Public water supply

2.1.1 Sources of water and production

In the Netherlands, a rather constant amount of yearly about 1.2 billion m$^3$ of drinking water is produced (see table 2.4). About 62% of this amount originates from groundwater (see table 2.1). Surface water is the source of 19% of drinking water and 2% is dune water (rainwater fed). The remainder of 17% is infiltration water (surface water infiltrated in the soil).

Table 2.1: Sources of water used in the Netherlands in 2003 for public water supply

<table>
<thead>
<tr>
<th>Source of water</th>
<th>Amount (billion m$^3$/year)</th>
<th>% of total supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>0.74</td>
<td>63</td>
</tr>
<tr>
<td>Surface water</td>
<td>0.24</td>
<td>19</td>
</tr>
<tr>
<td>Dune water</td>
<td>0.02</td>
<td>2</td>
</tr>
<tr>
<td>Infiltration water</td>
<td>0.20</td>
<td>17</td>
</tr>
<tr>
<td>Total supply</td>
<td>1.20</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: www.cbs.nl

Dune water as source of water is used only in the coastal provinces of North- and South-Holland. In these two provinces surface water and infiltration water are the most important sources. In the province of Zeeland surface water is used as source of water. In all other provinces groundwater is the most important or only source of public water supply.

The increase in the demand for drinking water due to population growth is compensated by the decreasing demand for water in the manufacturing industries and services industries.

2.1.2 Use of drinking water in households

Drinking water is used for different purposes (see table 2.2). The use of water per head per day decreased with 8% from 135.0 liter per head per day (lhd) in 1992 to 123.8 lhd in 2004, mainly due to household appliances becoming more water efficient (Kanne, 2005).

The average use of drinking water differs between user categories. Important use determinants are (Kanne, 2005):

- Age: the highest use (145 lhd) is observed for people aging from 25 up to 34 years, mainly due to more showering. Children under 13 years use only 91 lhd.
- Sex: females use 7% more drinking water than men, mainly due to more toilet flushing.
• Income: the lowest income class uses 10% more drinking water than average, mainly
due to more showering. This can be contributed to the higher use of allochtone people
as allochtone people use more water for showering (81.0 lhd compared to 43.7 lhd on
average).

• City or rural: drinking water use in the three big cities (Amsterdam, Rotterdam, The
Hague) is 26% above average. This can be contributed to the higher use of allochtone
people: 41% above average (see also income as a determining factor).

Table 2.2: Use of drinking water per head per day in 2004

<table>
<thead>
<tr>
<th>Application</th>
<th>use (liter per head per day)</th>
<th>% of total use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath</td>
<td>2.8</td>
<td>2</td>
</tr>
<tr>
<td>Shower</td>
<td>43.7</td>
<td>35</td>
</tr>
<tr>
<td>Wash basin</td>
<td>5.1</td>
<td>4</td>
</tr>
<tr>
<td>Toilet flush</td>
<td>35.8</td>
<td>29</td>
</tr>
<tr>
<td>Cloth washing by hand</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Cloth washing by machine</td>
<td>18.0</td>
<td>15</td>
</tr>
<tr>
<td>Dish washing by hand</td>
<td>3.9</td>
<td>3</td>
</tr>
<tr>
<td>Dish washing by machine</td>
<td>3.0</td>
<td>2</td>
</tr>
<tr>
<td>Food preparation</td>
<td>1.8</td>
<td>1</td>
</tr>
<tr>
<td>Coffee and tea</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>Water consumption</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>Other use of kitchen tap</td>
<td>6.4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>123.8</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Kanne (2005)

It may be expected that the use of water by household appliances will decrease further in
future. Climate change affects water use as is illustrated by the increased water use per
head per day in 2003, when the summer was very hot. In 2003, the sales of drinking water
to households and small businesses were 3.5% higher than in 2002 (Geudens, 2004).

Apart from variations due to weather conditions the sales to households and small
businesses is rather stable since 1993. Taking this fact into account, it may be expected
that water use per head will stabilize more or less at the current level.

2.1.3 Costs and prices of drinking water

Producing drinking water from groundwater as a source is mostly rather simple as deep
groundwater has a constant and good quality. The quality of surface water is less good
and less constant. Surface water bodies are polluted by the use of pesticides by agriculture
and communities (which affects the quality of run-off) and by waste water discharges. As
a result, surface water as a source for public water supply, requires more intensive
treatment making the costs of drinking water produced from surface water higher than
that from groundwater. Higher tax levels on groundwater as source compared to surface
water level out the price difference to the consumer to some extent. Table 2.3 presents an
overview of the average price of drinking water in the Netherlands.
In 2005 the average drinking water price varied between the supply areas in the Netherlands from € 1.09 to € 1.99 per m³, not including € 0.146 tax on public water on the first 300 m³ consumed by a household and also not including 6% VAT (Geudens, 2005).

An overview of the average price of drinking water including taxes is presented in Table 2.3. Large users get discounts and are charged a lower price. This decreases the average price paid for drinking water in the Netherlands. Households and other small users pay a higher price.

Table 2.3: Average cost and price of drinking water in the Netherlands in 2003

<table>
<thead>
<tr>
<th>Cost / price item</th>
<th>average price of drinking water for all users (€/m³)</th>
<th>average price of drinking water for households (€/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of withdrawal, treatment and distribution</td>
<td>1.15</td>
<td>1.26</td>
</tr>
<tr>
<td>Cost increasing taxes</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Tariff exclusive VAT</td>
<td>1.29</td>
<td>1.40</td>
</tr>
<tr>
<td>VAT (6%) and tax on public water</td>
<td>0.19</td>
<td>0.23</td>
</tr>
<tr>
<td>Price for consumer</td>
<td>1.48</td>
<td>1.63</td>
</tr>
</tbody>
</table>

a Including large users with discounts
b Including small businesses
c In 2003 the tax on public water was € 0.141 for the first 300 m³ consumed
Source: Geudens (2004)

In the Netherlands household awareness of costs and prices of drinking water is rather low as these costs represent only 6% of the total costs of utilities supplied and the costs of removal of wastes (see Table 2.4). Consequently the price elasticity will also be rather low.

Table 2.4: Costs to households of utilities supplied and of removal of wastes in 2004/2005

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Average costs (€ per year)</th>
<th>Share of total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking water</td>
<td>147</td>
<td>6%</td>
</tr>
<tr>
<td>Heating / gas</td>
<td>972</td>
<td>41%</td>
</tr>
<tr>
<td>electricity</td>
<td>711</td>
<td>30%</td>
</tr>
<tr>
<td>waste removal</td>
<td>253</td>
<td>11%</td>
</tr>
<tr>
<td>waste water collection (costs of sewer system)</td>
<td>125</td>
<td>5%</td>
</tr>
<tr>
<td>waste water treatment</td>
<td>156</td>
<td>7%</td>
</tr>
<tr>
<td>total</td>
<td>2364</td>
<td>100%</td>
</tr>
</tbody>
</table>
Source: RIONED (2005)

Dalhuisen et al. (2003) studied the price and income elasticity of drinking water demand by means of an analysis of the variation in empirical estimates reported in the literature. They found that, though price elasticity of drinking water demand may differ over the world, the elasticity usually is rather low. They also conclude that income elasticities are inelastic. Contra dictionary, in the Netherlands, demand decreases at higher income levels.
Development of policy scenarios and measures 10

(see Section 2.1.2). There is some evidence that elasticities on the long run are larger than those on the short run (Dalhuisen et al., 2003).

2.1.4 Economic data on the public water sector

Table 2.5 gives some economic data on the public water sector in 1993 and 2003. In 2003 in total 17 water companies produced and distributed drinking water. In the past there were more, but due to merging of companies the number decreased.

Sales of drinking water are about 5% below production due to leakage losses and use as fire extinguishing water (which is not paid for) and measuring differences (Geudens, 2004). The total turnover of the water companies together grew from € 0.9 billion in 1993 to € 1.5 billion in 2003 at current prices.

The price of drinking water supplied and the returns increased in ten years with more than 50%. Inflation and increasing taxes to be remitted to government are the main causes for this increase.

Water companies strive for an efficient drinking water production and a reduction of the costs. This is among others shown by the decrease of more than 30% in the number of employees.

<table>
<thead>
<tr>
<th>Variable</th>
<th>in 1993</th>
<th>in 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of water companies</td>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td>number of employees (fte)</td>
<td>8039</td>
<td>5443</td>
</tr>
<tr>
<td>public water production (million m$^3$)</td>
<td>1186</td>
<td>1191</td>
</tr>
<tr>
<td>sales to households and small businesses (million m$^3$)</td>
<td>699</td>
<td>734</td>
</tr>
<tr>
<td>sales to large users (million m$^3$)</td>
<td>431</td>
<td>399</td>
</tr>
<tr>
<td>total sales (million m$^3$)</td>
<td>1130</td>
<td>1132</td>
</tr>
<tr>
<td>returns of households and small businesses (current prices, € million)</td>
<td>680</td>
<td>1024</td>
</tr>
<tr>
<td>returns of large users (current prices, € million)</td>
<td>259</td>
<td>437</td>
</tr>
<tr>
<td>total returns (current prices, € million)</td>
<td>939</td>
<td>1461</td>
</tr>
<tr>
<td>investments (current prices, € million)</td>
<td>582</td>
<td>433</td>
</tr>
<tr>
<td>length of mains (1000 km)</td>
<td>96</td>
<td>112</td>
</tr>
</tbody>
</table>

* Compared to 709 million m$^3$ in 2002. The higher sales in 2003 are attributed to a hot Summer.

Source: Geudens (2004)

2.1.5 Quality of produced drinking water

The Law on Public Water Supply of April, 6th 1957, the Government Decision on Public Water Supply of June, 7th 1960, and the EU Directive for Public Water Supply describe the demands and standards on public water supply in the Netherlands. The quality of drinking water generally is good. Incidental exceeding of standards is observed and will also be observed in future (Versteegh et al., 2004). The number of violations per year decreased from 1993 to 2003 (Versteegh et al., 2005).

To be able to determine the quality of drinking water supplied, in close cooperation between the water companies and RIVM, a Water Quality Index (WQI) is developed. A
score of 1 means that drinking water just complies with the standard, while a score of 0 means that drinking water is ‘perfect’. From the year 1997 to 2003 the WQI improved from a value of 0.07 to 0.05 (Lawick van Pabst, 2004). This good score is obtained by applying extensive treatment and the presence of excess treatment capacity enabling the water companies to remove unexpected and possible increased concentrations of pollutants.

Consumers are satisfied with the drinking water quality and assign a mark of 7.7 for the quality on a scale of 0 to 10. The consumers find a reliable supply and a good quality the most important aspects of public water supply. They consider this much more important than the price (Lawick van Pabst, 2004). A low price elasticity as observed for drinking water demand is in agreement with this (see Section 2.1.3).

2.1.6 Costs related to changes in surface water quality

The treatment of water to produce drinking water is extensive and such that the risk of chemical and biological contamination of produced drinking water is very small. Growing use of medicines and hormones cause some worries, but at present the concentrations of these substances after treatment in drinking water are far below levels that are expected to have health effects (Versteegh et al., 2003).

Though the quality of produced drinking water is very good, maintaining this good quality in the distribution system requires special care, especially to prevent the risk of legionalla. Such a biological contamination is not related to the quality of the source of water used for drinking water production, but is caused by long residence times of water in the distribution system at moderate temperatures. By keeping residence times short and temperatures low, or by heating the water to temperatures above 60\(^\circ\)C, the risk of biological contamination in the distribution system is minimized.

About half of the extractions of surface water as source for drinking water production does not meet the standards of the European Guideline (75/440/EEG) and the standards for pesticides in the ‘Waterleidingbesluit’ are exceeded regularly (MNP, 2004). Pesticides in surface water cause most problems, nutrients and PAH’s to a lesser extent. Temporarily ceasing the extraction of surface water is one of the methods water companies apply when concentrations of substances violate the standards.

The presence of pesticides in the sources of water used for drinking water production increases the production costs. Monitoring, extra analyses and precautionary measures are needed as well as additional treatment when the presence of pesticides is observed. The additional costs for public water supply due to the presence of pesticides amount to about € 30 million per year (Puijker et al., 2004). Mülschlegel & Tangena (2005) estimate these costs higher: at € 50 million per year. They also estimated the total costs of pollution of surface water for public water supply (see Table 2.6) at about € 400 million per year.
Table 2.6: Cost increase of public water supply due to contamination of surface water as source

<table>
<thead>
<tr>
<th>Substance</th>
<th>Cost increase of public water supply (€ million per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>nitrate and phosphate</td>
<td>110</td>
</tr>
<tr>
<td>heavy metals</td>
<td>70</td>
</tr>
<tr>
<td>pesticides</td>
<td>50</td>
</tr>
<tr>
<td>other substances</td>
<td>170</td>
</tr>
<tr>
<td>total</td>
<td>400</td>
</tr>
</tbody>
</table>

Source: Mülschlegel & Tangena (2005)

The costs presented in Table 2.6 can be saved when the WFD is fully implemented and surface water quality is permanently good. But it is not certain if these costs savings will be realised in practice. Drinking water companies are averse to risking problems with quality of water supplied, and may not be willing to go back on treatment and save (marginally) on costs. Besides, when incidents remain possible, excess treatment capacity will still be needed meaning that only part of these costs can be saved.

2.2 Fish catch and consumption

When considering households and recreation, fish caught by anglers and eaten may be considered extractive use of water. Only a minority of the anglers eat the fish they caught (e.g. eel and pike perch). The majority of the anglers return their catch again into the water (Smit et al., 2004).

Eel and pike perch are marketed by professional fishermen on inland waters. Prices for pike perch amount to € 6-7 per kg (BN/DeStem, 2004). The fish caught by anglers and eaten thus represents a positive and significant market (consumption) value. As the amount of fish caught and eaten by anglers is not known, this consumption value cannot be determined. But certainly, this value will contribute to the recreation value anglers ascribe to their activities. It is assumed here that the consumption value is part of the recreation value (see Section 3.1).

The high value anglers ascribe to pike perch is illustrated by the competition between anglers and professional fishermen for this fish in the Hollandsch Diep. Both groups compete for this fish and do not want to make sacrifices to each other (BN/DeStem, 2004).

Water quality probably has effect on the abundance of eel and pike perch in the waters in the Netherlands. Implementing the WFD therefore probably may also affect the amount of fish consumed by anglers.
3. Non-extractive use

This chapter deals with the non-extractive use of water. This use encompasses (active) water recreation and the positive effects of experiencing the water environment.

3.1 Water recreation

3.1.1 Introduction

Leisure and recreation activities on and along water comprises: swimming, surfing, boating, angling, walking and biking, and in periods of frost skating. Especially for swimming water quality is important, but the water quality also affects (the appreciation of) other activities.

The EU imposed a guideline for the quality of swimming water (last changed cf. Guideline 91/692/EEG of December 23th, 1991). Recently, the EU agreed upon a new guideline for the quality of swimming water coming into effect in 2015. In this new guideline, as indicator for the quality the presence of two bacteria in the water is used. At the moment 8% of the inland surface water does not meet the new standards. The water quality can be improved by abating emissions with overflow of sewer systems, by additional treatment at waste water plants, and by setting rules for the discharge of waste from recreation boats (Brouwer and Bronda, 2005; Maaskant, 2005).

3.1.2 Intensity and expenditures

About half of the population of the Netherlands recreates at least once a year on water or at the waterside. Yearly, 59 million daytrips are made aimed at water recreation (T&R, 2005). The participation and intensity of different water recreation activities as well as the expenditures per daytrip are presented in table 3.1.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Participation</th>
<th>Annual average frequency per participant</th>
<th>Average expenditure per daytrip</th>
<th>Total number of daytrips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of population</td>
<td>€</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sunbathing</td>
<td>24</td>
<td>7.6</td>
<td>10.21</td>
<td>23.5</td>
</tr>
<tr>
<td>swimming</td>
<td>19</td>
<td>6.8</td>
<td>5.90</td>
<td>16.6</td>
</tr>
<tr>
<td>angling</td>
<td>6</td>
<td>10.4</td>
<td>10.32</td>
<td>8.0</td>
</tr>
<tr>
<td>boating</td>
<td>7</td>
<td>5.5</td>
<td>12.93</td>
<td>4.9</td>
</tr>
<tr>
<td>sailing</td>
<td>4</td>
<td>6.0</td>
<td>17.70</td>
<td>3.1</td>
</tr>
<tr>
<td>rowing</td>
<td>3</td>
<td>5.1</td>
<td>11.34</td>
<td>1.9</td>
</tr>
<tr>
<td>canoeing</td>
<td>3</td>
<td>2.8</td>
<td>14.97</td>
<td>1.1</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td></td>
<td></td>
<td>59.2</td>
</tr>
</tbody>
</table>

Source: T&R (2005)

The level of participation is highest for sunbathing, but among the anglers the daytrip frequency is highest. The participation as well as the average frequency per year is lower...
Development of policy scenarios and measures

for the other water recreation activities. The number of recreation boats larger than 6 meter, including open sail boats, is estimated at 265,000.

The water recreation related expenditures are estimated at € 3.9 billion in 2000. Gross value is estimated at € 5.9 billion. The number of full time employees (fte) related to water recreation is estimated at 58,000. As jobs are mostly part time the total number of jobs amounts to 92,000. Further growth of water recreation is not expected, the intensity will stabilize (Verwey et al., 2002).

A trend is observed that people are willing to spend more money on higher quality recreation (more facilities enabling people to enjoy different experiences). That means that improving the quality of recreation and the facilities needed for that the expenditures on water recreation may increase (Verwey et al., 2002).

3.1.3 Effects of changes in water quality

Presently, about half of the population of the Netherlands perceives the surface water quality as rather to very good. Nearly 40% perceives it as not good and not bad, while 10% does not know. Less than 10% considers the surface water quality as rather to very bad (Sietsma, 2005). This rather good perception of the surface water quality will have effect on the participation and intensity of water recreation: this will not be affected significantly by water quality improvement.

That recreation intensity hardly depends on water quality is confirmed by the results of studies on climate change. In an extreme dry year inland surface water quality deteriorates which has effect on swimming intensity: the number of day trips decreases with 4%. However, the good weather has a much larger effect on recreation: an increase of 40% (Bresser et al., 2005). The same holds for employment: the weather conditions are much more important for employment in recreation and tourism than water quality.

Berkhout et al. (2003) present another example of the limited effect of water quality on recreation intensity and expenditures. Using the SEO water recreation model for the Netherlands it was concluded that faecal pollution of the North Sea water along the coast of North- and South-Holland will result in only 1.4% decrease of the number of day trips to the beaches and 0.1% decrease of the expenditures. It will have no effect at all on employment.

Taking into account that an effect of 1% on the recreation expenditures represent a value of about € 40 million, it may be estimated that the effect of water quality improvement of implementing the WFD probably will be in the order of magnitude of € 100 million per year.

3.2 Experiencing quietness and nature

People like to be in nature. They want to see, to hear, to smell, or stated otherwise to experience nature and to lose oneself in it. Being in nature and experiencing the quietness relieves stress, is wholesome and generally has a positive effect on health (Berg & Berg, 2001). The beneficial effect of being in nature can be valued and expressed in money terms. E.g. ECORYS-NEI (2002) estimated that the costs of health care in the Netherlands are lowered by about € 2 billion per year due to nature just being there and
enabling people to experience it. Being active in nature by practicing sport and leisure activities has also beneficial effects on health.

As about half of the day trips made by Dutch people in the Netherlands directly or indirectly is related to water (Verwey et al., 2002; T&R, 2005) half of this € 2 billion, thus about € 1 billion, could be attributed to the presence of water.

Assuming that the beneficial effects on health is linearly related to the number of day trips and knowing that a worse or better water quality results in a few percent change of the number of water oriented day trips, the health value of water quality is estimated roughly at some tens of million euro per year.
4. Indirect use, optional use and non-use

Indirect use of water comprises the discharge of waste and waste water by households (communities) into water bodies and the effects of the presence of water on house prices. The economic value of non-use equals the value people assign to the presence of (good quality) water, without intentions to use it. The option value, not being a non-use value but also not really being a use value, also is dealt with in this chapter.

4.1 Waste water discharge

Waste water of households is collected in sewer systems and treated collectively. Only a very minor part of the households is not connected to a sewer system.

4.1.1 Sources of waste loads entering sewer system

The sewer system receives water that may be polluted with different substances originating from many sources. Households, industries and the service sector are the main sources of waste water for which the municipal waste water plants are designed. But diffuse sources such as atmospheric deposition, traffic, and corrosion of building materials may contribute too to the discharge as these sources pollute the run-off to the sewer system (see Vermij, 2003). Below the main sources are listed as well as the polluting substances that are discharged:

- Households:
  - corrosion of hot drinking water pipes in the houses (contributes mainly to copper emission),
  - discharge of used drinking water (see Table 2.2; this waste water may contain many substances: nutrients, detergents, cleansing agents, heavy metals, medicines, hormones),
  - substances eroded from roofs and building materials in and around the house (lead, zinc, copper) and from fireworks (copper). This pollutes the rain water run-off entering the sewer system.
- Industry and services: waste process water (different substances depending on the process involved) and furthermore the same waste loads as from households.
- Atmospheric deposition: dry and wet deposition of substances on roads and other concrete surfaces polluting run-off water entering the sewer system.
- Traffic: substances in exhaust gas, leakage (oil) and e.g. due to corrosion of tires and traffic conduction systems all land up on the roads and roadsides and may flush with the run-off to the sewer system.
- Municipalities: pesticides used to destroy weeds along the roads and road sides enter the sewer system with run-off.

When considering sewer systems discharge a distinction is made between dry weather discharge (waste water discharge of households, industries and the service sector) and the rainy weather discharge including storm water run-off. Due to this run-off the discharge
to the sewer system increases strongly, which may lead to overflow of discharge water (with pollutants) to neighbouring surface waters. This happens when, during intensive rainfall, the total discharge to the sewer system exceeds its capacity.

On one hand, the run-off flowing into the sewer system adds substances (e.g. originating form traffic) and on the other hand dilutes the ‘regular’ dry weather discharge. As a result the efficiency of the treatment decreases also affecting the quality of the effluent discharged into surface water.

4.1.2 Waste loads entering sewer system and discharges into surface water

About 92% of the waste water of businesses and companies and about 98% of the households in the Netherlands is discharged to the sewer system. The percentage of households connected to sewer systems is already very high compared with other West-European countries and will further increase to over 99%. The waste water of households not connected to sewer systems is treated in individual purification systems before discharge (RIONED, 2005).

At present, part of the waste water discharged to the sewer system is discharged directly into surface water (2.1%), a small part (0.2%) is infiltrated in the soil, and the remainder (97.7%) is purified in a treatment plant (Milieucompendium, 2005). Government policy is to abate the discharge of untreated waste water, meaning that the percentage purified will increase.

Table 4.1 Waste loads entering sewer system and discharged into surface water in the Netherlands in 2003 (1000 kg/year)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Influent</th>
<th>Effluent</th>
<th>Removal (%)</th>
<th>Overflow, etc.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Nitrogen</td>
<td>83,600</td>
<td>23,600</td>
<td>72</td>
<td>590</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>14,100</td>
<td>2,800</td>
<td>80</td>
<td>86</td>
</tr>
<tr>
<td>Cadmium</td>
<td>1.0</td>
<td>0.4</td>
<td>62</td>
<td>0.005</td>
</tr>
<tr>
<td>Chromium</td>
<td>16</td>
<td>3.2</td>
<td>80</td>
<td>0.02</td>
</tr>
<tr>
<td>Copper</td>
<td>154</td>
<td>15</td>
<td>90</td>
<td>2.5</td>
</tr>
<tr>
<td>Lead</td>
<td>50</td>
<td>8.3</td>
<td>83</td>
<td>0.7</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.6</td>
<td>0.2</td>
<td>72</td>
<td>0.002</td>
</tr>
<tr>
<td>Nickel</td>
<td>18</td>
<td>8.7</td>
<td>53</td>
<td>0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>388</td>
<td>77</td>
<td>80</td>
<td>8</td>
</tr>
</tbody>
</table>

* Data on 2002. This comprises sewer overflow, discharges from rain water systems, and direct and untreated discharges of sewer systems.

Source: www.cbs.nl & www.mnp.nl

The waste loads generated by households and discharged with waste water to the sewer system increased since 1990 due to an increasing population. However, the waste loads of heavy metals decreased as a result of abatement of the emissions at the source (mainly industry). The total treatment capacity in the Netherlands increased from 24.0 million Population Equivalent (PE) in 1992 to 25.2 million PE in 2003. Since 1990 the treatment is improved and extended. As a result the percentage of substances removed during the treatment increased and the waste loads entering surface waters with effluents of sewer treatment plants decreased (Milieucompendium, 2005). E.g. the percentage of lead...
removed during treatment increased from 74% in 1990 to 83% in 2003 and the load of lead in the effluent discharge decreased with 67% in this period. Some abatement measures at the source also were effective. E.g. the waste load of phosphorus to the sewer system decreased strongly due to the substitution of phosphorus in detergents by other substances.

The number of treatment plants was reduced from 449 in 1992 to 378 in 2003, while the average capacity increased (CBS, 2005). Many different treatment systems are used to purify sewer system waste water. In 2003, the carousel is the one most applied. Carrousels cover 34% of the total number of treatment plants and 30% of the total treatment capacity in the Netherlands (CBS, 2005).

An overview of the waste loads entering the sewer system (influents) and the effluent discharges into surface water is given in Table 4.1. How the waste loads will develop in future depends on many factors (see also Water in beeld, 2004):

- The population number. This number will increase resulting also in an increase of the dry weather discharge and the waste loads into the sewer system.
- Use of building materials (in houses and other buildings, along roads). Abatement of emissions of this source get much attention and it may be expected that the waste loads will decrease over time.
- Waste water discharges from industries and services. Here, abatement at the source gets full attention meaning that the contribution of this source to the waste loads entering the sewer system will probably decrease further.
- Traffic and atmospheric deposition. Abatement of emissions to the air and on roads gets much attention in environmental policy and therefore it may be expected that – even with increasing traffic intensity - the contribution of these sources to the waste loads entering the sewer system will decrease.
- Direct discharges from the sewer system on surface water. This comprises overflow of the sewer system during intensive rainfall and discharge of untreated (dry weather) waste water. Preventing pollution of surface water due to sewer system overflow is a major issue in water pollution abatement policy. This will have effect over time meaning that the waste loads discharged from the sewer system into surface water will diminish.
- Sewer water treatment. The treatment facilities are optimized and improved. At many locations treatment is also extended. This will result in a further decrease of the waste loads in effluent discharges.
- Application of the Waterharmonica concept. This concept is meant as a natural, ecological link between the treatment plant and the receiving surface water. Well known applications of this concept are constructed wetlands used as natural treatment systems to improve the quality of the effluent by removal of nutrients and pollutants and – at the same time – making the quality more alike to that of the receiving surface water (Schomaker et al., 2005). Waterharmonica systems need space and must be designed and operated in such a way that these systems fit optimally in the local situation and resolve local environmental issues.
4.1.3 Costs of communal waste water collection and treatment

In the Netherlands waste water is transported through a pipe network with a length of 181,000 km. This pipe network is valued at €114 billion (replacement value). 44% of this pipe network is free flowing, the remaining part is flow induced by 91,000 pumps (Rioned, 2005). The sewer system has 13,500 over flow locations and also 4,200 locations of emergency discharges.

The present costs of waste water collection in the sewer system and treatment are presented in table 4.2. The costs of waste water collection in the sewer system increased with 32% from 2000 to 2003 (inflation corrected) and the costs of treatment increased with 25% in these years (Water in beeld, 2004). It is expected that the costs will increase further in the coming years. E.g., many sewer systems were built in the nineteen fifties after World War II. As the technical life span of such systems is about 60 years, renovation will be needed in the coming years. Costs will also increase due to investments in separate rain water systems that discharge rain water directly into surface water, therewith decreasing the rainy weather discharge to the treatment plants.

Table 4.2: Costs of sewer system and treatment in 2003 (€ billion)

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Households</th>
<th>Industries and services</th>
</tr>
</thead>
<tbody>
<tr>
<td>collection and transport of waste water</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>treatment a</td>
<td>0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>total</td>
<td>1.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

a Fee, that households and industries pay to the water boards. Apart from costs of treatment of waste water, this includes also costs water boards make for water quality management.


4.1.4 Costs related to changes of emission standards

What the costs will be of water quality improvement and fully implementing the WFD related to the sewer system is not yet fully known. Several rough estimates are available:

- CPB (2004) estimates the costs of additional treatment at €37 per year per inhabitant making a total of about €600 million per year for all households. But CPB does not exclude the possibility that the costs will be twice as high. Added to that households have to pay for improving the collection of waste water in the sewer system and to reduce the overflow. CPB (2004) estimates these costs at €500 million per year. Both cost items together lead to a cost increase to households of €1.1 billion per year or more.

- Korzelius (2005) estimate the additional treatment costs at sewer system plants of fully implementing the WFD higher at €300 per household per year. For 7 million of households together this amounts to €2 billion per year.

- A report of STOWA (De Jong et al., 2005) gives information on the costs of additional treatment at communal treatment plants. The costs of additional treatment are dependent on the scale of the treatment plants. For a plant size of 100,000 PE (Population Equivalents) costs of additional treatment to meet WFD goals are estimated at €5 to 18 per PE per year. For smaller plants of 20,000 PE the costs per PE per year increase by a factor of two to three. In the Netherlands, the majority of
the waste water is treated in plants with a capacity of 100,000 PE or more. Based on a total treatment capacity of 27 million PE, and assuming average costs of €10 to 25 per PE, the costs of additional treatment in the Netherlands can be estimated at €0.3 to 0.7 billion per year.

- Ligtvoet et al. (2006) conclude that the emission of Phosphorus is most critical for realizing WFD goals. The waste load of Phosphorus discharged with effluents of communal treatment plants into regional waters in the Netherlands must be reduced with 640 tons per year assuming that agriculture takes its part in reducing the emissions. The costs of this emission reduction are estimated at €30 to 100 million per year for the regional waters. For all waters in the Netherlands the costs are twice as high.

- Ligtvoet et al. (2006) give some more information on the costs of additional treatment to realize WFD goals (using data of De Jong et al., 2005). At present, in the Netherlands, on average 79% of Phosphorus present in the influent to the communal treatment plants is removed. That costs about €50 per kg of Phosphorus. The percentage of phosphorus removed can be increased by a fourth stage of treatment. That costs €150 per kg of Phosphorus in 20,000 PE treatment plants decreasing to €50 per kg in 100,000 PE treatment plants. In this way 2400 tons of Phosphorus can be removed from the effluent. Taking into consideration that others priority substances have to be further removed as well the costs increase fourfold. Removal of the last 15% of priority substances currently present in the effluent (mainly due to peek flows) is still more expensive per kg.

In Table 4.3 based on the above mentioned sources estimates are made. The estimate of Korzelius (2005) seems rather high and probably includes costs of sewer system renovation as well. Excluding this high estimate the estimated cost increase ranges from €0.3 to 0.9 billion per year for additional treatment. Households generate 16 million of the 27 million PE of waste water load to the sewer system meaning that their share of the cost increase amount to €0.2 to 0.5 billion. When emission abatement measures in other sectors are more cost effective and less reduction have to be realized in communal treatment plants the costs to household will become less high.

Table 4.3: Cost estimates of additional treatment in communal treatment plants of fully implementing the WFD based on different sources (€ billion per year)

<table>
<thead>
<tr>
<th>Source of information</th>
<th>Costs of additional treatment</th>
<th>Costs of renovation of sewer system</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPB (2004)</td>
<td>0.6 or more</td>
<td>0.5</td>
</tr>
<tr>
<td>Korzelius (2005)</td>
<td>2.0</td>
<td>a</td>
</tr>
<tr>
<td>De Jong et al. (2005)</td>
<td>0.3 – 0.7 b</td>
<td>b</td>
</tr>
<tr>
<td>Ligtvoet et al. (2006)</td>
<td>0.6 – 0.9 c</td>
<td>c</td>
</tr>
</tbody>
</table>

* These costs might be included in the estimate of €2 billion per year
b Assuming average costs of €10 to 25 per PE per year
c Assuming average costs of €60 to 90 per kg of Phosphorus (2400 tons removed) and a fourfold increase for the removal of other priority substances
4.2 Effect of the presence of water on house prices

The presence of water in the neighbourhood affects the house price. Houses at or near water cost on average 16% more than houses in areas without water. This cost increase was determined by comparing prices of houses situated along water with those of houses without water in the neighbourhood. This was done for six communities in the Netherlands (BD, 2004). In the province of Zeeland houses with a view on water are, on average, 40% more expensive than houses without such a view (ZZ, 2005).

This price increase reveals the value people assign to the presence of water near houses. This revealed value is partly dependent on water quality. The effect of water quality on the hedonic price is not known, but it may be assumed that the effect is more or less comparable to that of water quality on recreation. Thus, probably only a few percent of the hedonic price effects due to the presence of water can be attributed to water quality.

4.3 Optional use and non-use

Literature makes a distinction between the option value (preserving the opportunity to use it in future), the existence value (of just being there) and the bequest value (preserving it for future generations) (e.g. Pearce and Turner, 1990). These values cannot be determined from revealed preferences as can be done to determine the effects of the presence of water on house prices. One has to rely on methods that determine stated preferences like willingness to pay. Such survey methods have their limitations often making the results less reliable. E.g. bias is possible when people respond strategically. And verification of the stated preferences is not possible. For a matter of fact, it must be remarked here that revealed preference methods also have their limitations.

In practice, it is difficult to determine the option value, the existence value and the bequest value separately as respondents of surveys often do not fully understand the difference between these values and have problems to express these values in monetary terms and above that, splitting up values over the different items. Long ago, Greenley (1981) tried to distinguish between these values for a case study of water quality improvement and found that the use value (non-extractive use by recreation) was about equal to the sum of the other values. In more recent work, Brouwer et al. (1999) investigated differences between use and non-use values estimated separately for wetlands and when estimated together and found that the two do not simply add up.
5. Costs and benefits of improving water quality and possibilities of modelling

This chapter addresses the costs and benefits to the two sectors households and recreation. Costs and benefits of water quality improvement for other sectors are not considered.

5.1 Costs

Direct costs to households, including recreation, or costs accounted on households related to water quality improvement comprise:

- higher costs for waste water collection and treatment;
- costs of diminishing the use of and replacing materials in and around the house that may be eroded by rain water and hence affect surface water quality through run-off;
- costs of more efficient water use in the house to reduce the flow of water to the sewer system and to improve the treatment efficiency;
- costs of facilities on boats to collect waste and waste water and to discharge it into harbour collection facilities.

Due to higher costs for waste water collection and treatment households may face a total direct cost increase of €0.2 to 0.5 billion per year (see Section 4.1.4), or on average €30 to 70 per household per year. This direct cost increase might decrease when water quality goals are reached by implementing measures in other sectors that are more cost effective and / or measures of which others have to bear the costs.

The costs of the other measures listed above have to be determined separately. As industries and the service sector as well as government also will take measures, households will also be faced with indirect cost increases. These indirect costs are not considered here.

5.2 Benefits

Benefits to households of implementing the WFD and improving surface water in the Netherlands comprise:

- cost savings of public water supply using surface water as source;
- value of fish catch by anglers;
- increase of recreation values;
- beneficial effect on health;
- effects on house prices; and
- increase of option and non-use values.
Potential cost savings (benefits) from an improved water quality for public water supply are estimated at € 0.4 billion per year (see table 2.5). Households (and small businesses) use 65% of public water (see table 2.4) meaning that about 65% of these potential savings, equaling to about € 0.3 billion per year, might accrue to the households. But it is not sure that these savings will be realized actually (see Section 2.1.6).

Brouwer (2003) used the contingent valuation method asking for public willingness in the Netherlands to pay to improve the bathing water quality of surface water and reduce negative health effects. Based on the results of the survey the benefits were estimated at roughly about € 200 million per year. In a later study he determined the total willingness to pay for water quality improvement in the Netherlands due to the implementation of the WFD. This survey resulted in an estimate of roughly about € 700 million per year (Brouwer, 2004). This value includes the recreation value, the health effects of swimming and recreation, and the option and non-use values.

The health effects of experiencing an improved water quality are probably rather small and may be valued at roughly some tens of million euro per year (see Section 3.2). The effects of an improved water quality on house prices may be significant but is not known.

Based on what is stated above it is expected that the total benefits to households of water quality improvement will amount to roughly about € 1 billion per year.

5.3 Modelling of costs and expenses

5.3.1 Costs of emission reduction

For households the most important cost item of water quality improvement is collection and treatment of waste water. The communal treatment plants are scattered over the country. Mostly the effluent from the treatment plants – certainly from the larger ones - is discharged into the large national waters while sewer overflows mostly run into local waters. The effect of additional treatment or measures to reduce the overflow of the sewer system therefore is unevenly spread over the water system in the Netherlands. Moreover the degree of treatment and the percentage of substances currently removed in the treatment plants differ regionally and locally between the plants.

Figure 5.1: Costs of emission reduction in treatment plants and sewer systems
The focus of this research project is primarily an analysis on a national scale. In a later stage the regional scale will be considered. That means that some kind of aggregation is needed or a simplification to come to a national analysis of measures aimed at reducing the emissions from the sewer system. This may be done in three ways:

1. Using **average costs** for all sewer systems in the Netherlands. This is based on the following assumptions: 
   (i) the current level of treatment in the municipal treatment plants and preventing overflow is more or less equal; 
   (ii) the effluent requirements are equal for the whole nation; and 
   (iii) the costs per household to meet the effluent requirements are more or less equal in the whole country. Then – depending on the effluent requirements - all households will be faced with the same costs. These costs may vary from zero (no measures needed) to about € 70 per household when reduction targets are set very high. The costs are rising non-linear with increasing treatment level as shown in Figure 5.1 (see Section 4.1.4).

2. Using an **incremental cost function** for all sewer systems in the Netherlands together. The underlying assumption is that the treatment level can be increased gradually over the country with gradually rising costs by taking measures subsequently at different treatment plants and sewer systems. The costs are again rising non-linear with increasing treatment level but will become more convex as the emission reduction can be realised by starting with the most cost-effective treatment plants.

3. Using **different costs** for each treatment plant and sewer system. Then regional data is needed on the emission reductions to be realised locally and the costs involved.

The third method is most accurate and reliable but in this stage of the research project less practical as it is not known yet where in the country the measures are needed in the treatment plants and the sewer system to realise regional and local WFD goals.

The first method seems appropriate when effluent standards for municipal treatment plants and sewer systems are about equal everywhere in the Netherlands, while the second method might be preferred when for each region and within that local areas a specific cost-effective mix of measures will be elaborated.

Changing materials in and around the house to decrease erosion and pollution of rain water also involves costs. Such changes affect house prices as well as the costs of operation and maintenance. The costs will differ dependent on the substance considered and the kind of measure and have to be determined separately.

### 5.3.2 Recreation expenses and expenditures

The costs of measures to reduce the emissions of recreation boats and in harbours also have to be determined separately.

In Section 3.1.3, it is estimated that water quality improvement of implementing the WFD may result in an increase of the recreation expenditures in the Netherlands of roughly about € 0.1 billion. It may be assumed that these expenditures rise linearly with the water quality improvement or the reduction of the emissions.

The effects on the recreation expenditures might also be determined with the SEO recreation model. This model determines recreation intensities and expenditures depending on (the perception of people of) water quality. As this model cannot be
calibrated it is not at all sure that the results of this model are more accurate and more reliable than the rough estimates made above.

5.4 Modelling of benefits

Improving the water quality will have effect on the costs of public water supply. These costs might decrease. However, these cost savings are only partly dependent on the average improvement of water quality. More important is that the risk of exceeding certain threshold levels in surface water used as source of public water production is excluded. Than really cost savings are possible. This means that the cost savings do not increase linearly with the average improvement of water quality.

In Section 4.2, it is estimated that the cost saving of public water supply accruing to the households may amount to € 0.3 billion per year. As stated above these cost savings can be realised only by fully implementing the WFD. The cost savings of partially (over time) implementing the WFD probably are not significant.

The benefits to households increase with the level improvement of the water quality. It is not expected that the benefits will rise linearly with the improvement level. A convex course seems likely. The benefits of fully implementing the WFD are estimated at roughly about € 1 billion per year (see Section 5.2).
6. Conclusions and recommendations

The costs of public water supply for households, including small businesses, are about €0.7 billion per year. It is estimated that fully implementing the WFD might reduce the costs with €0.3 billion per year, but it is not sure that such a cost saving will actually be realized.

The costs of collection and treatment of waste water from households are estimated about €1.5 billion per year. Fully implementing the WFD will result in cost increases. The cost increase to households of additional treatment of implementing the WFD may amount to €0.2 to 0.5 billion depending on the degree of additional treatment needed.

In the Netherlands about 60 million day trips are made per year for water recreation. The expenditures for water recreation amount to about €4 billion per year. It is estimated that fully implementing the WFD might result in an increase of these expenditures of roughly about €0.1 billion per year.

It is estimated, that apart from the savings in public water supply as mentioned above, the household benefits of fully implementing the WFD amount to roughly about €0.7 billion per year.

It is complex and difficult to determine the costs, expenses and benefits of water quality improvement accruing to households accurately and reliable. Simplifying assumptions are needed that differ between the cost items and between the benefit items.
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Publications of the project “Water Economic Modelling for Policy Analysis”
(See also [www.ivm.falw.vu.nl/watereconomics](http://www.ivm.falw.vu.nl/watereconomics)):

### WEMPA reports

<table>
<thead>
<tr>
<th>Report number</th>
<th>Authors</th>
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</tr>
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<tbody>
<tr>
<td>WEMPA Report-01</td>
<td>Roy Brouwer</td>
<td>Toekomstige beleidsvragen en hun implicaties voor de ontwikkeling van een integraal water-en-economie model (in Dutch)</td>
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<tr>
<td>WEMPA Report-02</td>
<td>Paul Baan, Aline te Linde</td>
<td>Inventory of water system models</td>
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<td>WEMPA Report-03</td>
<td>Stijn Reinhard, Vincent Linderhof</td>
<td>Inventory of economic models</td>
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<tr>
<td>WEMPA Report-04</td>
<td>Rob van der Veeren</td>
<td>Development of policy scenarios and measures</td>
</tr>
<tr>
<td>WEMPA Report-05</td>
<td>Gideon Kruseman, Roy Brouwer, Vincent Linderhof, Stijn Reinhard, Paul Baan</td>
<td>Integrated river basin modelling: basic concepts and characteristics</td>
</tr>
</tbody>
</table>

### WEMPA working papers

<table>
<thead>
<tr>
<th>Working paper</th>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEMPA working paper-01</td>
<td>Paul Baan</td>
<td>Households and recreation: use and value of water</td>
</tr>
</tbody>
</table>
Development of policy scenarios and measures