ECORYS

Study supporting the revision of the EU Drinking Water Directive

Evaluation Report

Client: European Commission, DG Environment

Rotterdam, May 2016

Study supporting the revision of the EU Drinking Water Directive

Evaluation Report

Client: European Commission, DG Environment

Authors: Erik Klaassens, Hans Kros, Paul Romkens, Wim de Vries, Adriana Hulsmann, Joachim Schellekens

Study team

The study team supporting the European Commission in the review of Directive Study supporting the revision of the EU Drinking Water Directive is drawn from the following institutions:

Ecorys Nederland BV - an international organisation for economic consultancy and research. Its highly qualified staff members work to serve the interests of private and public clients worldwide. The company specialises in advice on complex market, policy and management issues and bases its work on the best available research, knowledge and expertise. Ecorys covers a wide range of water policy areas such as drinking water resources, production and distribution, wastewater collection, treatment and discharge, flood control, storm water surge, and drainage systems, coastal zone development, wetlands, climate adaptation urban and rural areas, and water pricing, privatisation of water companies, and governance. Ecorys has a strong track record in evaluating policies, programmes and institutions and in impact assessments.

Alterra (Netherlands) - part of the Wageningen University and Research Centre concern, Alterra offers a combination of practical and scientific research in a multitude of disciplines related to the green world around us and the sustainable use of our living environment. Alterra engages in strategic and applied research to support design processes, policymaking and management at the local, national and international level. Expertise includes the interactions between land and water management, land use and climate for the purpose of sustainable water management, taking account of various sectoral interests and ecological and habitat requirements.

ACTeon (France) - a research and consultancy bureau dedicated to innovative approaches to environmental policy. Specialized in the “soft” dimensions of the environment, i.e. (environmental) economics, sociology and governance issues, ACTeon is covering a wide range of policy issues, namely water, agriculture & the environment, forestry, marine resources, renewable energy, biodiversity. ACTeon is active in the European scene where its economic expertise is widely recognized (in particular in the field of water).

KWR Watercycle Research Institute (Netherlands) - owned by the Dutch water (cycle) companies, provides services to ascertain a well-functioning water cycle through optimal water management. KWR is responsible for the execution of the joint research programme of the Dutch water sector (water supply companies and water cycle companies). KWR has many years’ experience with the technical, scientific and administrative aspects of the Drinking Water Directive 80/778/EEC and 98/83/EC.

REC (Regional Environmental Centre for Central and Eastern Europe) is an international organization with a mission to assist in solving environmental problems. The Centre fulfils this mission by promoting cooperation among governments, non-governmental organizations, businesses and other environmental stakeholders, and by supporting the free exchange of information and public participation in environmental decision making.

Table of contents

Abbreviations

CAP	Common Agricultural Policy
CPD	Construction Products Directive
DWD	Drinking Water Directive
EAS	European Acceptance Scheme
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
ECI R2W	European Citizen Initiative *Right to Water*
E. coli	Escherichia coli
EPA	Environmental Protection Agency
EU	European Union
JC	judgement criteria
MS	Member State
NSF	USA National Sanitation Foundation
RBA	Risk Based Approach
WFD	Water Framework Directive
WHO	World Health Organization
WSP	Water Safety Plan
WSZ	Water Supply Zone[1]

Member States

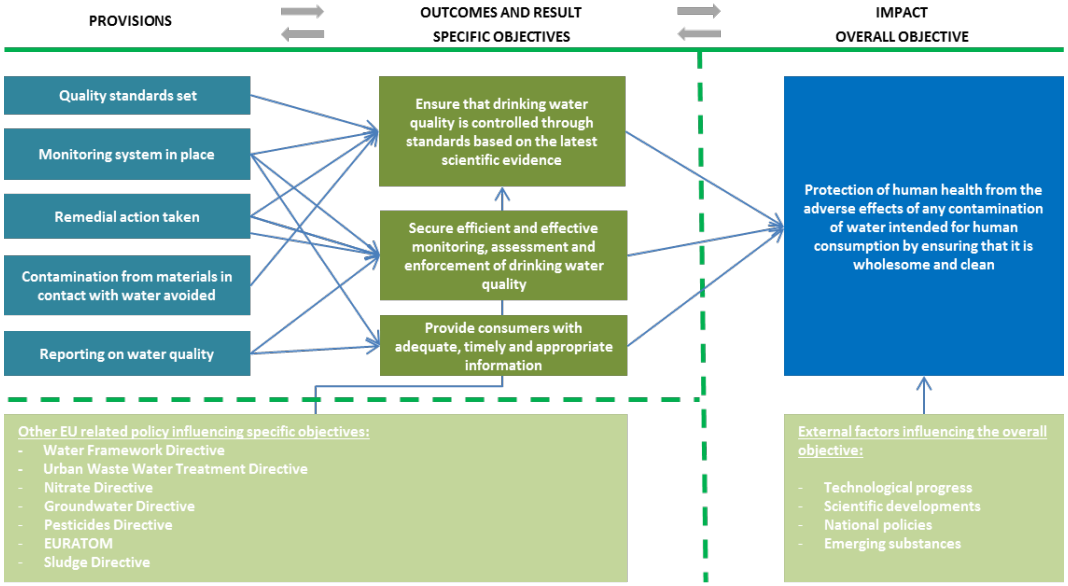
AT	Austria	IT	Italy
BE	Belgium	HU	Hungary
BG	Bulgaria	LV	Latvia
CZ	Czech Republic	LT	Lithuania
CY	Cyprus	LU	Luxembourg
DK	Denmark	MT	Malta
DE	Germany	NL	Netherlands
EE	Estonia	PL	Poland
FI	Finland	PT	Portugal
IE	Ireland	RO	Romania
EL	Greece	SI	Slovenia
ES	Spain	SK	Slovakia
FR	France	SE	Sweden
HR	Croatia	UK	United Kingdom

[1] The DWD defines small WSZ as serving less than 5,000 people or less than 1,000 m3 a day on average

Executive Summary

The Drinking Water Directive (98/83/EC)

The objective of the Drinking Water Directive (DWD) is to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean. Member States are to take measures necessary to ensure that water intended for human consumption complies with the requirements of the Directive, and that the measures taken to implement this Directive in no circumstances have the effect of allowing any deterioration of the present quality of drinking water. The requirements, set out in the specific provisions of the DWD are to ensure that drinking water is controlled through standards based on the latest scientific insights and to secure efficient and effective monitoring, assessment and enforcement of drinking water quality, and to provide consumers with adequate and timely information (see figure below).



Objective and methodology of the evaluation

The overall objective of this study is to assist the European Commission with the evaluation of DWD. To this end, the study assessed to what extent the provisions of the Directive have been effective, efficient, coherent and relevant and have provided value added at EU level. The evaluation covers the period 1998-2014.

As no impact assessment had been carried out prior to the adoption of the 1998 DWD, the counterfactual has been defined as what might have occurred if the 1998 DWD had not been in place. This makes a quantitative analysis problematic as recognised by the EC Better Regulation Package, and the evaluation therefore mostly relies on qualitative, reasoned arguments about the likely contribution of the DWD to the changes observed. In order to carry out the evaluation, an intervention logic and a methodological framework was developed on the basis of five evaluation criteria: effectiveness, efficiency, coherence, relevance, and EU added value. Guided by a set of evaluation questions, a combination of research tools was used. These tools included a review of relevant documents and publications, collection and analysis of data from published sources, analysis of the responses provided by Member States and stakeholders to the online survey (5,875 completed responses and 56 position papers), analysis of the outcomes of the stakeholder conference (70 attendants) and, finally, an interview programme.

Effectiveness of the DWD

It can be concuded that the Directive has been effective in terms of compliance rates for parameters which have improved for the period 1998 onwards and there is a broad consensus among experts that this conclusion can be extended to the objective of protecting human health from the adverse effects of any contamination of water intended for human consumtion (EQ1). An example of a significant improvement in compliances rates has been the stepwise reduction of lead and trihalomethanes in drinking water. Another significant result has been the reduction in the presence of the fecal indicator E.coli in drinking water. Less evidence exists for a DWD induced increase in compliance for several agriculture/catchment related parameters, such as pesticides and nitrate. The analysis also showed that water quality in small water supply zones is poorer than in large water supply zones.

The possible effect on human health of changes in compliance rates have been analysed for exceedences of chemical parameters and for waterborne pathogens. For chemical parameters, the effect on human health cannot be established as most incidences go unnoticed except in those few cases where there are acute physical effects or consumers reject tap water because of taste, appearance or odour (organoleptic aspects). Instead, water supply zones (WSZs) with exceedances of fluorite, lead, nitrate and nitrite are known to pose health risks. If the exceedance rates of these chemicals have reduced over time (such as for lead), it can be concluded that health risks due to drinking water have been reduced. For most other chemical substances cases of non-compliance cause no or low risk to human health. For micro organisms, two indicator parameters have been included in the DWD and for these indicators, epidemiological data have shown an increase rather than a decrease in incidences. For Legionella (the only micro-organisms which can be clearly linked to drinking water), this increase almost certainly reflects the improved national surveillance schemes and improved reporting between countries, making comparisons over time not very meaningful.

When looking at the impact of the DWD on drinking water sources compared to that of other directives (such as Nitrates, Pesticides, and Urban Waste Water Treatment Directive) only in two cases point to the DWD as the main contributing factor to a reduction in regulated substances: i) for deep groundwater contaminated with substances related to local geoechemical conditions (arsenic); and ii) for shallow groundwater contaminated as a result of incidences such as industrial spills. For parameters for which exceedances are related to causes in the distribution network (especially lead and copper), the DWD has been one of the main drivers which has resulted in the decrease of non-compliance.

The Directive's provisions for setting parameters, monitoring, remedial action, reporting and for materials in contact with drinking water have mostly been effective for the protection of human health (EQ2). For the individual provisions the following findings have been recorded:

- The selection of parameters for the 1998 DWD was based on WHO guidelines and the opinion of the Commission's Scientific Advisory Committee. There has been widespread agreement that this choice reflected the latest scientific insights. As for updating the list of substances in Annex I, the requirement for regular (five-yearly) review has been duly followed, but this has not resulted in adaption of the list even though some of the substances have become less relevant and other new ("emerging") substances which are a potential health threat have not been included. An important reason for not updating Annex I has been the lengthy (legislative) procedure (ex "codecision").
- The DWD requires Member States to set up systems to he quality of drinking water. This has been done in most Member States where effective systems for collecting and analysing information on water quality are now in place. Although the quality of monitoring (mostly related to the frequency of taking samples) has improved over the past 17 years, it is still low for some

Member States. Especially in the case of small water supply zones (not subject to regular reporting to the EC) the lack of monitoring has led to insufficient insight into the quality of its drinking water.

- Remedial actions are to be taken in case the water supplied does not meet the standards in the DWD. This provision has been effectively used by Member States to re-establish good quality drinking water, as evidenced by the (modest) increase in the observed compliance of microbiological and chemical parameters in the period 2005 – 2013. However, with over 5,000 remedial actions reported by 12 countries in that period, a more pronounced increase in compliance could have been expected.
- The need to regulate materials and substances in contact with drinking water was correctly recognised in the DWD, as products used for the distribution of drinking water may have a negative effect on human health. However, national approval systems have not been harmonised at EU level which constitutes a technical barrier to trade, which makes the provision ineffective (only some specific standards on on durability and performance have been produced). Currently some Member States are introducing systems to test all new materials, raising concerns on the administrative costs involved.
- Member States are to provide adequate and up-to-date information on water quality for human consumption to the public tri-annually (Article 13 of the DWD and Guidance Document on Reporting under the DWD (2011). The reporting obligation has improved transparency and knowledge on the quality of drinking water for consumers, one of the elements missing from the 1980 DWD. Although most Member States follow the reporting guidelines, and national reports on drinking water quality has been available through webites and other means, consumer satisfaction on the information has been low. Furthermore, as Member States are only required to provide data on WSZ for supplies exceeding 1,000m^3 per day or more than 5,000 persons, non-reporting affects some 15 percent of consumers. In addition, Member States are to send their reports to the Commission. Although this requirement is generally complied to, giving the Commission an overview of the quality of drinking water in the EU, the evaluation found gaps in the continuity of the reported data and the quality of reporting varies. The Commission therefore lacks adequate information to perform a thorough analysis of drinking water quality developments in the EU on which to base its policy monitoring.

There have been several factors that influenced or stood in the way of achieving the objectives of the DWD (EQ3), such as:

- Member States have not always succeeded in supplying water in compliance with the quality requirements of the DWD, and in some cases non-compliance was not immediately addressed. Causes of non-compliance have been mostly related to treatment and distribution systems.
- In some cases the instrument of derogation was stretched to the limit, not only using a first and second derogation period but also requesting a third period (of three years). This raises the question if actions were taken to remediate problems as soon as technically possible.
- Insufficient knowledge of the location and quality of drinking water supplied by small water supplies can have an impact on achieving the objectives of the DWD.
- Even though Article 4 addresses all substances and organisms that might impact on the quality, not all water suppliers will (be able to) look for all factors that might adversely affect the quality.
- There is insufficient knowledge of the many new substances on the market and entering the aquatic environment. This includes absence of a total overview of substances, toxicological impacts and analytical methods to detect and quantify.
- Sampling water at the tap is not always possible due to national legislation that prohibits water suppliers entering private premises. This is an important factor in some Member States that does not help to achieve the objectives of this ‘tap water Directive’.

The study identified some results beyond the main aim of the DWD (EQ4), namely:

- Hightened consumers awareness on the quality of their tap water.
- A reduction in the use of nitrate and pesticides (in combination with other legislation).
- A decrease of metals in wastewater originating from plumbing.
- Cost reductions for industries (such as food and tourism) which do not treat water anymore.

Efficiency of the DWD

By comparing the costs involved with implementing the DWD with the (assumed) health benefits of the DWD, it is concluded that the DWD is efficient as benefits outweigh costs (EQ5). The total cost for supplying drinking water in the EU in 2014 amounts to roughly €46.5 billion of which around 18% (€8 billion or €16 per capita) can be attributed to the implementation of the DWD.[2][3] Benefits of providing wholesome and clean drinkingwater to consumers is related to a reduction in exceedences. The direct causal relationship between a reduction in exceedences and (health) benefits can not be made. Subsequently a direct link between DWD provisions and total health benefits can not be assessed using quantitative methods. However, it was found that the lead standard set by the DWD and the subsequent replacement of lead pipes or dosing of orthophosphates has significantly contributed to a lower level of exposure through drinking water across Europe.[4] Other notable benefits that can be attributed to the DWD are the organoleptic improvements with respect to drinking water, having an EU baseline regulatory framework in place that sets an equal minimum standard and also reduces the need to invest in additional water treatment by the food industry. Based on these arguments and supported by a majority of stakeholders, it is concluded that the benefits of the DWD regulation outweigh the costs of implementation.

There have been various technical and other developments since the elaboration of the DWD which have contributed to an improved efficiency of the DWD (EQ6). First is the use of water safety plans to describe water supply systems which can lead to faster decision making in case a distortion in water quality is found. These plans can also result in less monitoring efforts for parameters that are (almost) absent, and thus increase efficiency of monitoring by focussing on parameters that are of real importance in a given water supply zone. Second, new methods for the analysis of water quality such as molecular tools give faster, more sensitive and more specific results compared to the current methods based on culturing.

Efficient policy monitoring has not been possible as Member States have not been able to supply reliable, quantitative, and up to date information (EQ7). As highlighted under effectiveness, there have been limitations to the (quality of) information in Member States reports related to inconsistencies in methods of sampling, methods of analysis and in reporting formats. Also reporting on small water supply zones has only been actively pursued by the EC from 2011 onwards. These limitations obviously have had a negative effect on the quality of the synthesis reports and therefore on the ability of the Commission to use this information for policy monitoring.

---

2 The share of total cost per MS that is related to provisions in the DWD (the attributability) has been estimated through a combination of interviews with MS experts and expert judgement.

3 Calculated by extrapolation information available from 6 MS. The extrapolation is based on population and income differences and the total cost figures provided should be seen as a rough indication of actual cost.

4 It is beyond doubt that lead levels in drinking water have been reduced since the stricter standard, but it is not directly possible to determine the effect of the DWD as other interventions were taken at the same time.

Coherence of the DWD

The DWD is found to be internally coherent except in relation to i) sampling at the tap for some substances and ii) Article 10 on materials in contact with drinking water (EQ8). Regarding the first issue, Member Sates water authorities are supposed to regulate drinking water quality at the tap but not all Member States have legal access to domestic premises and furthermore, the provision (and Annexes) do not make clear how representative samples are to be taken. As for materials in contact with drinking water, the parametric values mentioned in Annex I are predominantly related to the treatment and distribution of drinking water and not to the materials used for installations. Although this can be seen as a lack of understanding rather than an issue of internal coherence, the result is that a diversity in approval systems among Member States is emerging, creating an additional administrative burden to enterprises opeating in more than one Member States.

The DWD is coherent with Directives relevant for drinking water such as the Water Framework Directive and the Nitrates Directives (EQ9). Both Directives set values for the protection of water sources intended for the production of drinking water. The Urban Waste Water Treatment Directive for improving the quality of receiving waters. The coherence of the DWD with the Water Framework Directive is especially important as the protection of drinking water resources is established as an indispensable part of the plans and measures under the WFD. Water managers and water boards in many Member States therefore work jointly with water supply companies to achieve the high quality in water resources and to protect these water supplies.

Relevance of the DWD

The DWD has been highly relevant when considering its overall objective of providing wholesome and clean drinking water to improve and/or safeguard human health (EQ10). Having in place a Directive with requirements that set an overall minimum quality within the EU ensures that there is an equal level of protection from any adverse effects drinking tap water might have on consumers. Secondly, the DWD has provided a framework that, compared to the previous directive, brought more transparency and harmonisation.

In the past the scope of the DWD did not cover all the needs of EU citizens. The recent revision of Annex II and III has addressed this issue. Next to the parameters currently included in the DWD other parameters have emerged as a risk to human health, such as: virus, parasites (e.g. Legionella), chlorophenols, microcystin and uranium. These and other (emerging) pollutants has made Annex I less relevant. It was found that there is a growing demand to better link EU legislation on drinking water with the needs of citizens regarding information provision and participation . This demand has emerged in spite of the fact that EU citizens consider their drinking water of good quality and generally affordable.

The section below discusses the relevance of each of the main provisions:

- Parameters included in the DWD are considered relevant indicators of water quality. Overall Article 5 on quality standards and the need for transposition to national legislation has been essential to ensure a minimum level of water quality.
- Monitoring is necessary for the verification of the parametric values set in Annex I of the Directive. The required frequencies, with reduction possibilities, might still result in unnecessary sampling and analytical efforts. Some ten Member States have experience with using a risk-based approach, based on a risk assessment for the water supply zone and targeted monitoring. These Member States consider that the risk-based approach is relevant in view of the overall objective of the DWD.

- Remedial actions form an essential link in the DWD by coercing water suppliers to improve deviating water quality. The provision of remedial action is crucial for Member States as it provides enforcement authority to take measures in the case of non-compliance by drinking water producers.
- Stakeholders recognised the need to regulate materials in contact with drinking water at EU level. The provision, Article 10, in the DWD is however much debated as it did not lead to the desired harminozation across all Member States. This provision, in its current state, has not been found to be very relevant in addressing objectives of the DWD.
- Reporting information is relevant as it provides a regular overview of the water quality per large water supply zone to consumers and the Commission. The information provided to the Commission is relevant to prepare evidence based policy. In addition, the EC has asked the Member States, refering to Treaty, to provide information on the quality of water supplied by small water supply zones (two requests were made). Since then more is known about the water quality of small water supplies and even more importantly, more attention is now given to these supplies by both Member States and the EC.

EU added value of the DWD

The improvement of the water system directly contributes to overall public health which is one of the main priority actions of the EU (Article 9, TFEU), and without drinking water legislation in place at EU level, it is unlikely that improvement in water quality would have been as widespread as we witness today (EQ11). The reasons are:

- All Member States are progressing towards the same level of drinking water quality;
- The DWD has stimulated and enhanced the information to consumers especially in areas where internet-based tools and social media are widely available. This has led to an increased awareness of the importance of high quality drinking water;
- The DWD is an opportunity to optimize processes and share knowledge between Member States EU institutions and WHO, resulting in various efficiencies and cost savings for both water utilities and governmental institutions and bodies; and
- Efficiency gains of the availability of drinking water for industry that uses water of drinking water quality for production (e.g. food industry), and harmonization of production processes across borders. Secondly, minimum standards for water quality improves the internal market by ensuring a level playing field for water intensive industries (Art. 114, TFUE).

Comparing EU legislation on drinking water with that in other regions shows considerable health gains in the EU compared to less developed countries and lessons to be learned from other approaches (EQ12). It has not been possible to link cases of polluted drinking water in the EU to the number of people fallen ill with waterborne diseases, but the numbers involved are far lower than in less developed countries. Benefit-cost ratios of investing in drinking water in other regions therefore are much higher than in the EU. For example, providing urban populations in India and Indonesia with safely managed drinking water services requires investments per capita of €18 and €32 respectively. In comparison, in the EU the cost per capita is estimated at €91.

Comparing legislative approach towards drinking water in the EU with that in the USA, Canada, Australia and New Zealand it was found that monitoring approaches are somewhat similar although most of the other countries have already adopted a risk-based approach. A second difference is that in the USA the public (consumers) is more actively involved in the various stages of drinking water management. Thirdly, certification for products in contact with drinking water is required in Australia and recommended in Canada. In both cases, the safety of new materials is embedded in legislation related to construction standards and not in specific legislation for drinking water.

1 Introduction to the study

1.1 Objective and scope of the study

The study aims to support the Commission in the evaluation of the Drinking Water Directive (DWD), in line with the requirements of the regulatory fitness programme (REFIT) of the European Commission.[5] This evaluation is a direct follow-up to the first successful European Citizens' Initiative (ECI) *Right2Water -Water and sanitation are a human right! Water is a public good, not a commodity!*[6]

The evaluation has been conducted in line with the EC evaluation guidelines and evaluation standards, including the identification of those provisions of the Directive which would benefit from a revision and of those which are still fit for purpose is expected.

This report is the key deliverable of the evaluation process, presenting the critical judgements and answers to the evaluation questions.

1.2 Policy context of the 1998 Drinking Water Directive

High-quality, safe, sufficient drinking water is essential for life: we use it for drinking, food preparation and cleaning.[7] For the past 30 years, EU drinking water policy has been designed to ensure that water intended for human consumption can be consumed safely on a life-long basis, and this represents a high level of health protection.

European water policy began in the 1970s with the adoption of programmes as well as legally binding legislation. As regards programmes, the First Environmental Action Programme covered the period 1973–1976. In parallel, a first set of legislation was adopted, starting with the 1975 Surface Water Directive and culminating in the 1980 Directive relating to the quality of water intended for human consumption (80/778/EEC).

The underlying principle for the previous Directive was –similar to the current Directive - that, in view of the importance for human health of water for human consumption, it was necessary to lay down quality standards with which water was to comply. To this end, the 1980 Drinking Water Directive established a high number (62) water quality standards regulating water intended for human consumption.

However, in spite of the many benefits of the 1980 Directive, by the end of the 1980s, it was realised that there were some shortcomings. For example, the Directive did not provide Member States with an adequate legal framework within which to respond to variations in the quality of raw water and to the technical difficulties encountered in the production and distribution of drinking water. Furthermore, both scientific and technological knowledge had changed substantially during the decade that had passed,[8] and it was necessary to adapt the original Directive in accordance with the principle of subsidiarity by reducing the number of parameters for which Member States

[5] Regulatory Fitness and Performance Programme (REFIT): State of Play and Outlook Accompanying the document Better Regulation for Better Results – An EU Agenda {COM(2015) 215 final} {SWD(2015) 111 final}

[6] Commissions' reply to the ECI - (COM(2014) 177 final)

[7] European Environment Agency (2014). Performance of water utilities beyond compliance. ISSN 1725-2237, Copenhagen.

[8] Towards Effective Environmental Regulation: Innovative Approaches in Implementing and Enforcing European Environmental Law and Policy; Demmke (2001).

were obliged to set water quality objectives and by focusing on compliance with essential quality and health parameters. The new Directive also aimed to provide for the safeguarding and promotion of sustainable use of water intended for human consumption, an objective which can be considered as foreshadowing the Water Framework Directive. In the 1998 DWD, three groups of standards were identified which are important for the quality of drinking water and are relevant for the EU as a whole. Some standards had been revised based on then new scientific evidence to better protect human health.

The legal process for the new Directive started in 1994 with the submission of the "Proposal for a Council Directive concerning the quality of water intended for human consumption".[9] After a first and second reading by the European Parliament, the Directive was formally adopted by the Council of the European Union on November 3, 1998.[10] After the Directive had been adopted, Member States have transposed and implemented the standards at national level to ensure the same level of protection all over the EU.

The key aim of the Directive is to protect human health from the adverse effects of contamination of water intended for human consumption by ensuring that it is `wholesome and clean' (Art. 2(1) and 3). It applies to all water intended for human consumption, as well as water used in the production and marketing of food, subject to certain exceptions including natural mineral waters which are regulated pursuant to Council Directive 80/777/EEC (Art. 2(1)).

1.3 Intervention logic

The intervention logic as shown in Figure 1-1 presents a birds-eye-view of the objectives and the anticipated effects. It illustrates, in particular, the expected linkages between the identified needs and broader policy goals and the more specific operational objectives of the Directive. This intervention logic is described in more detail below.

Objectives. The key (global) objective of the DWD is "to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean".[11] As the causal link between contaminated drinking water and human health is often difficult to determine, the effect of the Directive is usually measured by a proxy-indicator: compliance rates with with the drinking water standards (parameter values). In addition, this study has looked in the changes in water-borne diseases. Indirect impacts (not indtended) include i) land-use in water abstraction zones; ii) agricultural behaviour related to fertilisation and use of plant protection products; and iii) research and production of water distribution material.

The specific objective of the Directive are to i) to ensure that drinking water quality is controlled through standards based on the latest scientific evidence; ii) secure an efficient and effective monitoring, assessment and enforcement of drinking water quality; and iii). provide the consumers with adequate, timely and appropriately information.

Output and activities. The Directive's provisions provide the legal context for actions by Members States (MS) and the Commission (EC). These outputs and related actions are discussed in more detail in the following chapters. Below we list the six outputs that are considered to be the core

[9] Proposal for a Council Directive concerning the quality of water intended for human Consumption (95 /C 131 /03) COM(94) 612 final — 95/0010(SYN), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:51994PC0612&from=EN.

[10] Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31998L0083&from=EN.

[11] *Ibid*; Article 1.

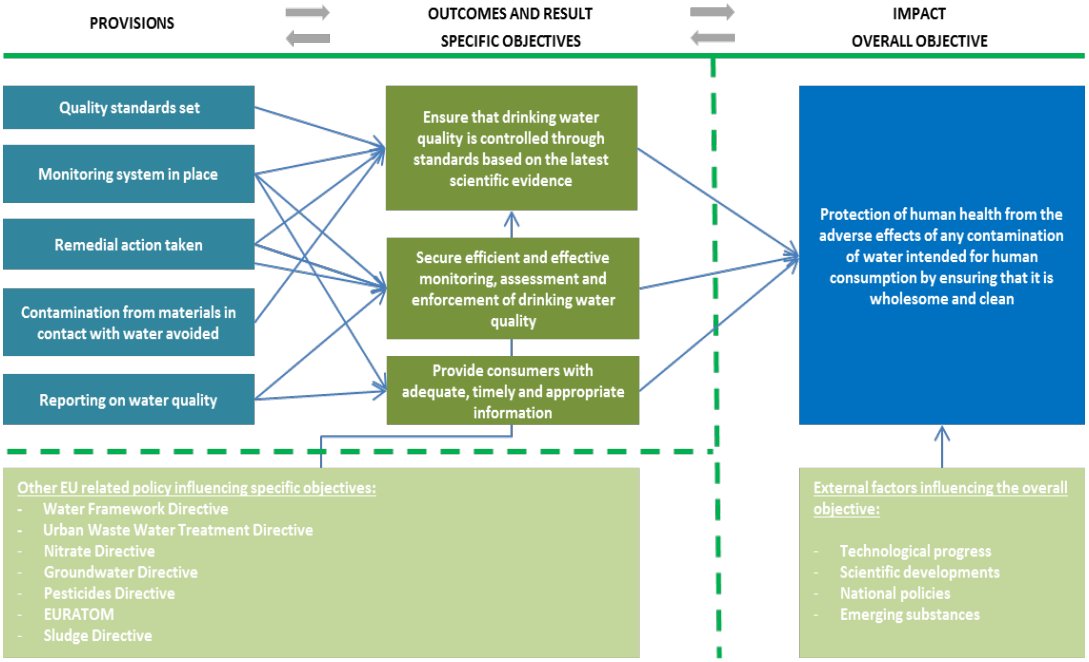
provisions of the Directive, together with the related activities. A schematic overview of the intervention logic is presented overleaf:

- Parametric values set:
  - Parametric values are determined at EU level;
  - MS set values for other parameters.
- Standards set for materials in contact with drinking water
  - MS to set up an approach to avoid contamination from materials in contact with drinking water.
- Limited derogations provided:
  - Limited derogations are prepared / approved by MS or Commission.
- Monitoring system in place:
  - Monitoring performed by MS according to Annex II and III of the DWD;
  - Supply zones and water distribution are established and adapted.
- Remedial actions taken:
  - Remedial actions are taken by MS;
  - Measures are taken to reduce or eliminate the risk of non-compliance;
- Reports on water quality available:
  - Monitoring performed by MS;
  - Up-to-date information is made available to consumers;
  - Reports on water quality are submitted to the Commission.

External factors. There is a number of external factors with important consequences for the Directive's impact, results and outputs. These factors, which will be discussed at appropriate points in the report include, are among others:

- National/regional characteristics related to drinking water management such as abstraction sources, disinfection;
- Evolution of treatment techniques;
- Scientific development of analytical methods;
- Other EU legislation (water framework, agriculture (CAP), nitrates, pesticides, food, construction products);
- Pressures related to human and economic activities;
- Climate change effects (floods, droughts, scarcity).

Figure 1 Intervention logic DWD



Source: Ecorys (2015)

1.4 Evaluation methodology

1.4.1 Evaluation approach

According to the Commission's Better Regulation Guidelines for Evaluations and Fitness Checks, all evaluations are to consult on the mandatory evaluation criteria, which are[12]:

- Effectiveness of the intervention;
- Efficiency of the intervention in relation to resources used;
- Coherence of the intervention with other interventions which share common objective;
- Relevance of the intervention in relation to the identified needs/problem it aims to address; and
- EU added value resulting from the intervention compared to what could be achieved by Member State action only.

These criteria have been used in this evaluation and linked to the DWD intervention as illustrated in Figure 1-2. A set of evaluation questions from the Evaluation Roadmap, has guided the process of assessing the evaluation criteria.[13]

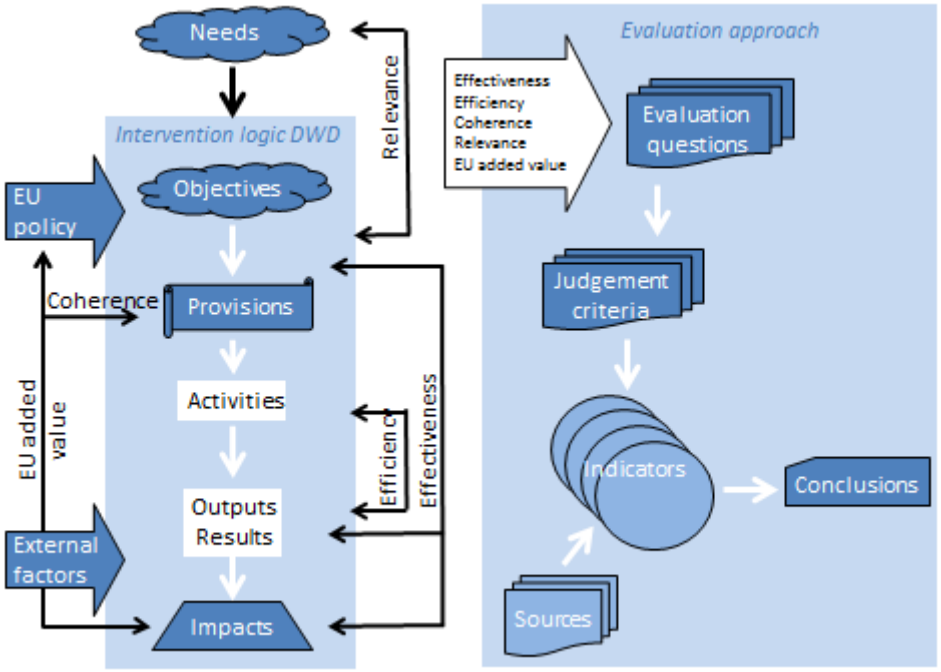
To help answer the evaluation questions, judgement criteria (JC) have been defined for each of the evaluation questions. For each of the judgment criteria, indicators were defined.[14] In the figure below we illustrate the linkage between the various elements of the intervention logic and the evaluation methodology.

[12] Commission Staff Working Document "Better Regulation Guidelines", {COM(2015) 215 final}; {SWD(2015) 110 final}. Note: this study started before the new REFIT guidelines were published.

[13] http://ec.europa.eu/smart-regulation/roadmaps/docs/2015_env_041_drinking_water_en.pdf.

[14] See Annex A

Figure 2 Linking the intervention logic with the evaluation approach



Source: Ecorys (2015)

Where available, quantitative indicators were used. However, in most cases information on indicators was only available in qualitative terms and judgements were based on plausible reasoning. The lack of quantitative information was particularly problematic for the analysis of costs and benefits. Benefits are mostly related to the avoidance of illness and research carried out in his domain does generally not provide input for a qualitative analysis. On costs, two paths were followed. A top-down approach analysing the total income of the drinking water sector (as proxy for costs), the breakdown into cost categories and attributability to the DWD and a bottom-up analysis (that better reflects national differences) for which we were able to assemble data on some but not all cost categories related to drinking water. The link of these categories to the Directive is not always clear and the study adopted the approach of attributability assessment through national experts to obtain an as close as possible percentage attributable per MS for a series of 'practical' DWD effects. A more detailed discussion the efficiency methodology and its limitations is found in chapter 2.2.1.

1.4.2 Evaluation questions

Below we list the evaluation questions for each of the five evaluation criteria. As the nature and scope of these question vary considerably, the depth and scope of the analysis also vary.

Effectiveness analysis considers how successful EU action has been in achieving or progressing towards its objectives. The evaluation is to form an opinion on the progress made to date and the role of the EU action in delivering the observed changes. We will therefore look at changes in compliance with the drinking water quality standards, and relate these with the actions called for by the Directive's provisions. The evaluation questions related to effectiveness are:

EQ1 To what extent has the Directive achieved its objectives, e.g. to reduce contamination of water intended for human consumption and to protect human health?

EQ2 Have the specific and the general provisions of the DWD been effective for protecting human health and why?

EQ3 What main factors, in particular related to water bodies, agriculture and distribution networks, have influenced, or stood in the way of, achieving the objectives of the DWD?

EQ4 What results did the DWD achieve beyond its main aim to protect human health, and the Directive cause any other unexpected or unintended changes?

Efficiency considers the relationship between the resources used by an intervention and the changes generated by the intervention (which may be positive or negative). In order to assess if the DWD is efficient, the evaluation looks at the various cost categories related to the provisions of the Directive such as administration, monitoring, remedial actions, and reporting and relates these to the (changes in) volume of water supplied or number of people served. The evaluation also looks at the benefits related to providing wholesome and clean drinking water. These benefits are largely indirect (such as avoiding cost of sickness and absence of work) and difficult to quantify. Questions on efficiency are:

EQ5 To what extent are the costs involved with implementing the DWD justified given the benefits which have been achieved?

EQ6 Have there been technical or other developments since the elaboration of the Directive that could contribute to achieving the objective more efficiently?

EQ7 To what extent does the Directive allow for efficient policy monitoring?

Coherence of the DWD is assessed at two levels: i) by verifying to what degree the internal provisions of the Directive work together or not and ii) if verifying the interlinkages with other legislative acts in the same policy field that came into force afterwards. Questions on coherence are:

EQ8 To what extent are the DWD provisions internally coherent?

EQ9 To what extent can effects (on quality of drinking water) be linked to provisions in other EU legislation -in particular regarding pollution prevention water abstraction, preparation and distribution (including materials and products used)?

Relevance looks at the relationship between the needs and problems in society and the objectives of the intervention. In this context, the evaluation needs to establish whether the overall objectives of the Directive in terms of improved drinking water remain fit-for-purpose and it needs to look at any changes in the regulatory framework over the last years. More specifically, the evaluation looks at the relevance of drinking water parameters and at the relevance of other important provisions. The evaluation questions related to relevance are:

EQ10 To what extent is the DWD approach still appropriate and are the specific provisions still relevant?

EU-added value looks for changes that can reasonably be related due to EU intervention, rather than non-EU interventions. In many ways, the evaluation of EU added value brings together the findings of the other criteria, presenting the arguments on causality and drawing conclusions, based on the evidence to hand, about the performance of the EU intervention. Questions on coherence are:

EQ11 What has been the EU added value of the Directive?

EQ12 Is there any possibility to compare EU legislation on drinking water quality with what is in place in other regions?

Annex A (Evaluation matrix) brings together the evaluation questions, judgement criteria, indicators, and the sources of information. The matrix initially included in the Inception Report was slightly adapted to reflex more fully the elements contained in the Evaluation Roadmap.

1.4.3 *Information sources*

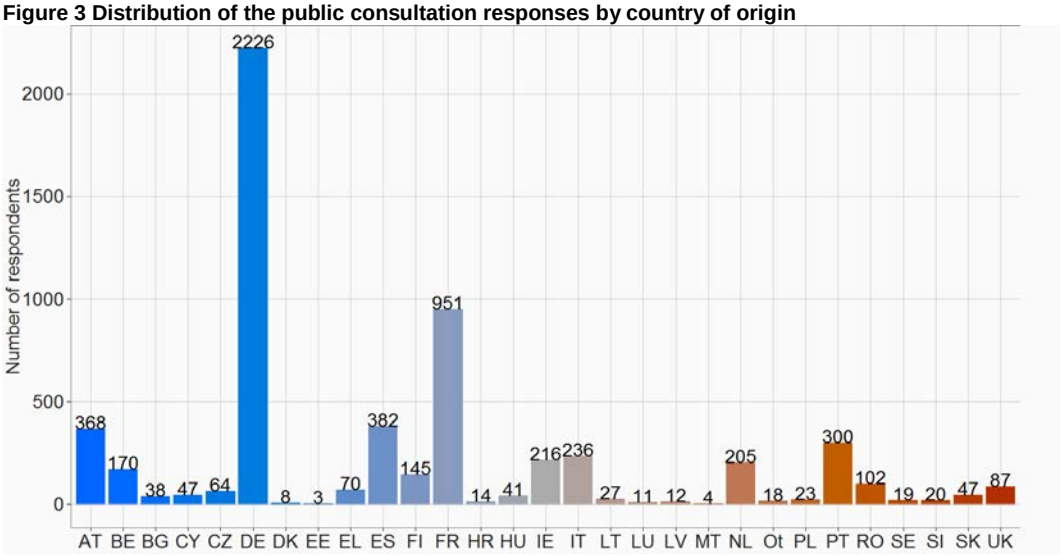
In this section we list the relevant information sources which were used to obtain the necessary information for this evaluation and we discuss the limitations linked to these information sources. Besides these sources, the study team was able to draw on the available expertise of the consortium partners, notably KWR and Alterra.

Public Consultation

In 2014, the Commission launched an EU-wide public consultation on the DWD, notably in view of improving access to quality drinking water in the EU. The aim of this consultation was to get a better understanding of citizens' views on the need and the possible range of actions which could be undertaken in order to improve the supply with high quality drinking water. The survey was opened from 23.06.2014 until 23.09.2014 at http://ec.europa.eu/eusurvey/ (see the questionnaire in Annex 3) and was available in all EU languages. The report on the Public Consultation is part of the current evaluation study and provides a valuable source of information. The draft report is available online as a separate document: "Analysis of the public consultation on the quality of drinking water".[15]

In total, 5908 answers were received. Some surveys were incomplete and hence removed from the database. The final database therefore consists of 5875 surveys. In addition to the survey, stakeholders (national authorities, international organisations, non-governmental organisations and other interested parties including individual citizens) were invited to submit their position on the issues addressed in the questionnaire. As a result of this invitation 56 positions form institutions were received. Furthermore a total of 80 citizens also expressed their opinion and sent their positions.

Figure 3 Distribution of the public consultation responses by country of origin



Source: Ecorys (2015)

After accounting for the biased answers, the survey answers were each given unique identification number. All answers to open questions were translated into English and all closed questions were coded. Identification of data was done according to; the type of respondent; type of institution; type of sector; country of origin; type of area – rural or urbanized; and the size of the WSZ.[16] Country-related weights were calculated and attributed to each response in the survey. These weights are proportionate to the share of the population per member state in total EU population and they are

[15] Analysis of the public consultation on the quality of drinking water; Ecorys (2015); http://ec.europa.eu/environment/consultations/pdf/analysis_drinking_water.pdf

[16] Large water supply zone (serving more than 5,000 persons) or a small water supply zone (serving less than 5,000 persons).

inversely related to the number of responses to the public consultation received. The aim of the attribution of weights is to ensure that the average proportions analyzed better represent outcomes at EU level.

The outcome of the survey provides the evaluation study with some very interesting and important outcomes, such as:

- Drinking water in the EU is perceived as accessible (82%), as long one does not go abroad;
- Drinking water and drinking water services are affordable in the EU (65%);
- The quality and sensation of drinking water in the EU is acceptable (71%).

However, there are also threats to the quality of drinking water. Consumers perceive the pollution from agriculture (such as pesticides and fertilizers), abstraction of hydrocarbons (shale gas and oil), industrial sources (heavy metals) and human consumption in combination with inadequate treatment (ammonium and nitrate).

Respondents were additionally asked to provide feedback regarding the functioning and future aims of the DWD. Questions related to the quality standards in the DWD, the monitoring approach and control of drinking water, outcome of activities to inform consumers on the quality of their drinking water and most effective ways to improve providing information to consumers. The most notable results are provided below:

- Consumers disagreed (55%) with the statement that the list of parameters to be monitored could be reduced to a few key parameters, most relevant for human health.
- 57% agreed that the parameter list should be updated to include new and upcoming polluters, however this should only in special cases lead to an increase in costs for the consumer.
- Consumers believe that monitoring should not be reduced and that results need to be more transparent and available (through online fora).
- Consumer information should, if not done already, be easily available to consumers and more importantly be understandable for the general public. In the coming years consumers additionally expect that information is more up-to-date or near real-life.
- In the case of a pollutant in the water supply around 50% of respondents believe that the current regime for taking remedial action is OK. However, the current regime should be supplemented by additional preventive actions (and faster communication if there is a drinking water problem).
- Respondents were not overly positive or negative when it came to derogations. Overall the data shows however that respondents favour a reduction in the number of granted of derogations. Furthermore a new derogation regime should be stricter.

In additional to this, respondents were invited to provide feedback in a broader context. Main interest of respondents, with respect to possible aims that the DWD can in the future deal with, are related to materials in contact with drinking water, incentives to reduce the amount of drinking water consumed, move from controlling at the tap towards a system control approach and inform consumers on the possibilities of water reuse in households.

Stakeholder conference

At an early stage of the evaluation, a stakeholder conference was organised. The goal of the conference was to inform stakeholders on the evaluation methodology approach and to gather information on the functioning of various aspects of the DWD. The stakeholder conference provided an interesting platform where participants shared opinions regarding the functioning of the DWD. The stakeholders represented industry (17), consultants (2), research centres or universities (4), government or public authorities (13), and NGOs or civil organisation (2).

The outcomes of the stakeholder conference fed - together with the first desk research and preliminary expert opinions - into the development of interview questions, which the project team used to approach various MS regulators, water utility operators, members of the academia, members of the industry and consumer stakeholder groups to collect further information for the main evaluation questions.[17]

Desk research

The desk research has involved a review of a wide range of documents; a bibliography of which is provided in Annex E. These include, among others, Member State reports on investments in drinking water, EUR-Lex reports on parametric values (national monitoring data, including derogations per parameter and member state), position papers from various stakeholder groups and the text of other relevant Directives. Some of the main considered reports/papers are:

- Appelman, J. & B. Mendel (2015) Presentation on the lessons learned and the need for European harmonisation. *Symposium on materials and products in contact with drinking water*. *Brussels;*
- EPA (2002) Assessing the benefits of Drinking water regulations: A primer for stakeholders;
- European Commission (2015) Regulatory Fitness and Performance Programme (REFIT). State of Play and Outlook;
- VEWA (2015) Comparison of European Water and Wastewater Prices;
- World Health Organization & Unicef (2011). Guidelines for drinking-water quality. Fourth edition: volume 1 Recommendations. Geneva.

Interviews with key stakeholders (30)

After the stakeholder conference consortium experts developed a list of questions which was used to collect additional, where possible evidence-based, information regarding the functioning of the DWD on the five main evaluation criteria. The evaluators interviewed various MS regulators, water utility operators, members of the academia, members of the industry and consumer stakeholder groups. A full list of all interviewed persons is found in Annex F. In total experts from 16 MS are interviewed directly and presumably more MS have provided input through their representative organisation in Brussels and (6) interviews with some of these organisations.

1.4.4 Information challenges

It is recognised by the EC Smart Regulation Guidelines that when evaluating EU legislation, it is particularly difficult to identify what the situation would have been if a piece of EU legislation had not been adopted (the counterfactual), making absolute quantitative analysis problematic[18]. Therefore, this evaluations mostly relies on qualitative, reasoned arguments about the likely contribution of the DWD to the changes observed. Furthermmore, where “hard data” was available (e.g. on the non-compliance rates at MS level), the data gathering process was frustrated by the uneven quality and quantity of data.

1.5 Structure of this report

After this introductory chapter, the following five chapters are devoted to the five evaluation criteria (effectiveness, efficiency, coherence, relevance and EU added value). For each of the evaluation questions the evidence relating to the judgement criteria is described and analysed, and at appropriate places conclusions are drawn. These conclusions are summarised in Chapter 7.

[17] Report on the first stakeholder meeting on 26th of May can be found here: http://www.safe2drink.eu/dwd-evaluation/

[18] http://ec.europa.eu/smart-regulation/guidelines/ug_chap6_en.htm

2 Effectiveness

The evaluation of the effectiveness of the Drinking Water Directive is based on evaluation questions which focus on the degree in which the Directive has reduced the contamination of water intended for human consumption (EQ1), the appropriateness of the specific obligations (EQ2) and the main factors influencing the objective of the DWD (EQ3). The monitoring reports by national authorities and the periodic synthesis reports of the Commission offer a good basis to perform an assessments of the effectiveness. Based on this data we evaluated the recorded trends in concentrations over time in view of the protection of drinking water, i.e. the parametric values. Furthermore we assessed where and under what circumstances non-compliance occurred (locations of and their characteristics in terms of Source-Pathway-Receptor aspects (e.g. industrial area in a region with sandy and receptor is surface water or rural area with small water supply zones).

2.1 To what extent has the Directive achieved its objectives? (EQ1)

The answer to the first evaluation question is based on an analysis of three judgement (or success) criteria: i) the compliance rates for parameters show an improvement of drinking water quality (JC1.1); ii) the improvement of drinking water quality has had a positive effect on human health (JC1.2); and iii) the DWD can be considered the main factor in the improvement of the quality of water intended for human consumption (JC1.3).

2.1.1 Compliance rates of parameters show an improvement in water quality in the EU (JC1.1)

Parameters selected for analysis

For the first judgement criterion we have analysed the changes in compliance rates of parameters, making a distinction between microbial, chemical and indicator parameters. The following datasets were used for the evaluation of the compliance:

- Non-compliances (drinking water contamination data) of the selected parameters in time based on synthesis reports at MS level (1993-2005) and more detailed information since 2005 using the plain submitted data by the MS including the period 2005-2013[19].
- Based on summary reports at MS level and the Eionet data, trends of the water quality at EU level were evaluated in terms of compliance of parameters that have been monitored during the whole period 1993 – 2013.

It should be noted that this analysis does not cover (emerging) parameters not regulated by the DWD. Furthermore we noticed that to some extent the usefulness of the available Eionet data was limited due to erroneous and /or missing data. As a result, it was possible to evaluate the compliance during the whole monitoring period 1993 – 2013 for 9 parameters in only four MS.

Overall, the number of exceedances decreased between 2005 and 2013 for the sum of all microbial, chemical, and indicator parameters. Some parameters show clear positive trends, including cadmium, nitrate, *clostridium perfringens (Cl. perfringens)*, colour, iron, manganese and turbidity and the effect has been significant in countries with initial large (IE, PT, UK) or very large (PL) exceedances. However, those countries where small exceedances were recorded in 2005 showed hardly any change between 2005 and 2013.

[19] Eionet data, see http://rod.eionet.europa.eu/obligations/171

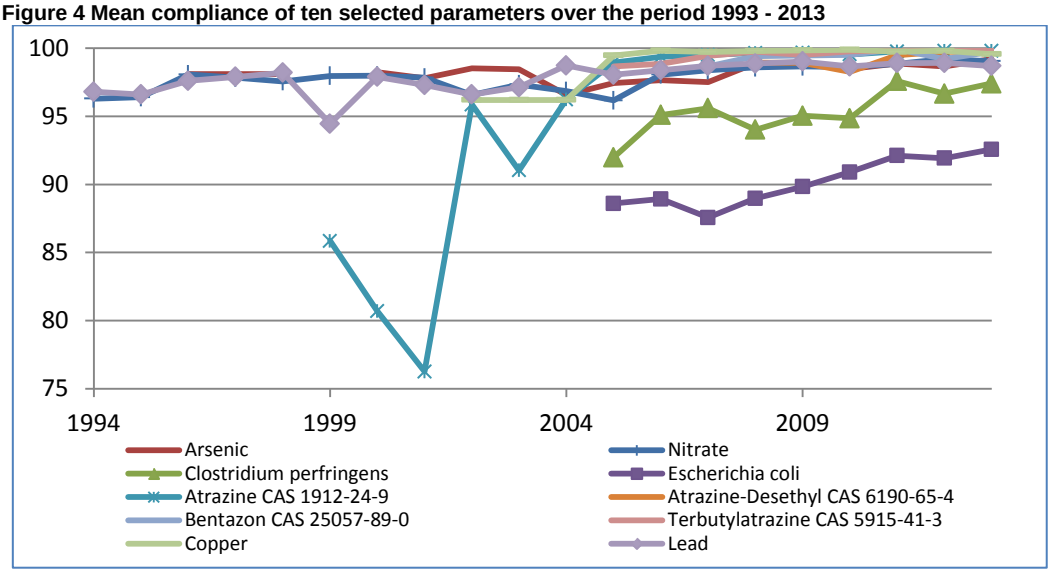
As an analysis of all parameters in the DWD is beyond the scope of the study, the detailed analysis was limited to the ten parameters presented in the table below. The selection of parameters was agreed with DG ENV, and included at least one parameter from each of the main groups (microbial, chemical, indicator and others). The full study on pollution in drinking water is included in Annex B of this report, including a more elaborated discussion on the potential contribution of the DWD in water quality improvement.

Table 2-1 Parameters for which the evaluation was carried out

Group parameters	Included in the initial pilot study
Microbial parameters	*Escherichia.coli* (*E. coli*),
Chemical parameters	Arsenic, nitrate, lead, copper
Indicator parameter	*Cl. perfringens*
Others (related to plant protection)	Atrazin, *desethylatrazine*, *terbutylatrazine*, Bentazon

Figure 2-1 shows an increase in compliance with time for all parameters over the period 1993 - 2013, changes being largest for *E. coli*, *Cl. perfringens* and *Atrazine*. For all other parameters compliance changed from ca. 95% to nearly 100%. Note that the increase in compliance of *Atrazine* was most likely due because this pesticide was banned by the EU in 2004.

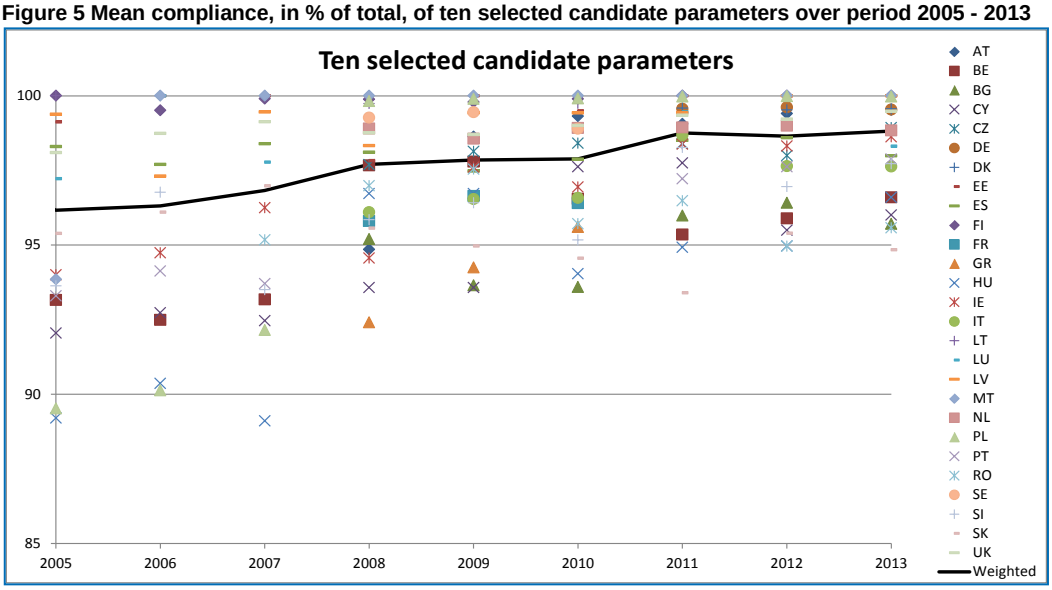
Figure 4 Mean compliance of ten selected parameters over the period 1993 - 2013



Source: Alterra/KWR. based on Eionet data and Synthesis report data

Figure 2-2 below shows the trends in mean compliance of the ten selected parameters (each value represents a MS) for the period 2005-2013 with the line indicating the average for the EU. The trends for the individual parameters are presented in Annex B Section 3.2.

Figure 5 Mean compliance, in % of total, of ten selected candidate parameters over period 2005 - 2013

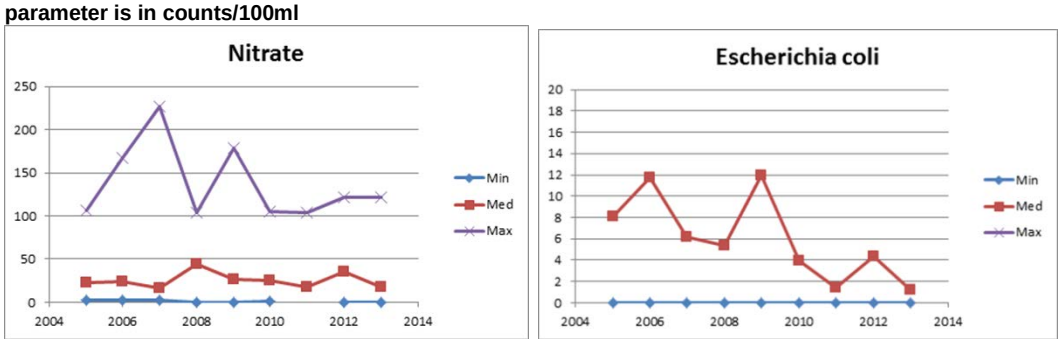


Source: Alterra/KWR. based on Eionet data

The graph shows an increasing mean compliance with time over the period 2005-2013, both in each separate MS and in the whole EU . These results represents the aggregated national summaries for the 10 parameters as submitted by the MS. However, the spread of compliances per MS and per parameter has been rather large (see Table B2 in Annex B). E.g. for Arsenic 72% of the reported non-compliances took place in HU, which has been related to the natural origin of arsenic in groundwater (mainly in eastern HU). Nevertheless, the mean compliances per MS for the 10 selected parameters has been either increasing or remains constant for all MS.

As an illustration, below we show trends in annual minimum, median and maximum concentrations over the period 2005-2013 derived for two of the ten candidate parameters at EU level. The results show a decrease in the median concentration of E. coli but no clear trend for Nitrate.[20]

Figure 6 Trends in water use weighted minimum, median and maximum concentration at EU level of two selected parameters over the period 2005 – 2013. The nitrate parameter is given in µg/l and the E. coli parameter is in counts/100ml



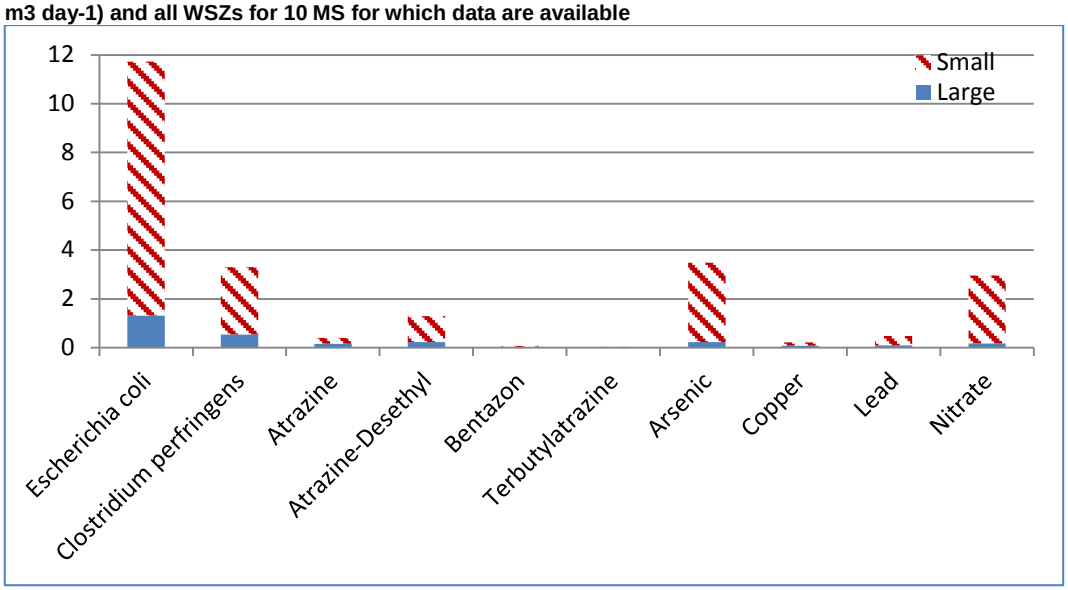
Source: Alterra/KWR, based on Eionet data.

In general water quality has been poorer in small than in large water supply zones (WSZs). This is illustrated in Figure 2-4 for the ten candidate parameters, in terms of percentage non-compliance based on an analyses of all individual large and small SWZ at EU level for the period 2010-2013. Results are based on the ten MS for which data was available for both small and large WSZs, i.e.

[20] Beware that median concentrations are not always calculated in national databases. For example, in the Netherlands, the database only contains minimum, average and maximum concentrations at a given sampling location and in the dataset, the average concentration is thus provided instead of the median.

BG, CY, ES, HU, LU, MT, PT, RO, SI and SK. While non-compliance is always less than 2% and mostly near negligible for all ten parameters in large WSZs, it is up to 12% for E Coli in small WSZs.

Figure 7 Percentage non-compliance of the ten candidate parameters for large and small WSZs (< 1000 m3 day-1) and all WSZs for 10 MS for which data are available



Source: Alterra/KWR, based on Eionet data.

Main findings on JC1.1

- For the selected parameters changes over time were largest for *E. coli*, Cl. p*erfringens* and Atrazine. For all other parameters compliance changed from ca. 95% to near 100%;
- In respect of the selected parameters, an overall improvement in all MS was observed, but the variation among them was significant, especially the exceedance of *E. coli* and *Cl.* p*erfringens* which showed a rather erratic behaviour. Results have shown a decrease in the median concentration of both lead and *E.coli*;
- The overall number of non-compliances for the 10 selected parameters was less than all parameters (totalling to a number of 40,695). The overall distribution of causes for non-compliances for the 10 selected parameters was, however, more or less equal to that of all the parameters;
- Nitrate, arsenic and pesticides are largely controlled by catchment conditions. Lead and copper are largely related to distribution systems and both *Cl. perfringens* and *E. coli* did not have a dominant cause of non-compliance.
- In general water quality has been poorer in small than in large water supply zones.

2.1.2 Improvement of drinking water quality has had a positive effect on human health (JC1.2).

In this section we provide a description of the possible consequences of contaminated drinking water for human health and how interventions to improve the quality of drinking-water provide significant benefits to health. This is followed by a discussion on the likeliness of diseases due to the non-compliance of chemicals, the epidemiological information on outbreaks of water borne diseases and we present examples of trends in waterborne outbreaks. More details on these topics are found in Annex C.

Effects on human health

Trends in microbiological and chemical compliance in the various MS have been identified in the previous section by an analysis of the official reported data to the EC, and the likely contribution of the DWD to improved drinking water quality has been assessed there. The objective of this section is to identify trends in microbiological outbreaks and chemical incidences and the impact (if any) the DWD may has had. This should provide an answer to the question: has the DWD led to a reduction in health incidents, which can be linked to drinking water?

In general, a distinction is made between chemical incidents and microbiological outbreaks:

- Chemical incidents include events in which there is unintended (or sometimes deliberate) release to the (aquatic) environment of chemicals with potential to cause harm to human health through drinking water. In the case of a microbiological outbreak the effects on human health are most acute and obvious.
- Microbiological outbreaks through drinking water include events in which two or more people must be linked epidemiologically by time, location of exposure to water and illness characteristics and the epidemiological evidence must implicate drinking water as the probable source of illness.

Chemical incidences

It should be noted that identifying chemical incidents is notorioiusly difficult. Unless there has been a 'major' event that was reported in the public press most incidents go unnoticed. Water companies are rather hesitant to report on such incidents and also if it is for a short period of time and they can restore the normal situation quickly such events do not have to be reported to the authorities. No national or European records are kept on chemical incidents. Here we provide one example of a recent incidence, but the evidence needed for chemical risks comes from an analysis of exceedances of chemical parameters.

In August 2015, the River Meuse water used for the production of drinking water in the Netherlands did not meet the quality criteria and the intake by the Dutch water companies WML, Evides and Dunea was stopped. This remedial action was taken because the source of the pollution the wastewater treatment plant at a chemical factory did not operate properly and pyrazoles were discharged on the surface water and ended up in the Meuse. Temporary closure of the intake of river water has been a common remedial action taken by surface water companies to protect the quality of drinking water. Since 2010 there have been five intake stops of River Rhine water due to the too high presence of pesticides[21]. When a groundwater well has been polluted with chemicals, it has been often abandoned and alternative sources (including deeper wells) are exploited. In some cases groundwater does not comply with values for the chemical parameters in the DWD and alternative solutions are not readily available. Such examples are generally addressed through derogations and mostly concern arsenic in some areas of the EU, fluoride or chromium VI. These are not considered as incidents but as structural problems. Here the DWD will have an impact as MS have to take remedial actions to comply with the requirements of the DWD.

We evaluated the possible health impacts of exceedances of chemical parameters by comparing the reported median exceedance concentrations and maximum concentrations with the parametric value and comparing the ratio of both with the safety factor for the relevant chemical. Results thus derived are given below. The total number of WSZs in the EU27 and the criteria used for the assessment of the risk level in the WSZs are as follows:

- When ratio of median exceedance/PM > SF: high risk for the related WSZ
- When ratio of median maximum /PM > SF: median risk for the related WSZ
- When ratio of maximum /PM > SF: low risk for the related WSZ

[21] Personal communication Harry Römgens, Director RIWA Maas, at TAPES conference in Brussels in September 2015

- When ratio of maximum /PM < SF: no risk

It has been not possible to assess the risk level in WSZs for non-threshold parameters, mostly carcinogenic substances. Most cases of non-compliance for the chemical parameters cause no or a low risk. The exceptions are WSZ's where fluoride has been exceeding the value in the DWD as there has not really been a safety margin and non-compliance could result in adverse effects in humans. The other exception are WSZs with exceedance of nitrate and nitrite levels as there has not be a safety margin but the strict limit was already based on protection of the most vulnerable groups (pregnant women and infants) and the allocation to drinking water. Table 2-2 below shows the risk of values found for chemical parameters

Table 2-2 Risk of values found for chemical parameters

Chemical element	Nr. of WSZs with non-compliance	Parametric value (µg/l)	Risk
Antimony	6	5	No risk
Arsenic	76	10	n.a.
Benzene	1	1	n.a.
Benzo(a)pyrene	9	0.01	n.a.
Boron	11	1	No risk
Bromate	10	10	n.a.
Cadmium	3	5	No to low risk (smokers)
Chromium	2	50	No risk
Copper	22	2	No risk bad taste
Cyanide	0	50	
1,2-dichloroethane	0	3	
Fluoride	54	1.5	Above 1.5 high risk of fluorosis
Lead	120	10	High risk
Mercury	5	1	No risk
Nickel	105	20	No risk
Nitrate	84	50	Low- medium risk for vulnerable groups
Nitrite	2	0,50	Low-medium risk for vulnerable groups
Pesticides — Total	13	0.5	Low risk
Polycyclic aromatic hydrocarbons	3	0.1	
Selenium	5	10	No risk
Tetrachloroethene and Trichloroethene	9	10	No risk
Trihalomethanes — Total	82	100	Low risk
Vinyl chloride	0	0.5	

Microbiological outbreaks

To collect information on microbiological outbreaks we both studied information from literature, information supplied by MS regulators and we consulted microbiological experts. In this section epidemiological information on outbreaks of mostly food and water borne diseases has been addressed and next we look at examples of trends in waterborne outbreaks.

Examples of trends in waterborne outbreaks

For the **EU**, an inventory was made in 2005 by the Microrisk project on outbreaks in public water supplies. The inventory summarised the outbreaks featuring enteric waterborne pathogens (*E. coli*,

Campylobacter, Cryptosporidium, Giardia, Shigella, Salmonella, Norovirus and gastroenteritis of unknown aetiology) related to drinking water derived from public supplies in the EU. In the years from 1990 to 2004 a total of 86 enteric disease outbreaks associated with EU public drinking water supplies. Outbreaks were identified in 10 of the 25 countries of the EU. According to the project, levels of endemic waterborne disease are probably low in most MS. However, public supplies serve very many consumers and as such contamination, even if causing illness in a small proportion of consumers, can pose a significant threat to public health. Although private water supplies serve a smaller population, they are frequently prone to faecal contamination and probably pose a greater risk to people reliant on them for their primary drinking water source. Heavy rainfall and livestock activity are frequent contributory factors involved in the occurrence of outbreaks. Although the probability of occurrence has been less, the magnitude of effect has been greater for distribution system incidents. Increased awareness of the public health hazard associated with illegal cross-connections and source water contamination could ameliorate these issues. The detection and investigation of outbreaks has been important for the protection of public health, yet detection and reporting varies from one European Member State to another making comparison across Europe difficult.

In the **Nordic countries** (Denmark, Finland, Norway and Sweden)**,** 175 waterborne outbreaks affecting 85,995 individuals were recorded in the period 1998 to 2012 (SE 1998 to 2011). Viruses belonging to the *Caliciviridae* family and *Campylobacter* were the pathogens most frequently involved, comprising 41% and 29% of all 123 outbreaks with known aetiology respectively. Although only a few outbreaks were caused by the parasites Giardia and/or *Cryptosporidium*, they accounted for the largest outbreaks reported during the study period, affecting up to 53,000 persons. A large proportion of the outbreaks (76%) affected a small number of people (less than 100 per outbreak) and were linked to single-household water supplies. However, in 11 (6%) of the outbreaks, more than 1,000 people became ill. Although outbreaks of this size are rare, they highlight the need for increased awareness, particularly of parasites, correct water treatment regimens, and vigilant management and maintenance of the water supply and distribution systems. In the period concerned there does not seem to be a trend in the number of outbreaks reported.

In **England and Wales** a structured surveillance of outbreaks of infectious intestinal disease (IID) has been conducted since 1992. Between 1992 and 2003, 89 waterborne IID outbreak reports were recorded affecting 4321 people. There was an average of 119 case patients per public water outbreak and 22 cases per private water outbreak. *Cryptosporidium* was implicated in 69% of outbreaks, *Campylobacter* sp. in 14%, *Giardia* in 2%, *E. coli* O157 in 3% and *Astrovirus* in 1%. From 2000, there was a consistent decline in the number of outbreaks of waterborne disease associated with public water supplies. The incidence rate of outbreaks in recipients of private water supplies may be as high as 35 times the rate in those receiving public water supplies (1830 *vs.* 53 per million population). There was a consistent decline in the number of outbreaks of waterborne disease associated with public water supplies, particularly noticeable since 2000. However, outbreaks of waterborne disease associated with private water supplies increased in number during this period.

In **Ireland** the majority of drinking water comes from surface water supplies for several reasons. In addition to the large amount of surface water available, groundwater resources are not as suitable for use as most other MS as Ireland has large areas of karst geology as well as a fractured pattern of geology around the country. This means that many of our groundwater resources are heavily influenced by surface water. As a result most of our raw waters contain E. coli as it has been ubiquitous in surface waters everywhere. This means considerable treatment for drinking water supplies has to be put in place, as disinfection alone will not be sufficient in many of our groundwater sources. This has been the reason for historically having high levels of non-

compliance with E. coli compared to other MS which have better quality groundwater resources. Since the Directive came into force in 2004 the number of incidents of E. coli contamination of water supplies in Ireland has reduced by around 90% in public water supplies and private group water schemes. The real improvements in public water supplies took place after 2007 when EPA was given enforcement powers over the public water supplies. and several initiatives were taken to reduce the number of incidents and enforcement actions were taken. The community run local water supplies went through a massive programme of improvement to reduce the number of incidents. The majority of plants were upgraded or amalgamated with nearby schemes which resulted in a significant drop in the number of such schemes (from 698 in 2004 to to 417 in 2013). The quality of remaining schemes has also improved dramatically (only 78% of samples analysed in 2004 complied with the E. coli standard improving to 97.6% in 2013).

Epidemiological information on outbreaks of food- and water borne diseases

The European Centre for Disease Prevention and Control (ECDC) collects information on infectious disease outbreaks, including those for which water was confirmed as route of exposure. Information relating to occurrences of cases of 52 communicable diseases and health issues under mandatory EU-wide surveillance has been sent to ECDC according to case definitions established by the EU[22]. It should be noted that most surveillance systems capture only a proportion of the cases occurring in their countries. Some cases of disease remain undiagnosed ('under-ascertainment'), and some are diagnosed but not reported to public health authorities ('underreporting').

The epidemiological information as collected and reported by ECDC does not concern DWD parameters. This has been obvious as the DWD only has indicator organisms in the list of microbiological parameters. Below we shortly summarise information on microbiological outbreaks that might be caused by drinking water besides other routes for pathogenic coliform bacteria, Cyrptosporidium, Giardia, Campylobacter, Shigella and also for Legionella.

Infection with **pathogenic E. coli** has been mainly acquired by consuming contaminated food, such as undercooked contaminated beef or contaminated vegetables, or water, but person-to-person and direct transmissions from animals to humans may also occur. The main reservoirs for STEC/VTEC bacteria are ruminants such as cattle, goats and sheep. In 2012 10 EU countries reported 51 outbreaks from food and 10 waterborne outbreaks to ESFA, caused by pathogenic VTEC Strains. This represented 0.9% and 63% of all the reported food- and waterborne outbreaks in the EU. The EU/EEA notification rate about 1.0 cases per 100 000 population has been reported since 2007 until 2010. However, a year after the outbreak a 1.5 fold increase in the EU/EEA notification rate and an increasing trend was observed compared with previous years. This has been most likely due to the increased public health interest and detection of the STEC/VTEC cases as a response to the 2011 outbreak. After removing the outbreak cases in year 2011, a statistically significant increasing EU trend could still be observed in 2008–2010. Details on number of cases per MS can be found in Annex C.

Number and rates of confirmed STEC/VTEC reported cases, in the EU, 2008–2012

2008	2009	2010	2011	2012
3 163	3 580	3 657	9487	5 870

Cryptosporidiosis is an important cause of acute diarrhoeal disease worldwide, and the burden of illness in childhood can be important. Transmission is through the faecal-oral-route via contaminated water, soil or food products and the most common identified vehicles are

[22] 2002/253/EC: Commission Decision of 19 March 2002 laying down case definitions for reporting communicable diseases to the Community network under Decision No 2119/98/EC of the European Parliament and of the Council. Official Journal, OJ L 86, 03.04.2002, p. 44–62.

contaminated drinking water and contaminated recreational water. The oocysts are resistant to chlorine at the concentrations normally used for treating drinking water and swimming pools. There are well documented large outbreaks of cryptosporidiosis caused by the contamination of drinking water.

Out of the 21 EU/EEA countries reporting data on cryptosporidiosis, seven countries reported zero cases, three countries reported just one case and only seven reported 50 or more cases (see Table 3.3). In addition, nine countries did not report data on cryptosporidiosis at all. Therefore, it is likely that cryptosporidiosis has been underreported in most of the EU/EEA countries. The reason for this is most likely a lack of laboratory diagnosis of cryptosporidiosis in laboratories diagnosing diarrhoeal diseases. The number of cases reported has increased in several EU countries in 2012. Epidemiological situation in 2012 Cryptosporidium cases in 2012 were 68% higher than in 2011, with 9 591 cases reported.

Although outbreaks caused by contamination of drinking water or recreational water may happen at any time of the year, without primary diagnostic testing of faecal samples through recognised methods these outbreaks are unlikely to be detected. Human activities, such as drinking untreated water, recreational water activities, and contact with farm animals, increase the risk of becoming infected with Cryptosporidium. Details on number of cases per MS can be found in Annex C.

Number and rates of confirmed cryptosporidiosis reported cases in the EU, 2008–2012

2008	2009	2010	2011	2012
7 028	8 016	6 605	5 697	9 591

Campylobacteriosis has remained the most commonly reported gastrointestinal disease in Europe since 2005. Campylobacter also has the potential to cause large waterborne outbreaks. The sources of infection causing sporadic disease seem to derive from chicken, but the routes of transmission remain unclear. Where diseases appear, the main route of transmission is rarely identified. Outbreaks are associated with the ingestion of contaminated food (mainly chicken or unpasteurised milk) or water. At the EU level, the rate of human campylobacteriosis increased between 2007 and 2011 but has reduced slightly in 2012 (see Table 2-3). Details on number of cases per MS can be found in Annex C.

Table 2-3 Number and rates of confirmed campylobacteriosis reported cases in the EU, 2008–2012

2008	2009	2010	2011	2012
190 579	201 711	215 397	223 998	215 217

Giardia lamblia is a flagellated, cyst-producing intestinal parasite able to infect humans and animals. Giardiasis is the most common cause of parasitic diarrheal disease worldwide. Waterborne outbreaks due to inadequate treatment of drinking water are frequently reported and infants and children are at a particularly increased risk for infection. Cases of giardiasis were reported in 23 out of 31 EU countries (see below). The case rate of reported confirmed cases of giardiasis has been relatively constant over the past five years.

Table 2-4 Number and rates of confirmed giardiasis reported cases in the EU, 2008–2012

2008	2009	2010	2011	2012
18 274	16 564	16 844	16 207	16 223

Shigellosis is caused by bacteria of the genus Shigella. Although a relatively uncommon and mostly travel-related infection in the EU, it remains the fifth most frequently reported cause of enteric infection. Outbreaks occur frequently but no public health threats associated with Shigellosis

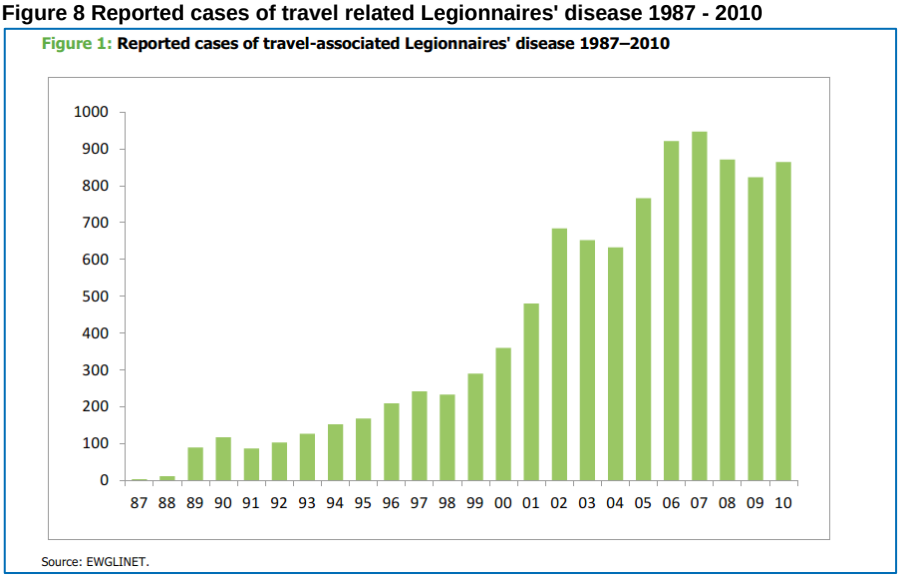
were reported at the EU level during 2012. In 2012, 7 336 confirmed cases of Shigella infection were reported from 28 EU/EEA countries. The reporting of cases has remained relatively stable in the previous five years (see Table 3.6 and Figure 3.5). Infections with some species may cause severe illness and death; most cases are less severe. Humans are the only significant reservoir. Transmission occurs by the faecal-oral route, either through person-to-person contact, including sexual contact, or through contaminated food or water. In 2012, the confirmed case rate for shigellosis was 1.6 per 100 000 population. Shigella is most common in children under five years of age, and very high rates in this age group are reported from some EU countries. Shigella infection, while relatively uncommon, remains of concern in some countries, and for some population groups within the EU/EEA. Bulgaria and Slovakia, in particular, continue to report high rates of infection, particularly among young children.

Table 2-5 Number and rates of confirmed shigellosis reported cases in the EU, 2008–2012

2008	2009	2010	2011	2012
7 441	7 076	7 187	7 157	7 342

Legionella has a clear link with (drinking) water. Data on Legionella cases have been collected since 1987. Figure 2-5 shows the travel related legionnaires disease cases reported in Europe since then. Even though the cases only reflect travel related cases it shows a significant increase within the European countries from less than 100 in 1987 till more than 900 per year in 2010. The disease does not relate to the consumption of water but often has a relationship with the drinking water supply system. Cases of Legionella are caused by poor design, maintenance and operation of the water supply system and the quality of the water supplied. This significant increase seen in Figure 2-5 almost certainly reflects increased ascertainment of cases through improved national surveillance schemes and can also be attributed to improved collaboration and reporting by participating countries.

Figure 8 Reported cases of travel related Legionnaires' disease 1987 - 2010



Main findings on JC 1.2

- The micro-organisms which can cause outbreaks through water are not directly included in the DWD as the Directive only includes two indicator parameters;
- In most cases outbreaks are caused by a number of sources besides drinking water and it is often not possible to relate outbreaks to (drinking) water;

- The epidemiological data on these micro-organism indicate an increased number of outbreaks for pathogenic E. coli STEC/VTEC between 2008 and 2012, no significant changes in the outbreaks related to Shigella and Giardia. Cases related to Campylobacter increased in the period 2007-2011 but showed a slight decrease in 2012. Cryptosporidium related cases showed an increase in 2012;
- The only micro-organism that most certainly related to (drinking) water Legionella showed significant increase from the start of monitoring the cases of Legionnaires' disease in 1987 till 2012. The significant increase in travel related cases within Europe almost certainly reflects increased ascertainment of cases through improved national surveillance schemes and can also be attributed to improved collaboration and reporting by participating countries;
- Epidemiological data are presumably only a fraction of outbreaks and incidents as water related disease surveillance systems are not necessarily capable to detect all waterborne outbreaks and incidences due to methodological problems. Comparisons over time are therefore not very meaningful in terms of assessing an impact of the DWD unless there is convincing evidence that the disease was water borne and reduced due to remedial actions taken because of the DWD.

2.1.3 DWD has been the main contributing factor to the observed improvements in drinking water quality (JC1.3)

The overall trends as reported in the previous section illustrate an improvement in compliance rates of drinking water parameters. The question now arises to what extent the DWD can be considered the main contributing factor to this improvement of drinking water quality across the EU. This issue has been explored by analysing the potential impact of the DWD i) on substances controlled by land use and geology; ii) on lead and copper and iii) on mixed causes.

Impact of DWD on substances controlled by land use and geology

For parameters such as nitrate, arsenic and pesticides where *catchment related causes* dominate, it can be deducted that other directives regulating the inputs (e.g. the nitrates directive and pesticides directive; Directive 2009/128/EC) could be held responsible for the observed trends in water quality, especially if acceptable levels as regulated by those directives are equal to or lower than those imposed by the DWD. However, substances such as arsenic (in groundwater) are of natural origin and related to rather local geochemical conditions and they cannot be regulated by emission control. One also has to consider the travel time and decay rate of substances in relation to the timeframe during which the DWD has been in place. Considering the long time-delay in the case of abstraction of *deep groundwater* for drinking water it is highly unlikely to observe impacts of measures reducing inputs in deep aquifers within a time scale of 1 to 2 decades. The travel time of water on average equals 1 meter per year which implies that it takes more than 20 years for dissolved nitrate to reach deep groundwater wells. This holds even more for arsenic which interacts with the solid phase resulting in retention (notably via sorption to oxides). This line of reasoning suggests that for *deep* groundwater, observed changes in concentrations must have been due to the DWD (Article 5/4, Annex I), e.g. by mixing of waters or closing wells rather than a relation with reduced inputs as imposed by other Directives.

Since the impact of land use (emission) clearly will become noticeable in shallow groundwater (let alone surface water) it is likely that, such as in the Netherlands, several water abstraction zones using shallow groundwater have been closed due to increased levels of nitrate which was considered unacceptable because of the implementation of the DWD. In those cases, the Nitrates Directive was not able to prevent non-compliances for nitrate and an additional improvement of water quality was achieved due to the DWD (Article 5/4, Annex I). Despite the observed improvements in water quality, nitrate concentrations in subtracted (shallow) groundwater may still

exceed the DWD standard. In order to prevent this, it is more effective to monitor the nitrate concentrations in shallow groundwater rather than in subtracted water.

In shallow groundwater or surface water used for drinking water purposes, it cannot be ruled out that reductions in concentrations and in non-compliance have resulted from increased efforts to reduce inputs of nitrate and pesticides as well.

An absolute scaling of the impact of the DWD relative to that of other directives which have become active during this timeframe (including Nitrates Directive, Pesticides Directive) is not possible since all of these Directives share to some extent the level of regulation (for nitrate and pesticides both the DWD and related Directives regulate water quality at the same level).

Impact of DWD on lead and copper

For copper and lead, for which *distribution network related causes* dominate the exceedances, the DWD has clearly been one of the main drivers which has resulted in the decrease of non-compliances, mainly due to Article 10. This holds in general for all parameters for which exceedances are related to causes in the distribution network, since the DWD has been the single most important Directive addressing these substances after the water has been processed and requires remedial action in case of non-compliances. A reduction of non-compliances can thus be attributed to the DWD.

On the other hand, the DWD has had limited or no impact on the quality of water *prior to* the interaction of water with the distribution network. Water quality in groundwater and surface water is largely controlled by natural processes (retention of metals by sediments and soils), whereas inputs to the system are regulated by Directives targeting environmental quality. These include: (i) the Water Framework Directive, in which the acceptable copper levels in surface water has been much lower than the parametric value of the DWD and (ii) the Nitrates Directive and the Directive regulating additives in feed and fodder (70/524/EEC), which both regulate application rate and quality of manure. Considering the allowed input levels either via fodder, manure or water and the strong retention of copper and lead to the solid matrix it has been highly unlikely that concentrations of copper in aquifers (i.e. before interaction with the distribution network) would reach levels at which the DWD becomes effective. Normal observed ranges of copper in shallow or deep groundwater are in the order of magnitude of 1 to several 10's of micrograms per litre whereas the DWD regulates copper at levels in excess of 2000 microgram per litre.

Impact of DWD on mixed causes

For some parameters in the DWD, notably the microbiological parameters, no clear main cause for the observed non-compliance was found. Based on the data supplied other than the chemical substances discussed earlier (nitrate, pesticides, copper, lead), increased levels of microbiological parameters are not so much related to land use or slow processes (infiltration to groundwater), but related to (partly unpredictable) incidents such as shortcuts in distribution systems leading to the accidental contamination of the drinking water distribution system with (treated) sewage effluent. The latter may also be catchment-related in the case of contamination of surface water used for drinking water. Having a DWD in place clearly accelerates the chances of early detection even though the frequency of the monitoring periods can be such that outbreaks can occur and lead to widespread infections. It is thus very likely that the DWD has contributed to the decrease in microbiological parameters. An indicative illustration of a qualitative assessment of the likelihood that DWD has had an impact on the drinking water quality is given in the table below. It is, however, not possible to determine the extent to which the DWD indeed has resulted in a decline in exceedances of the non-compliances of microbial parameters.

Table 2-6 provides a qualitative assessment of the likelihood that DWD has had an impact on water quality for particular parameters. For more details we refer to Annex B.

Table 2-6 Illustration of an indicative qualitative assessment of the likelihood that DWD has an impact on water quality in the catchment and distribution system and on the reduction of non-compliances

Parameter	Likelihood that DWD has an impact on water quality in a specific aquifer			Likelihood that the DWD has an impact on water during distribution	Likelihood that the DWD resulted in a reduction of non-compliances
	Surface water	Shallow GW	Deep GW		
Nitrate	+?	+	0	0	+
Pesticides	+	+?	0	0?	0
Arsenic	-?	-	+	0	+
Microbial indicators	+?	0	0	+?	+
Copper	0	0	0	++	++
Lead	0	0	0	++	++

++ very likely that the DWD has an impact
+ likely that the DWD has an impact
0 likely that the DWD has no impact
- very likely that the DWD has no impact
? Not sure

Main findings on JC1.3

An absolute scaling of the impact of the DWD relative to that of other directives (such as Nitrates Directive, Pesticides Directive, Urban Waste Water Treatment Directive) has not been possible since all of these Directives share to some extent the level of regulation. Where other directives regulate equal to or lower acceptable levels of water quality, the DWD did not have a direct impact on water quality. However, in two cases other directives have had less impact: i) for deep groundwater contaminated with substances related to local geoechemical conditions, such as arsenic; and ii) for shallow groundwater contaminated as a result of incidences such as industrial spills.

For all parameters for which exceedances are related to causes in the distribution network (especially lead and copper), the DWD has been one of the main drivers which has resulted in the decrease of non-compliance.

The Directive played a major role in the decrease of the number of non-compliances of microbiological parameters even if its role is difficult to determine. First, it was the ban of atrazine which caused the decline in pesticides in drinking water. Furthermore,there is an overall improvement in all MS, but the variation among them is significant.

2.1.4 *Conclusions based on EQ1*

An analysis of three judgement criteria was made to answer the first evaluation question: i) compliance rates for parameters show an improvement of drinking water quality; ii) improvement of drinking water quality has had a positive effect on human health; and iii) the DWD can be considered the main factor in the improvement of the quality of drinking. Based on an analysis of exceedance rates in relation to the main causes of pollution (land use and geology, distribution networks and mixed causes), the following conclusions where reached:

- For selected parameters, an overall improvement in all MS was observed, but the variation among them was significant;
- The overall distribution of causes for non-compliances for the 10 selected parameters was, however, more or less equal to that of all the parameters;
- Nitrate, arsenic and pesticides are largely controlled by catchment conditions. Lead and copper are largely related to distribution systems and both *Cl. perfringens* and *E. coli* did not have a dominant cause of non-compliance.
- In general water quality is poorer in small than in large water supply zones.
- In most cases outbreaks are caused by a number of sources besides drinking water and it is often not possible to relate outbreaks to (drinking) water;
- The epidemiological data on micro-organism indicate an increased number of outbreaks for pathogenic E. coli, but no significant changes in the outbreaks related to Shigella and Giardia. Cases related to Campylobacter increased in the period 2007-2011 but showed a slight decrease in 2012. Cryptosporidium related cases showed an increase in 2012;
- The only micro-organism that most certainly related to (drinking) water Legionella showed significant increase from the start of monitoring the cases of Legionnaires' disease in 1987 till 2012. The significant increase in travel related cases within Europe almost certainly reflects increased ascertainment of cases through improved national surveillance schemes and can also be attributed to improved collaboration and reporting by participating countries;
- Epidemiological data are a fraction of all outbreaks and incidents. Comparisons over time are therefore not very meaningful in terms of assessing an impact of the DWD unless there is convincing evidence that the disease was water borne and reduced due to remedial actions taken because of the DWD.
- An absolute scaling of the impact of the DWD relative to that of other directives (such as Nitrates Directive, Pesticides Directive, Urban Waste Water Treatment Directive) has not been possible since all of these Directives share to some extent the level of regulation.
- Where other directives regulate equal to or lower acceptable levels of water quality, the DWD did not have a direct impact on water quality. However, in two cases other directives have had less impact: i) for deep groundwater contaminated with substances related to local geoechemical conditions, such as arsenic; and ii) for shallow groundwater contaminated as a result of incidences such as industrial spills.
- For all parameters for which exceedances are related to causes in the distribution network (especially lead and copper), the DWD has been one of the main drivers which has resulted in the decrease of non-compliance.
- The Directive played a major role in the decrease of the number of non-compliances of microbiological parameters even if the role of has been difficult to determine. First, it was the ban of atrazine which caused the decline in pesticides in drinking water. Furthermore,there has been an overall improvement in all MS, but the variation among them has been significant.
- A further outcome of our analysis has been that water quality has been poorer in small than in large WSZ.

In summary, having a DWD in place is the main factor explaining the trends in water quality and decreases in non-compliances for distribution network related sources such as for lead and copper. Even though an additional effect of the DWD in view of the observed trends in non-compliances

cannot be excluded for several land-use/catchment related parameters including pesticides and nitrate, the main drivers of change are very likely other relevant directives. The absolute magnitude of the contribution of the DWD relative to that of other directives is however impossible to quantify.

2.2 Have the specific and general provisions of the DWD been effective for protecting human health and why? (EQ2)

The answer to the second evaluation question is based on two judgement criteria: i) the specific provisions of the DWD for parameters requirements, monitoring, remedial actions and information to consumers have been effective for protecting human health (JC 2.1); and ii) the general provisions have enabled MS to implement the DWD effectively (JC2.2).

2.2.1 Of the provisions in the DWD, those relating to parameters, monitoring, remedial actions and information to consumers have been effective (JC2.1)

Below we discuss four specific provisions to assess their effectiveness in relation to the overall objective of the DWD, to protect citizens from the adverse effects of contaminated drinking water.

Parameters requirements

There are many microbial and chemical constituents of drinking water which can potentially cause adverse human health effects. In fact, it has been estimated that there are 30,000 to 70,000 chemicals in daily use which may find their way to natural waters. In addition, the detection of these constituents in both raw and treated water has been often slow, complex and costly, which limits early warning capability and affordability. The use of monitoring efforts and resources should therefore be carefully planned and directed at significant or key characteristics. The effectiveness of the parameter requirement is thus dependent on the effectiveness of a substance in terms of (protecting) human health, but also on the ability to monitor it in a cost-effective manner. Both aspects are discussed below.

In the Directive a total of 48 microbiological and chemical parameters have been included for regular monitoring and testng. WHO guidelines for drinking water and the opinion of the Commission's Scientific Advisory Committee have been used as a basis for the standards in the Directive.[23]

The choice of parameters has been based on the health impacts (severity) associated with the substance
and the probability of significant occurrence (exposure). Combined, these elements determine the risk associated with a particular hazard. A description of the three groups of parameters has been provided in Annex H.

When the current Directive was drafted, it was proposed to reduce the total numberr of parameters from 67 in Directive 80/778/EEC to 48 (this number included 13 new parameters). This was done as evidence had emerged that not all parameters included in the old Directive were essential to be monitored to ensure a continued high level of health protection. At the same time, it was noted that it may be necessary for Member States to set values for further parameters where local conditions so require, and as they see fit, in order to protect human health.

[23] Guidelines for Drinking-water Quality - Fourth edition. World Health Organization, Geneva, p. 541.

From 1998 onwards, Annex I (listing the parameters) was regularly reviewed, but up to today, this process did not lead to a revision Annex I.[24] MS have indeed added other parameters to the list (thus respecting the principle of subsidiarity)[25] and this has led to a differentiation of uptake of additional monitoring amongst the MS. Examples for additional parameters (for which no values have been set in the DWD) are virus, parasites (e.g. legionella), calcium/magnesium, *chlorophenols*, cadmium, *trihalomethanes*, *microcystin*, uranium and chlorite. In other cases, MS (such as AT, NL and UK) have more strict values for parameters already included in the DWD.

For pesticides, the Commision opted for a precautionary parametric value of 0.1 µg/1 as a matter of principle for each individual pesticide. Experience had shown that in most cases this value could be respected without the need for extra treatment provided that pesticides are used in a responsible manner.

It should be noted that although the WHO guidelines are universally accepted, interviews with water experts for this study highlighted the importance of regulating these parameters at EU level as in some Member States regulators would have had difficulties to convince water suppliers of the need for monitoring some substances. As formulated by one of the participants of the Stakeholder consultation in May 2015:

> "The introduction of DWD has significantly contributed to having a solid and stable reference framework both for the list of pollutants (and their parametric values) and the control system. This has helped water operators to streamline monitoring procedures and increased users' confidence. Major current problems with drinking water quality derive precisely from the uncertainties related to those pollutants that are not covered by the Directive."

This last remark refers to those substances which have been recognised as a potential threat to human health, but which are not (yet) included in the DWD. These "emerging substances" include endocrine disrupting compounds, for which there has not been sufficient evidence to include individual substances (e.g. as key indicator parameters), to set a parametric value or to have a suitable analytical method available. A complicating factor here is the unknown cocktail effect of emerging substances. The issue of emerging substances is further discussed under relevance.

The inclusion in the DWD of strict parametric values for the microbiological parameters (*E. coli* and *Enterococci*) in conjunction with monitoring for compliance for these parameters and the requirement to take remedial actions in the case of non-compliance has significantly reduced the risk has reduced microbiological contaminiation of drinking water and the possible impact on human health through illness e.g. diarrhoea and gastroenteritis.

The two microbiological parameters mentioned in the DWD - *E. coli* and *Enterococci* - are mere indicating organisms which normally do not cause any threats to human health. They only indicate a possible contamination of drinking water. Microbiological incidences causing disease are often reported for micro-organisms. These include for instance pathogenic *E. coli* - also known as STEC/VTEC - *Campylobacter*, *Shigella*, Salmonella, *Legionella pneumophila*, and viruses *Calicivirus*, *Rotavirus*, *Norovirus* and parasites (such as *Cryptosporidium* and *Giardia*). These are the most significant health risks associated with microbial contamination of drinking water. In the case of an outbreak it has been not always possible or easy to find out what the contribution of drinking water has been. Epidemiological information for the abovementioned organisms often does not specify the actual source of the contamination (whether it is food or water, for instance).

[24] A study with WHO is currently underway to investigate the possible revision of Annex I

[25] European Commission (1998). DWD. ANNEX II. MONITORING, TABLE A.

At least on annual bases, all EU MS and Iceland, Liechtenstein and Norway provide information from their surveillance systems to the European Centre for Disease Prevention and Control (ECDC) on the number of occurrences of the 52 communicable diseases and health issues under mandatory EU-wide surveillance. Reports are issued according to the case definitions established by the EU.

An investigation of the data shows that in many countries microbial incidents are relatively constant over time. The ECDC points out that epidemiological results have to be used and interpreted carefully as health and surveillance systems vary between countries.[26] The data is a mere qualitative indication of the occurrence of diseases.

In addition to the ECDC epidemiological data mentioned above there are examples that the DWD has considerably reduced microbial outbreaks. One example is Ireland where the majority of drinking water comes from surface water supplies. As a result, most of Ireland's raw waters contain *E. coli* as it has been ubiquitous in surface waters. Since the Directive came into force in Ireland in 2004, considerable treatment actions have been enforced and the number of incidents of E. coli contamination of water supplies in Ireland has reduced by around 90% in public water supplies and private group water schemes. The real improvements in public water supplies took place after 2007, when the Environmental Protection Agency (EPA) which was given enforcement powers over the public water supplies took several initiatives to reduce the number of incidents (e.g. setting minimum standards for disinfection systems including mandatory process alarms) and started to take enforcement action (including prosecutions) where action was not being taken.

Main findings on parameter requirements

It can be asserted that the DWD has actually contributed to the reduction of microbial outbreaks mentioned in the example of Ireland but also in other MS. Since the Directive came into force, countries have enforced considerable treatment actions and the number of incidents of E. coli contamination of water supplies has been reduced. Improvements should also be linked to the increased powers conferred to (environmental) protection agencies. Linking this analysis to the first judgement criterion listed for this evaluation question we can conclude that setting parametric values for microbiological parameters has indeed been an appropriate provision for the protection of human health.

Monitoring

Partly as a result of the transposition of the DWD into national law, monitoring systems have been designed and activated, and laboratories to analyse drinking water have been established in all MS. However, monitoring approaches differ between MS and even between different WSZ within individual MS, resulting in different levels and availability of monitoring data. The frequency of monitoring has been stipulated in Annex II to the Directive. This Annex defines the minimum frequency of sampling and analysis for drinking water in distribution networks (or from a tanker or used in a food-production undertaking), except for small WSZ where the frequency can be decided by the MS concerned.

With the recently adapted amendment to the Directive[27] the overall approach to monitoring has become more flexible, allowing MS to decide, on the basis of a risk assessment, which parameters to monitor.[28] MS can now choose to change the frequency of sampling, as well as to expand the list of parameters to monitor in case of public health concerns. For small WSZs, the revised Annex II

---

[26] Therre H. National policies for preventing antimicrobial resistance - the situation in 17 European countries in late 2000. Euro Surveill. 2001;6(1):pii=227. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=227

[27] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L1787&from=EN

[28] Statement based on preliminary feedback from stakeholders

and III prescribes a minimum frequency of monitoring of once per year. This change was welcomed by all stakeholders as it reduces the need to monitor parameters which pose no risk in the supply zone and at the same time requires water authorities to monitor water quality of small WSZ. During interviews stakeholders suggested to fully integrate a risk based approach into the DWD, not as an alternative for monitoring, but to give them equal weight: one to prepare for threats and one for keeping tabs on what actually happened.

The issue of small supply zones has long been perceived a potential risk to consumers as it has been estimated that about 65.5 million people or 13% of the EU population are served from small WSZs.[29] According to a report on the quality of water in small supply zones, 40% of these were not in compliance with the DWD regulations, and 19% were not monitored in accordance with the DWD requirements, affecting over 11.5 million people. Thus, although this situation has now been remedied, it illustrates the importance of monitoring requirements as an essential element to safeguard drinking water quality for all European citizens.

Monitoring can be considered the first step in a chain of control measures that will ascertain that drinking water meets quality standards as set by the DWD. As monitoring systems are operational in all MS, this is considered an effective provision. From the monitoring reports submitted by MS for the period 2008-2010 it was concluded that out of 27 MS, 9 did not meet the minimum monitoring frequency. This observation was based on self-reporting by MS who were asked to provide information at WSZ level on the number of analyses carried out compared to the number of analyses required by the Directive. The importance of this information lies in the fact that compliance with the monitoring frequency is a prerequisite of assessing compliance with the parametric values and thus affects the picture which emerges from synthesis documents on the quality of drinking water produced by the Commission. For all MS, it appeared that for five countries (BE, ES, IE, SE, SK) the percentage of WSZ that did not meet minimum requirements was very low (below 90%). For 13 countries (CZ, DE, ES, FI, FR, IT, LU, LV, MT, NL, PL, PT, UK) it was low (between 90-95%) and for another 9 (AT, BG, CY, DK, EL, HU, LT, RO, SL) it was reported to be high (between 95-99%).

With regards to the transparency of monitoring data it was interesting to observe opposing views being expressed. One paper (Norway) stated that results should be available online and/or made publicly available, whereas another (CZ) stated that this type of information should be restricted to the state authorities. Aqua Publica Europea was of the opinion that transparency, as a way of providing useful and understandable information which ensures greater stakeholders' participation, has been crucial to raise public awareness on common challenges, thus reducing conflict situations and increasing ownerships of decisions.

Some experts contacted for this study consider that on many occasions the frequencies of monitoring mentioned in Annex II are too low to safeguard the quality of drinking water year-round. They are in favour of more frequent monitoring. Some of them also suggest to include the end-users more in this process. During the stakeholder consultation, the national regulators indicated that the current density and selection of sampling points requires an update. They consider these insufficient and therefore advocate more frequent sampling and more extensive monitoring to guarantee the safety of all consumers, especially for the larger WSZ.[30] The recent revision of Annex II provided an answer to many of these concerns.

The inclusion of the option of using Water Safety Plans in the revised Directive was also welcomed by many stakeholders. In their opinion, this would lower the risk of contamination and enable water

[29] "Small water supply zones in the EU – Reporting year 2010" report (dated 26 March 2013)

[30] Stakeholder consultation on the revision of the DWD (May 2015) Member State regulators.

companies to learn more about their drinking water sources. The amendment to Annexes II and III allows MS to derogate from the monitoring programmes they have established, provided they perform credible risk assessments which may be based on the WHO Guidelines for Drinking Water Quality and should take into account the monitoring carried out under Article 8 of Directive 2000/60/EC.

Main findings on the effectiveness of monitoring activities

The monitoring systems and the laboratories set up in all MS are considered an effective way of collecting and analysing information on the water quality and this can be considered as the first and essential step towards the protection of human health from the adverse effects of any contamination of drinking water. However, for one-third of the MS countries the frequency of monitoring established by MS has been below that what is required which undermines the quality of the synthesis reports of the Commission. The recently revised Annex II and III allow MS more freedom in monitoring frequencies and parameters to monitor with Water Safety Plans in place. This revision also addressed the call for a minimum frequency of small WSZ.

Remedial action

Most of the remedial actions performed as reported by the MS are related to the microbiological parameters and to a lesser extent to chemical parameters. The remedial actions for *E. coli* are mainly treatment-related, for lead mainly domestic distribution network related and for nitrate mainly catchment related.

The DWD requires MS to regular monitoring of drinking water quality, to take remedial action in case the monitoring reveals problems, and to provide consumers with adequate and up-to-date information on their drinking water quality. Remedial actions differ from case to case, but can be roughly distinguished into two categories:

1. Catchment and treatment-related:
   - Action(s) to terminate or mitigate the cause;
   - Action(s) to change from one source to another;
   - Establishing, upgrading or improving treatment.
2. Network related:
   - Replacement, disconnection or repair of defective components;
   - Cleaning, scouring and/or disinfecting contaminated components.

Specific remedial actions are required to address the different sources of pollution. Competent authorities decide on what remedial actions should be undertaken when drinking water suppliers fail to meet the parametric values set in the DWD. The remedial action depends on what is most suitable per specific case.

Data from MS show that in cases of incidents and failures to meet the quality standards, in general remedial action has been taken by MS within an appropriate response time. In relation to the microbiological parameters and measures entailed improving the treatment and cleaning of the contaminated components of the public distribution system. For chemical parameters, failures were addressed through better agricultural practice, conditioning or treatment of the water, change of the source water, and providing information to the public.

An inventory of remedial actions (RA) reported by MS was made for the period 2005-2013 based on the EU MS reports ad the Eionet data.[31] This has been done for 12 MS with a continuous monitoring record for the 10 parameters as listed in Table 2.1 (see Appendix 2 of Annex B). A summary of the total reported RA is given in **Table 2-7**. Most RA were undertaken at catchment and

[31] Member State reports of the DWD (2010) and Synthesis report on the Quality of Drinking Water, 2008-2010 (EC, 2013).

treatment level, where pollution of the source water is the most common problem. The remedial action undertaken was most often aimed at terminating or mitigating the cause of the problem. Upgrading or improving the treatment was the second most applied remedial action and changing the water source was least often chosen as a measure. According to the Eionet data for the period 2005-2013, most of the remedial actions were treatment-related (in 1,185 out of 5,222 WSZ), either establishing, upgrading or improving treatment systems, followed by catchment related actions (942 WSZ), public distribution system related actions (756 WSZ) and domestic distribution related actions (483 WSZ). By far (about 85%) the most of the catchment related actions were actions to terminate or mitigate the cause.

Table 2-7 Total reported remedial actions per parameter for the period 2005-2013 based on data from 12 countries with a continuous monitoring record for the 10 parameters.

Parameter	Catchment	Treatment	Public Distr.	Domestic Distr.	Emergency Actions	Other	Total
Arsenic	133	49	5	3	0	67	257
Atrazine	12	7	0	1	1	19	40
Atrazine-Desethyl	31	41	1	0	9	44	126
Bentazon	10	6	0	0	1	4	21
Cl. perfringens.	294	249	95	48	25	396	1107
Copper	0	4	4	40	23	31	102
E. coli	274	646	601	228	92	587	2428
Lead	11	63	33	159	134	236	636
Nitrate	176	115	16	4	7	166	484
Terbutylatrazine	1	5	1	0	1	13	21
Total	942 [1)]	1185	756	483	293	1563	5222

[1)] For 821 WZS these are action(s) to terminate or mitigate the cause and for 106 WZS action(s) to replace source

Most of the RA are related to the microbiological parameters E Coli (for 2,428 WSZ) *C. perfringens* (for 1,107 WSZ), followed by lead (for 636 WSZ), nitrate (for 484 WSZ) and arsenic (for 257 WSZ). The remedial action for E. coli are mainly treatment-related. The RA for lead are mainly domestic distribution network related, but remarkably also catchment related. The RA for nitrate are mainly catchment related with an emphasis on replacing source. Except for the catchment related RA for lead, the RA performed by the MS seems plausible.

In case of water network related non-compliance, remedial action is evenly aimed at both replacement and repair of defective components, as well as cleaning, scouring and disinfecting contaminated components. Some MS also require the consumers to be informed, this is however not common practice throughout the EU according to the MS Reports.

In the current situation, the remedial actions come into play when the undesirable situation is already in existence; water quality is already below acceptable levels. Some parties therefore suggested the implementation of an additional preventive measure as a supplement to the remedial actions. These could include measures such as water safety planning and risk analyses.

Main findings effectiveness of remedial actions

In the period 2005-2013 there has been an increase in remedial actions reported by MS. Most of the actions were related to microbiological parameters (*E. coli* and *C. perfringens*) and - to a lesser extent - to chemical parameters (lead, nitrate and arsenic), and the actions dealt with treatment and distribution networks (both public and domestic). It is very likely that the remedial actions performed on the basis of Article 8 have improved the drinking water quality in the period 2005-2013. This is

supported by a (modest) increase in the observed compliance of the microbiological parameters (*E. coli* and *C. perfringens*) and the chemical parameters (lead, nitrate and arsenic) in that period (see Figure 2-1). With over 5,000 remedial actions reported, a more pronounced increase in compliance rates could have been expected.

Information to consumers

Regarding information provided to consumers we note that all MS provide information to consumers and in general national authorities provide some general information on the quality of drinking water and, in most of the cases, they make their national Drinking Water Directive reports also available to the public. In spite of this observation, 51% of consumers who responded to the stakeholder survey carried out for this study indicated that information provisions are inadequate and only 17% judged that information provisions are adequate, with a somewhat higher percentage of satisfied consumers in "old" MS compared to "new" MS. Of the 27 countries included in the survey, in three countries the share of unsatisfied consumers is more than 75%, in nine this percentage is between 50% and 75%, in four this percentage is between 25% and 50%, and one the percentage is lower than 25%. The main reasons of unsatisfied consumers is that they can't find information on the quality of water and it is often not clear to them what is paid for. Apart from providing information through water bills, consumers would like to receive information through social media..

Article 13 of the DWD requires that all MS are to ensure compliance with the Directive by providing adequate and up-to-date information on water quality for human consumption to the consumers. The article mentions a reporting obligation of once every three years and in addition, the Guidance Document on Reporting under the DWD indicates that data are required to be prepared annually.

Most national authorities (ministries of health, environmental agencies or water companies) provide some general information on the quality of the drinking water through various means (consumer leaflets, websites, etc.). This information contains details on and explanations of the key parameters of quality. Often, the reports national authorities submit to the Commission are also made available to the public. The latest DWD reports available refer to the period 2011-2013. As the DWD requires MS to submit reports for three years, it is often difficult to obtain more recent information.

In some cases, centralized online information systems exist which report on the quality of the drinking water per community and water supplier (e.g. CZ, FR, ES, EE, LU). In the majority of the cases, however, detailed information, including parameters' values, can be found either on the websites of the respective municipalities or on those of the water supply companies. In countries with a federal structure, information on water quality is usually provided through the environmental agencies at sub-federal level.

The water companies often see this obligation to provide information to consumers as a way to increase consumer satisfaction and transparency. However, others are more reluctant to share real time information with consumers. Consumers are increasingly interested in the topic of water quality as evidenced from the news reports, websites and discussion for covering this topic. An example of a topic which is recently attracting a lot of attention is micro-pollutants.

In the table below, we provide an overview of the availability and accuracy of consumer information with respect to the drinking water quality obtained from the national authorities' websites.[32]

[32] All relevant information about the drinking water quality per EU member state has been searched in the respective local languages; however the overview does not claim exhaustiveness with respect to the available information on the drinking water quality in the respective countries, but rather aims to present the reader with an idea of what kind of information is easily available online.

Table 2-8 How MS provide information on drinking water

Country	Information sources in MS
Austria	Austrian Drinking Water report (latest available for 2011-2013) is prepared by the Austrian Agency for Health and Food Safety and provides information, requested both by the DWD and the national legislation on the quality of the drinking water in Austria. It contains general information about the water supply in Austria and annual overview of the drinking water quality.
Belgium	The environmental site of Wallonia contains information about the water supply in Belgium. It features a comparison of water consumption distribution between different European countries, description of the structure of public water supply in Wallonia, and information about the microbiological quality of water consumed in Wallonia. Flemish Environmental Agency also published a regular annual report on the water quality. The latest report is dated 2013. Brussels Environment also monitors the quality of drinking water in the Brussels region and provides some very general information about the drinking water in the region. The latest report on the drinking water dates back to the period between 2008 and 2010.
Bulgaria	Water quality reports are available both on the sites of the majority of the water supply companies in Bulgaria, as well as on the sites of the Regional Health Inspectorates. They both feature some general information about the drinking water in Bulgaria, as well as detailed information for specific parameters, also by years.
Czech Republic	Reports on drinking water quality within the System Health Monitoring are published annually, where the latest one is for 2014. The report studies in detail the health consequences and risks of contaminated drinking water.
Cyprus	The Public Health Services of Cyprus publish reports to EU for the Control of Water for Human Consumption. The latest report dates from 2011 and contains very detailed yet technical information about parameters.
Denmark	The National Geological Investigations of Denmark and Greenland contains general information about the water quality in Denmark in the form of interactive maps. It also provides the consumers with the possibility to check the key parameters that are, defining the quality of the drinking water in their communities. The Danish Nature Agency also provides useful information about the drinking water in the country.
Germany	German Federal Environment Agency features a number of informative publications about the drinking water in Germany, its system and provides advice on whether to use drinking water from the tap, etc.
Estonia	Estonian Health Board provides overall assessment of the water quality by counties, cities and water supply companies. The reports also feature detailed information about the parameter values registered. The Ministry of Environment also published the DWD-related compliance report.
Finland	The environmental operators in Finland provide detailed information about the quality of the drinking water. For example, the Helsinki Region Environmental Services (HSY) supplies a list of water quality parameters, along with an explanation of the terms.
France	The French Ministry of Social Affairs, Health and Women's Rights provides very detailed information about the water quality by departments, communities and networks. The information contains some general conclusions about the water quality, as well as registered values of specific parameters.
Greece	Information about the drinking quarter quality is available on the sites of the Greek municipalities and water supply companies. They feature also detailed information about the parameter values[33].
Hungary	Hungarian National Public Health and Medical Officer Service provides detailed and up-to date information about the quality of the drinking water in Hungary. It contains detailed annual reports (latest from 2014), as well as answers to some frequently asked questions about the drinking water. The issue of the arsenic contamination of the drinking water in Hungary is treated as well. The site also hosts some scientific publications on the drinking water quality.
Ireland	Ireland's Environmental Protection Agency website is very well structured and contains detailed information about the quality of the drinking water in Ireland. It features both annual drinking water reports, drinking water remedial action lists, general information about the water supply system in Ireland and drinking water audit reports by counties.
Italy	In Italy there is also detailed information about the quality of the drinking water is available. It is usually provided by the water supply companies.[34] There is also some general information available at the Italian water portal site.
Latvia	Latvian Health Inspectorate features some general information on regulation and monitoring of drinking water, as well as detailed overviews of drinking water quality and monitoring overviews by year (the latest is for the 2014). The site also contains information on the lower limits of certain parameters to be achieved in certain districts along with the deadlines.
Luxem-bourg	The Water Management Administration of Luxembourg publishes general information about drinking water in Luxembourg. Water quality however is controlled at community level. Websites provide users with very detailed information, depending on their address. [35]
Lithuania	Lithuanian water supply companies publish reports on the drinking water quality.
Malta	Maltese Water Services Corporation publishes annual reports, where water quality parameters are given. The latest published report however dates back to 2011.
Nether-lands	Dutch National Institute for Health and Environment information about the drinking water quality in the Netherlands, including reports on the drinking water quality (the latest is from 2011). The Dutch government site also contains information about the quality of the drinking water in the Netherlands, including drinking water reports (latest – for 2012).

[33] Example: http://www.deyakav.gr/images/files/h2o_2015.pdf.

[34] Example:. http://aceaato2.it/ViewCategory.aspx?catid=eba39ca3fa0441f197512da921abbc25 or http://www.smatorino.it/monitoraggio?comune=.

[35] http://www.vdl.lu/Citoyens+et+r%C3%A9sidents/Energies_+Eaux+et+Canalisation/Eaux/Qualit%C3%A9+de+l%E2%80%99eau/Recherche+en+ligne.html.

Country	Information sources in MS
Poland	The Chief Sanitary Inspectorate of Poland publishes regular annual reports on the sanitary conditions in the country.[36] These reports are up-to-date (the latest is for 2014) and contain information on various issues, among which also on the quality of the water intended for consumption.
Portugal	The Portuguese Water and Waste Services Regulation Authority publishes regular in-depth reports on the quality of the water intended for human consumption.
Romania	In Romania a National Monitoring Centre of the Community Environmental Risks is established under the National Institute of Public Health. Its website provides link to the Romanian DWD Reports, where the latest is for 2011-2013.
Slovak Republic	The Slovak Environment Agency contains links to the Slovak Drinking Water Reports where the latest covers the period from 2011 to 2013.[37]
Slovenia	National Institute of Public Health publishes annual reports on the quality of the drinking water in the country (latest is for 2014), as well as various other analyses (e.g. on the situation in Slovenia with respect to the boiling water in 2010 as compared to 2005, recommendations in case of water pollution, etc.).
Spain	In Spain a National Information System on Drinking Water has been developed. It collects data on the characteristics of supply and quality of drinking water that is supplied to the resident population.[38] It can be accessed by two types of users – professionals or citizens – and provides very detailed information.
Sweden	The Swedish Food Agency and the trade association for water services companies Swedish Water provide some very useful information about the drinking water quality in the country.[39] Detailed information about monitored parameters is available at the websites of the respective municipalities.
United Kingdom	Drinking water quality monitoring is divided between three agencies with mandates respectively in England and Wales, Scotland and Northern Ireland. The Drinking Water Inspectorate (England and Wales) publish annual reports on the drinking water quality (latest from 2014) as well as consumer information leaflets. The Drinking Water Quality Regulator for Scotland also published very detailed information, both at national and local level.
Ireland	The Drinking Water Inspectorate with the Department of the Environment for Ireland publishes regular reports on the drinking water quality, where the latest is for 2013.

Source: Ecorys (2015)

In spite of the authorities efforts to provide information on drinking water, the stakeholder survey conducted for this evaluation indicated that consumers are generally dissatisfied with the information they receive on drinking water. Overall, only 17% of the respondents judged that no action has been necessary (on ways to inform consumers), because the information provisions are adequate and 51% was of the opinion that the information provisions were inadequate. Taking those countries into account for which 20 or more responses were received, we observe that of the 27 countries included in the survey, in three countries the share of unsatisfied consumers is more than 75%, in nine this percentage is between 50% and 75%, in four this percentage is between 25% and 50%, and one the percentage has been lower than 25%. By grouping the responses into "old" or "new" MS, we observe that consumers in "old" MS are somewhat more satisfied (17%) than those in "new" MS (10%). The results from the Flash Eurobarometer on consumer satisfaction with information on water-related issues correspond to the findings of the Survey: just 37% of the respondents feel well or very well informed.[40]

The statements below are examples of the critical opinions ventured by respondents on the information provision:

- "The current reporting arrangements do not meet their goal."
- "The enforcement/legislation in the DWD to provide consumers information on water quality is weak."
- "The DWD lacks provisions requiring utility providers to provide consumers with up-to-date information on their water quality."
- "DWD reporting is done every 3 years, but this time lag is considered too big for consumer feedback and the information is generally outdated. Therefore an annual reporting mechanism is proposed. Water supply companies, however, publish drinking water reports every quarter."

More positive responses were also received:

36 http://www.gis.gov.pl/?lang=pl&go=content&id=30).
37 http://cdr.eionet.europa.eu/sk/eu/dwd.
38 http://sinac.msc.es/SinacV2/.
39 http://www.svensktvatten.se/.
40 http://ec.europa.eu/public_opinion/flash/fl_261_en.pdf.

- "In Spain a National Information System of Drinking Water was already established in 1991.[41] It applies to all Spanish municipalities with more than 50 people. The use of this application is mandatory by law for all water suppliers, health authorities and municipalities."
- "Some water supply companies (e.g. in Spain) made declarations (paper of intent) aimed at giving more and more transparent information concerning the quality of water supplied by public aqueduct."
- "In HR a Central Information System for Consumer Protection is established, where answers and advice to consumers are provided."
- "DWD introduction has had an important positive effect on the conduction of consumer surveys and receiving feedback from the citizens about how they perceive the quality of their drinking water (DE). This has raised awareness."

Except for information related to the drinking water quality, consumers participating in the survey expressed the opinion that they would also like to receive information related to other issues such as water losses in the network, the cost of the supply and profit margins, the investments made, and information related to monitoring measures undertaken.

Below are some of the recommendations regarding the type of information we registered through the consultation. They point mostly to a desire to have more detailed information:

- Information should be summarized and presented in an understandable way for non-specialists. Different information might be provided, depending on the types of users. It should be clearly specified if the water supplied is potable.
- Any additives used in the water should be indicated as well as the residual levels remaining in the potable water along with information for the applied treatment procedures.
- The origin of drinking water and the catchment area should be specified.
- More information on the water pricing model should be provided – provide a breakdown of water costs and how water taxes are paid/ fees are used. Consumers also require information on planned or completed maintenance and repair works, expenses for preventive measure, data on profit margins.
- With respect to the monitoring and control of the water quality, respondents would like to be provided with information about the number of control measurements for each parameter, the percentage meeting the standards, minimum and maximum reference measurements and an indication of who made the measurement and when.
- Some respondents also request information from more thorough analyses, such as for example, whether in the same period a change took place in other environmental indicators, changes in diseases (including cancer, diabetes, etc.)

The public consultation further highlighted the need to ensure higher transparency which is seen as important for maintaining and improving public confidence (BG). This view is supported by others who claim that consumers have become more demanding on the information and the level of transparency about insecurities (risk communication). Stakeholders from different backgrounds indicated that insufficient information to consumers may turn them to other water resources than DWD protected drinking water. In particular, the responses about the control of drinking water quality included the following specific suggestions:

- Civilian control should be enhanced and non-profit organizations should be involved in water quality monitoring (or monitoring by an independent research body as additional control);
- Surveillance on demand: if there are consumer concerns, the water quality should be tested free-of-charge;
- Development of simple tests that are intended for citizen control on some important parameters should be made.

[41] http://sinac.msc.es/SinacV2/.

The Finnish regulator perceived more regular monitoring and thus more information on water quality and better public awareness of the water quality as a positive effect from the DWD. The German regulator saw the DWD as a catalyst for conducting consumer surveys and receiving feedback from the citizens about how they perceive the quality of their drinking water. These surveys are regularly carried out in other MS. Regulators see consumer surveys as one of the instruments to raise awareness.

Conclusions on information to consumers

We observed that most national authorities provide general information on the quality of the drinking water and, in most of the cases, they make their national DWD reports also available to the public. However, the variation in the quality of reporting is large and consumers' satisfaction on the way information is provided by the authorities is a low 20%.

Consumer preferences as to the type and level of detail of information they would like to have are mixed. Whereas two-thirds of the respondents would like to see easily understandable information, the same percentage asks for more detailed information. Providing (detailed) information is needed to ensure higher transparency and is therefore important for maintaining and improving public confidence.

2.2.2 *Other specific provisions*

Option of derogation

The provision of derogation was included in the DWD as a means for Member States to achieve compliance. has been found to be effective as it allowed a limited and conditional extention period for achieving compliance as the provision ensured compliance at the end of the derogation period without causing a potential danger to human health.

With a maximum of three derogation periods, MS have to take action to ensure the quality of their drinking water supplies as soon as possible and definitely within nine years to the quality standards as indicated in the DWD. Currently, most MS have drinking water supply systems which are compliant with the high quality standards of the DWD. Only six MS have asked for a third derogation, five of them were granted[42].

Country specific derogations and the impact on human health

Italy and Cyprus, both having high natural boron concentrations in their drinking water, find that compliance with EU boron regulation is more difficult and expensive than originally anticipated, while health benefits are questioned[43]. This opinion is backed by the Scientific Committee on Health and Environmental Risks (SCHER), which, notwithstanding the fact that drinking water concentrations exceed the DWD standards, is of the opinion that the risk is tolerable in general for all age categories.[44]

From the EU Survey the prevailing opinion of the MS is that a new derogation regime should be introduced to a limited extent and under strict conditions. All countries agree that the current derogation regime should not be extended for a further transition period and three countries are in favour of complete abolishment of the derogation regimes.

[42] http://cdr.eionet.europa.eu/ro/eu/dwd/envvphazg/

[43] Weinthall, ea (2005). The EU Drinking Water Directive: The Boron Standard and Scientific Uncertainty.

[44] Scientific Committee on Health and Environmental Risks (2010). Derogation on the Drinking Water Directive.

Main findings effectiveness of derogations

The provision of derogation has allowed MS to apply the parameter values as defined in Annex I of the DWD at a feasible pace, depending on local circumstances. This has proved to be efficient, because otherwise specific water sources could not have been used for an extensive period of time, without having to resort to other means. We found that the need for this Article has reduced over time, mainly because the Commission has become more restrictive in allowing derogations.

Article 10

Article 10 of the DWD regulates the impact of materials and substances in contact with drinking water. Much effort was put into the development of a harmonised testing and approval system for materials by experts, Member States and the European Commission. Even though the harmonisation of testing and approval is not directly an issue for the DWD, it would have made the protection of human health in the EU easier, as the quality of the materials and thus the protection of the water quality would have been better guaranteed. In other words if all materials used in the Member States would have been tested and approved in a harmonised way this would have meant a more equal level of protection to EU citizens than is the case now. We therefore conclude that Article 10 has not been effective as it did not provide a regulatory framework at EU level and as such MS regulators were not able to develop an effective national approach and many MS experienced problems with the implementation as no further guidance was offered.

Article 10 of the DWD deals with the *quality assurance of treatment, equipment and materials regulation of substances or materials used in new installations*. It aims to ensure that MS take all measures necessary to prevent hazardous concentrations of substances and materials from ending up in the drinking water as a result of treatment, equipment and materials used.

The quote below from the Commission proposal for the Directive for Drinking Water Quality (COM(94) 612 final) provided the background on a topic which has been in the centre of discussions between policy makers, industry groups and scientist for the last two decades:

'The acceptable concentration of treatment chemicals or impurities associated with them are no longer defined exclusively by the MACs given in the previous Directive 80/778/EEC. Account must now also be taken of the specifications for treatment chemicals which MS might adopt in the implementation of the Directive. Concentrations of treatment chemicals or of their impurities in water intended for human consumption should be no higher than is necessary for the purpose for which the treatment chemicals were used. This will have the effect of limiting contamination from treatment chemical and their impurities, and will require the use of good practice in the preparation of drinking water. The general problem of water contamination resulting from materials used for piping and fittings and which come into contact with water intended for human consumption are dealt with in the framework of the Directive 89/106/EEC – the Construction Products Directive. This Directive and its Interpretative Documents set out, amongst other thing, requirements concerning the protection of consumers' health. This will oblige MS to ensure that only those materials which are compatible with the relevant water quality will be available in the future use in contact with water intended for human consumption. This means that MS will have to legislate accordingly'.

In 2011 the Construction Products Directive (89/106/EEC) was repealed and replaced by Regulation (EU) No 305/2011 - laying down harmonised conditions for the marketing of construction products.[45] This raised its regulatory status to EU level and the basic requirements now referred specifically to drinking water.

Article 10 of the Directive covers both 'substances' such as chemicals used in the production and distribution of drinking water and materials used for new installations. Chemicals used in the

[45] Directive 98/83/EC

treatment of drinking water are generally (but not always) of certified quality. But even when quality has been checked they should not be used in such a way that they cause an impact on water quality. Examples are e.g. disinfection chemicals which are used to protect the microbiological quality of drinking water but might also cause adverse effects such as trihalomethanes and other disinfection-by-products.

The DWD specifies three chemicals that need to be controlled through product specifications. This was agreed at the time of the adoption process of the DWD because the parametric values which were then the lowest achievable were below the limit of detection of convenient analysis methods. These three parameters[46] are *acrylamide* (specified through the maximum concentration of monomer of acrylamide permissible in *polyacrylamide* used as flocculant), *epichlorohydrin* a coagulant aid (based on the advice of the CSTE), and *vinylchloride* (also based on advice of the CSTE).

Article 10 also covers all process steps used in the production of drinking water such as (membrane) filters, electro-dialysis systems and ion-exchange media. None of these should have an adverse effect on the quality of the water.

The focus is also on construction products in contact with drinking water, such as pipes, valves, appliances but also small parts such as rubber rings, washers etc., basically anything that can come into contact with drinking water. The materials used in the production and supply of drinking water are in principle covered by Article 10 from source to tap. The legal point of compliance in the DWD for water supplied through a distribution network is in accordance with Art.6 at the point, within a premises or an establishment, at which it emerges from the taps that are normally used for human consumption. MS shall be deemed to have fulfilled their obligations with respect to the quality of the water supplied where it can be established that non-compliance with the parametric values is due to the domestic distribution system or the maintenance thereof except in premises and establishments where water is supplied to the public, such as schools, hospitals and restaurants. However, if changes in water quality are due to materials used beyond the legal point of delivery and there is a risk that water would not comply with the parametric values there is a joint responsibility of both MS and property owners in accordance with Art.3. This responsibility includes measures to reduce and eliminate the risk of non-compliance and information to the consumers on remedial actions they can take.

The implementation of Art.10 has caused many discussions as the DWD does not give any guidance on the outline and the operation of a system for the assessment and the approval of chemicals and materials in contact with drinking water. Furthermore, the reference to the CPD (and the Regulation which replaced this Directive) has not solved the following issue from the manufacturing industry; who called for harmonized product standards before they are able to identify compliance. The implementation was left to the MS and given the number of substances and the complexity of test and field conditions in the various MS this turned out to be a laborious and long term task. Below we present two real-life case studies provided by an EU28 industry interest group in 2015 to illustrate the type of discussions taking place on this issue:

Case 1: A given substance used as desensitizing agent of organic peroxides is listed in the warenwet (Netherlands) and several chapters of BfR (Germany) but not in the French positive list of substances authorized for the manufacture of drinking water materials. This yields to the situation that polymers and articles

[46] Acrylamide is a monomer present in polyacrylamide flocculant, is used as grouting agent in reservoirs and boreholes and is present in some types of RO membranes
Epichlorohydrin is present in epoxy-resin coatings and as coagulant aid
Vinylchloride is present as monomer in PVC pipes and as degradation product of tri and tetra in groundwater (latter is not covered by art.10)

containing this substance were not approved in France. Industry was forced to run migration test studies in order to demonstrate that the migration into water is below 0.5µg/l. After four years of work and discussion with the French authorities a derogation was obtained recently with the obligation to verify that the migration is below <0.1µg/l. The applicant submitted then a risk assessment to the French Health Ministry (Direction Générale de la Santé), who after its evaluation requested industry to carry out new in-vitro test. The new requested tests were carried out and ANSES published an opinion confirming the safety of that substance in the intended drinking water applications. Currently industry is still awaiting the modification of the French law. The entire process described above lasted 6 years and during that period materials containing the mentioned substance were put on the market in other EU countries without further objections.

Case 2: A given processing solvent used in the production of a rubber based formulation used to make an O-ring. Given that the current German EPA (UBA) guidelines do not list solvent, the product was deemed as non-compliant. German authorities did not accept industry-self assessment of the use of that solvent in that specific application, not the approval based on mutual recognition, i.e. France follows acceptance of solvents with boiling point <150°C and The Netherlands accepts risk assessment. Industry had to show compliance with the 0.1µg/l migration limit following the UBA guidelines. The petitioner had to provide the analytical method. The certifying laboratories were not able to run migration modelling and the petitioner had to demonstrate compliance using migration modelling. This case lasted two years, during which the product could not be put on the market, which led to an estimated sales loss of an order of magnitude of millions of euros.

Main findings effectiveness of Article 10

Article 10 has not been effective as it does not provide a regulatory framework at EU level and as such MS regulators were not abled to develop an effective national approach. Article 10 asks the MS to take actions to remove substances in order to comply with the quality requirements in the Directive, but many MS experienced significant problems with the implementation of the article as no further guidance was offered. Effectiveness can be improved by better guidelines from the Commission.

Reporting to the Commission

The compliance with the requirement of reporting to the Commission is high if somewhat irregular and in general provides a good overview of the quality of drinking water supplied in the MS. Screening on the continuity of the reported data for all MS resulted in just 12 MS having delivered a continuous record of analyses. Furthermore, the quality of reporting is variable and did not provide the Commission with adequate information to perform a thorough synthesis of drinking water quality developments in the EU.

According to the DWD, the Commission is to publish a synthesis report on the quality of water intended for human consumption in the Community. However, since the DWD does not indicate a clear objective in the reporting procedure, each synthesis report is different, and the whole reporting exercise is somewhat incoherent and arbitrary.

Article 13 of the DWD also stipulates the reporting obligation for MS to the European Commission. The reporting to the EC covers three year periods, on the basis of which the EC publishes a synthesis report on the quality of drinking water in the Community. This reporting to the Commission is designed to check the implementation status of the Directive, and to request data for example on non-compliance, causes, and remedial actions. This information is quite specific, and can be used for legal prosecution by the EC, but also for legal action at national/ regional level to ensure human health protection.

The compliance to submit reports but often incomplete, and the Critical Analysis Report written in 2013 under the ENV.D.2/FRA/2012/0013 Framework Service Contract for Support to the

Implementation of the Water Industry Directives states that the information submitted by MS is insufficient for the Commission to perform a thorough compliance check and adequately inform e.g. the European Parliament. Additionally, the report notes that the DWD fails to provide a clear objective for the reporting, and lack of feedback to MS about their (incomplete) returns has caused bad reporting by some of them to continue for many years.

The Synthesis Report on the Quality of Drinking Water in the EU examining the MS' reports for the period 2008-2010 under Directive 98/83/EC corroborates the findings of the above report and states that the "current set-up for reporting does not provide the Commission with adequate and timely information to perform a thorough synthesis of drinking water quality developments in the European Union. This makes it difficult to provide the Council, European Parliament and the public with updated EU-wide information on drinking water policy and quality on a regular basis. In addition, the way data is collected, processed and reported differs across the EU, which makes it difficult to compare situations in different MS with regard to their performance and compliance with the Directive".

With a high compliance of reporting to the Commission and the increasing demand by consumers for more detailed information, the question is whether these two requirements (reporting to the Commission and informing the public) should not be combined.

The critical analysis report as mentioned above further states that the information relevant for consumers differs so much from the information needed by the Commission to perform compliance checks that it would be advisable to have these as two different activities, specifically aimed at the reporting objectives for the respective target groups.

Main findings effectiveness of reporting requirements

The compliance with the requirement of reporting to the Commission is high but the information submitted by MS does not provide the Commission with adequate information to perform a thorough synthesis of drinking water quality developments in the EU and thus the Commission lacks a suitable tool to inform the Council, the European Parliament and the general public.

2.2.3 *The general provisions have enabled MS to implement the DWD effectively (JC2.2)*

Under this heading we discuss the effectiveness of those provisions which relate to the objective, definition and exemptions (Articles 1, 2 and 3) and the obligation of the MS to take measures as described in Article 4. The review process (Article 11) will also be assessed in under this heading.

Objective and scope

The effectiveness of the objective and scope of the Directive depends to a great extent on the outcome of the transposition of the DWD into national law (how are provisions implemented at MS level?), and the clarity of the text of the general provisions.

The overall objective of the DWD as described in Article 1 ("to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it I wholesome and clean") is an accepted principle of protecting the health and well being of EU citizens and been a treasured piece of policy in the EU for the last decades. The broad acceptance of this principle and the willingness of Member States to implement the relevant legislation is also reflected by the large number of international treaties on this subject which have been signed by MS. The effectiveness of the general provision on DWD objective is therefore clear and is not futher discussed in this section. However, given the continued discussion on which indicators to include in the DWD, we will come back to this in the chapter on relevance.

Article 3 on exemptions (specifically the sub-article relating to individual supply providing less thatn 10 m^3 a day) has brought out more discussions and was also highlighted in the various interviews conducted for this study and comments received by stakeholders during conferences or in written form. This article allows MS to exempt these small supplies from the obligations of the DWD and this has led to differences in the transposition of the DWD in the various MS. In total nine Member States used the exemption of small types of water supply zones in the Directive (Belgium, Estonia, Finland, France, Hungary, Ireland, Sweden, United Kingdom and Spain). The main reason this exemption became a topic of debate was the recognition that the quality of drinking water from small supplies was not at par with that in larger supply zones[47].

Review process

Article 11 requires a full procedure (involving the European Parliament and the Council) to make any changes to Annex I. Given the technical complexity and far reaching implications of changes to the list of parameters and their values, this process is justified, even though some stakeholders have argued in favour of amending Annex I on a more regular basis. The procedure to make changes to Annexes II and III is quicker and simpler and allows more flexibility to respond to scientific and technical progress.

The review of the Annexes is a different process for Annex I and Annex II and III. Annex I is reviewed every five years by the Commission and if necessary the Commission will make proposals for amendments, where necessary. In the case the Commission decides that amendments are needed this is done by a full procedure involving both the European Parliament and the Council. Since the coming into force of the 98/83/EC Directive no changes have been made to Annex I as it was not deemed necessary and Annexes II and II were only amended for the first time in 2014.

The adaptation of Annex II and III of the Directive is subject to a five years cycle. The Commission decides together with the Committee composed of representatives of the MS whether an adaptation of Annexes II or III is needed. In the case adaptations are needed this is done through the Committee procedure. A process of revising Annexes II and III took place in 2014 and 2015. Amendments regarding the Annexes II and III take into account the provided comments from MS experts and stakeholders during and after the Drinking Water Expert Group meeting of 27 June 2014. The text also takes into account the outcome of the EU-wide public consultation for the relevant parts on monitoring and analysis, carried out from 23 June to 23 September 2014. The amendments now offer the option for MS to apply risk based monitoring. This means that deviation from the default monitoring programmes in relation to the parameter list and monitoring frequencies can only be done after a risk assessment, providing strong guarantees that the protection of human health is not compromised.

In 2008 preparations were made by the ad hoc Subgroup of the Standing Committee on Drinking Water to revise Article 10 of the DWD on Quality assurance of treatment, equipment and materials. However, this revision never took place.

Another issue that could be addressed in a revision of the DWD are the provisions on radioactive substances and radioactivity parameters as these issues are addressed in the developments in EURATOM legislation (Directive 2013/51/EURATOM). These provisions are detailed in Annex I and therefore need a full procedure involving the EP and the Council.

[47] KWR, 2011 Towards a Guidance Document for the implementation of a Risk Assessment for small water supplies in the European Union Overview of best practices

On the effectiveness of Article 11 and the distinction in review procedures it is observed that exapt for Annex II and III, the Directive can only be amended through a full procedure, a lengthy and time-consuming procedurs. However, this is deemed justified given the controversy around some of the parameters and the implications (especially for monitoring procedures) of any proposed changes. The decision to allow a rapid adaptation of the technical requirements of the Annexes II and III through a Committee procedure introduced some flexibility in the Directive to respond to scientific and technical progress.

Main findings on general provisions

The general provisions have been found effective, based on:

- the timely transposition of the Directive into national law across the EU;
- the broad acceptance of the principle of providing wholesome and clean water to citizens;
- the willingness of Member States to implement the specific provisions into national legislation;

Less effective has been the general provision regarding article 3 on exemptions, which potentially leaves a relatively large segment of the population (up to 17%), outside the realm of the DWD.

The procedure for revising the main text and Annex I of the DWD requires a full procedure (involving the European Parliament and the Council). Although the technicalities involved justify this process, some stakeholders have argued in favour of amending Annex I on a more regular basis. The procedure to make changes to Annexes II and III is quicker and simpler and allows more flexibility to respond to scientific and technical progress as evidenced by the change made in 2015.

2.3 What main factors have influenced, or stood in the way of, achieving the objectives of the DWD? (EQ3)

2.3.1 The majority of non-compliance cases can be related to agricultural or industrial pollution (affecting water bodies) or treatment and distributon systems (JC 3.1)

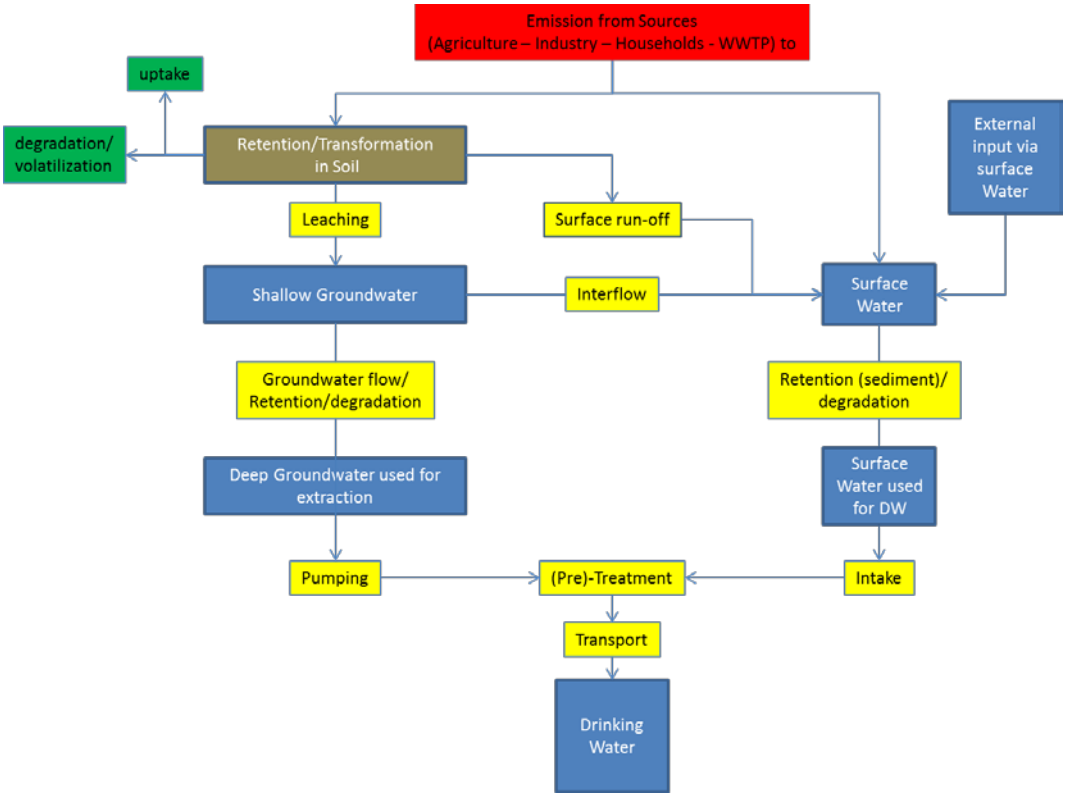
In this section we report on the causes of non-compliance and conclude with a discussion on the possibility of relating these causes to the DWD. To this end, we have i) collected generic information on causes of non-compliances by MS and presented likely dominant reason; ii) analysed trends in non-compliances in relation to causes as reported by MS; and iii) analysed trends in remedial actions as reported by MS. Our analysis uses the source-pathway-receptor concept, which is described below.

The source, pathway and receptor concept

The concentrations of the parameters are largely dependent on the process of drinking water production (abstraction) and distribution. During the process of drinking water production, several cases of non-compliance could occur. The sources of contamination of water resources are multi-fold and very much depend on a combination of activities (land use) in the abstraction area resulting in inputs of chemicals into the aquifer or surface waters, geological conditions in aquifers used for abstraction, and subsequent handling of water during processing and distribution.

To assess whether the DWD actions led to improvement of the drinking water quality, we looked at the dominant causes of the contamination of drinking water sources using source, pathway and receptor analysis, considering process-based factors such as retention and transport velocity. Figure 2.1 illustrates these dominant causes both for groundwater and surface water.

Figure 9 Source, pathways and receptors of (microbial, chemical and indicator) parameters in drinking water



Source: KWR/Alterra, 2015.

Conducting an analysis of all factors linking sources and the resulting concentrations in aquifers (and hence the impact of the DWD on such concentrations) has not been feasible due to the complexity of processes and variation across MS in both conditions (geology), land use (inputs) and policies. However, our (partial) analyses shows that for specific substances the source-pathway-receptor approach is the best way to quantitatively establish a link between all processes acting upon aquifers and hence the quality of drinking water. Below we discuss the three components of the source-pathways-receptor analysis.

The source-pathway-receptor analysis is used to drawn conclusions about the potential risks caused by the source of contamination. First, the cause or **source** of the contamination is identified. **Diffuse and point sources** are relevant for surface and groundwater quality, such as intended (nutrients) and unintentional (metals, pharmaceuticals, nano-particles) application to (arable) land via fertilization, manure application and or use of secondary nutrient sources (sludge, compost etc.), internal sources of contamination (e.g. lead and copper) that occurs during treatment and/or transport. Second, the **pathway** is the route the source takes to reach a given receptor. There are several **pathways** and **processes** that determine the magnitude of the flux of substances from source to receptor, such as. plant uptake, run-off to surface water and leaching to groundwater, retention/release processes in soils, sediments and aquifers e.g. adsorption, precipitation including redox controlled precipitation or dissolution. Finally, if contamination is to cause harm, it must reach a **receptor**. For our analysis we distinguish between two main types of **receptors** i.e. groundwater and surface water. Additional factors that need to be included in the source-receptor-pathway analysis are those that affect the flux of substances via an impact on processes and/or pathways and hence affect the quality of water (ground- or surface waters). Examples of such factors are:

- Soil properties that affect uptake (nitrogen, metals), retention (metals and organic pollutants) and degradation (nitrogen and organic pollutants) processes;

- Climatic conditions and foreseen changes therein that affect the water balance at the surface and hence surplus, dilution of substances, and travel time. Examples of such factors are precipitation and flooding;
- Size of the WSZ due to its impact on travel time and differences in (cleaning) technology applied in the abstraction and distribution process.

In view of the effectiveness, a relation between the Source Pathway Receptors and the parameters has been made. In this analysis we used the following main categories (as used in the MS Synthesis reports) during causes of non-compliances:

- Catchment related, resulting from either application to soil or water systems (e.g. nutrients, pesticides);
- Treatment plant related;
- Public distribution network related;
- Domestic distribution network related;

Analysis of the causes of non-compliances

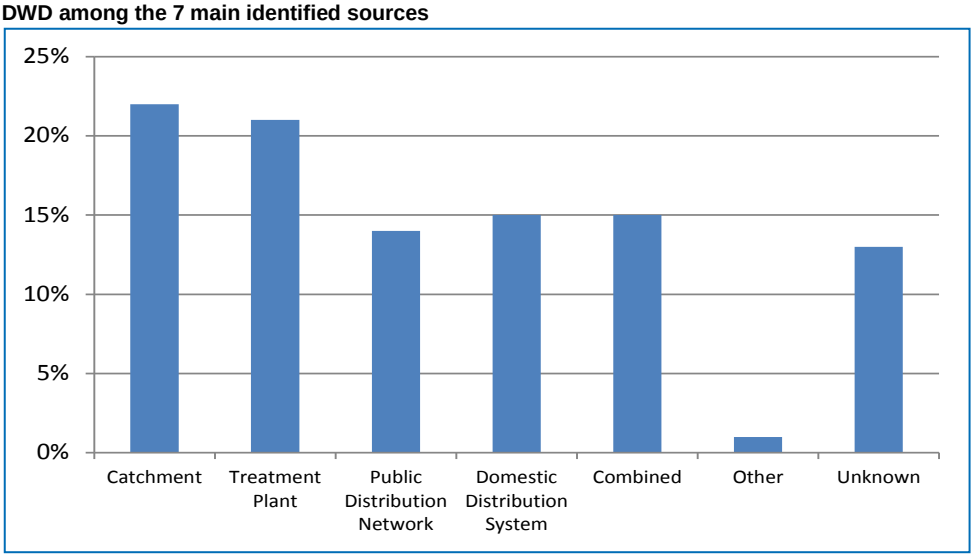
Based on the inventory of MS in 2013 non-compliances for all parameters and indicators were listed as well as for the 10 selected substances (*Escherichia.coli* (*E. coli*), arsenic, nitrate, lead, copper, *Cl. Perfringens,* atrazin, *desethylatrazine*, *terbutylatrazine*, and bentazon). In addition, the causes underlying the non-compliance as reported by MS were included.

Here a distinction between 7 different causes was made:

1. Catchment related; representing the impact of geology, land use, soil type and hydrology;
2. Treatment plant related, representing the impact of the installations used to treat the water after abstraction from either groundwater of surface water;
3. Public distribution network related; representing the impact of the distribution network between the treatment plant and the domestic system;
4. Domestic distribution systems; representing the impact of the quality of the water distribution systems after supplying the water to the private home-owners;
5. Combined sources;
6. Other sources not specified;
7. Unknown.

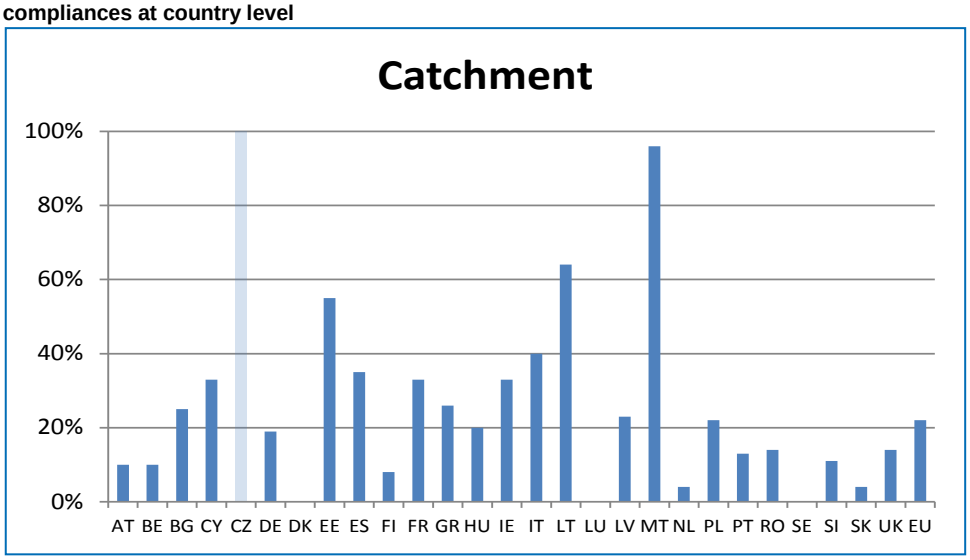
In Figure 2-7 the overall distribution of all reported non-compliances for all parameters included in the DWD at EU level (40695 in total) among the 7 groups of causes distinguished is shown. This figure shows that the contribution of catchment related sources and treatment plant sources combined contribute to approx. 45% of all non-compliances. The sum of the distribution networks, including public and domestic distribution amounts to approx. 29% of the sum of all non-compliances. The remaining part is equally distributed among combined sources (15%) and unknown sources (13%).

Figure 10 Overview of distribution of causes for the non-compliances of all parameters monitored in the DWD among the 7 main identified sources



Obviously significant differences in the distribution between countries and parameters exist. Figure 2-8 shows for example the relative contribution of catchment related sources to the total number of non-compliances at country level. In some cases the total number of non-compliances is low (e.g. CZ, 18 in total) and these appeared to be all catchment related. For most countries the contribution of catchment related causes ranged between 10 and 25% with the exception of EE, LT, IT and MT where catchment related causes are higher than 40% of the total number of observed non-compliances.

Figure 11 Contribution of catchment related non-compliances relative to the total number of non-compliances at country level

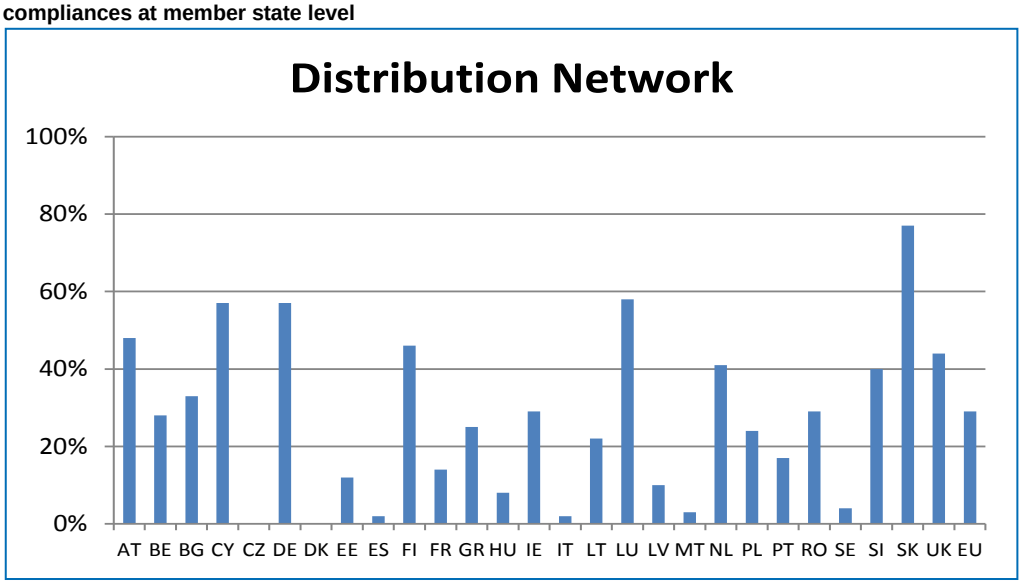


Obviously, the overall number of non-compliances for the 10 selected parameters is less (5,514) compared to all parameters (40,695). The overall distribution of causes for non-compliances for the 10 selected parameters is, however, more or less equal to that of the all parameters.

Noteworthy exceptions to average values include (data shown in Appendix 1) a relatively high contribution of the domestic supply system in CY, DE, IE, LU, SL, SK, UK, which partly (for LU, DE, SK) corresponds with relatively high contributions of the public distribution system. This is illustrated

in Figure 2.3 that shows the contribution of the combined effect of private and public distribution networks at country level

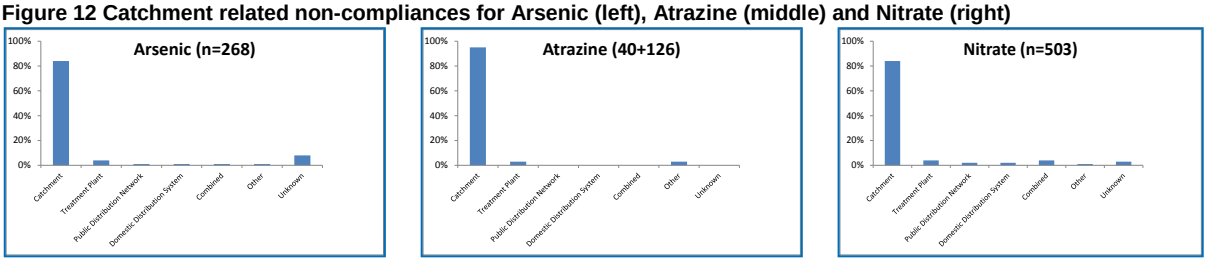
Figure 2.3 Relative contribution of private and public distribution network to the total number of non-compliances at member state level



Differences between MS can have difference reasons including differences in land use (e.g. intensity of agriculture related to catchment controlled sources versus the quality of the distribution network). The results from the 10 selected substances shows three different main causes, depending on the substance considered:

1. Non-compliances related to *catchment*. This is the case for arsenic, nitrate, and all pesticides. For these substances more than 80% of all non-compliances are related to catchment as shown in Figure 2-9. For Arsenic, this can be related the combined impact of geology and hydrology and for both pesticides and nitrate, this can be assigned to land use; more specifically the impact of agriculture, being the main source of these substances through application of manure, fertilizer and pesticides.

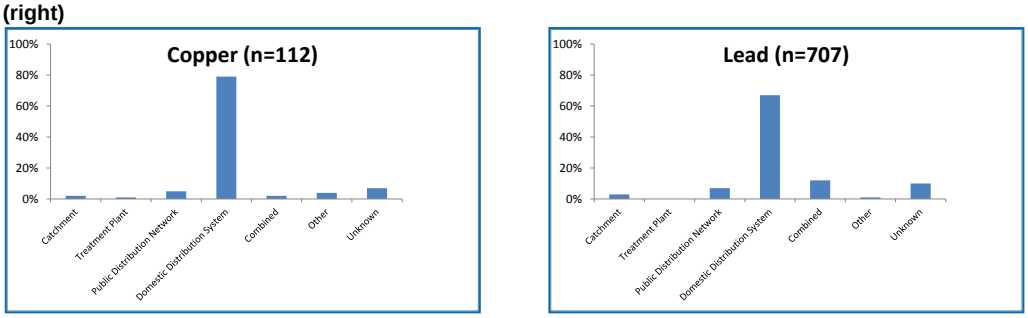
Figure 12 Catchment related non-compliances for Arsenic (left), Atrazine (middle) and Nitrate (right)



The distribution for the other pesticides included here is similar to that of Atrazine and dominated by catchment related sources.

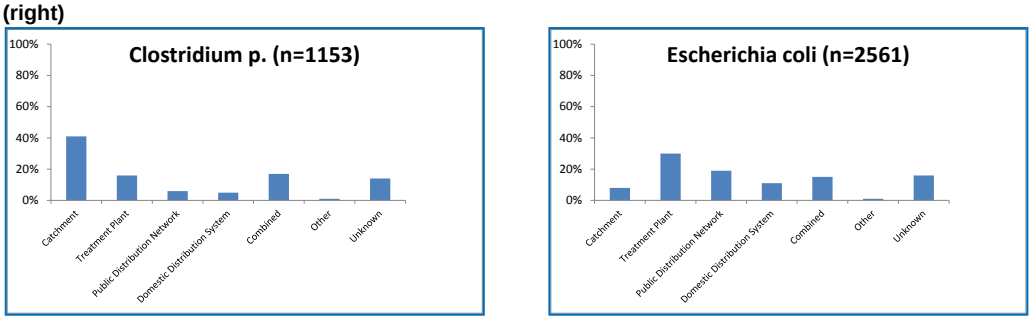
2. Non-compliances related to *the distribution network*. For both copper and lead the contribution of the distribution networks, and largely the domestic distribution network is the main reason for the observed non-compliances (Figure 2-10). For lead approximately 10% of all non-compliances is of mixed origin probably including the impact of catchment as well.

Figure 13 (Private) distribution network dominated causes of non-compliances for copper (left) and lead (right)



3. *Mixed sources.* For both *Cl. perfringens* and *E. coli*, there appears to be no clear single factor that controls the presence of these indicators (Figure 2-11) even though the contribution of the catchment (for Clostridium) and treatment plant (for Escherichia) are clearly higher than the other identified causes.

Figure 14 Contribution of difference sources to non-compliances for Clostridium (left) and Escherichia (right)



Analyses of trends in non-compliances in relation to causes as reported by MS

A substantial improvement of the water quality has been documented when looking at the trends in water quality as such. A clear link with causes can be identified for specific parameters. Nitrate, arsenic and pesticides are largely controlled by catchment conditions, lead and copper are largely related to distribution systems and both clostridium and Escherichia coli have no dominant cause of non-compliance. Especially in the situation of lead and copper, where a reduction in non-compliances occurred with the cause mainly being to distribution system related, it is clear that the actions carried out within the DWD is the main cause for this improvement. This is most likely also, at least partly true for both *Cl. perfringens* and *E. coli*. For nitrate, arsenic and pesticides, it may be an improvement due to other directives regulating the application.

An additional question is to assess to what extent *trends* in causes related to non-compliances can be identified. In order to perform the trend analysis the data were first screened on the continuity of the data for all countries. It was decided to only use data from countries that, for an individual parameter, have delivered a continuous record of analyses. This limits the number of countries included to 12 (BE, CY, ES, HU, IE, LV, NL, PL, RO, SI, SK, UK). Here we used the remaining data for the period 2005 – 2013. In Appendix 2 the full results are shown.

Results from the data analysis show that:

- For both *Cl. perfringens* and *E. coli* there is a clear decrease in non-compliances for the 12 selected countries with an increase in treatment plant related causes in time;

- For all pesticides there is no real trend and the data show that the main cause of non-compliance remains catchment related. The remaining number of samples however is too small to derive meaningful trends in causes of non-compliances;
- For arsenic the data are dominated by non-compliances reported by Hungary (325 out of 388) which largely appear to be catchment related although 133 cases are not related to any cause (blank);
- For lead a substantial number of non-compliances are still reported for the UK, B, IE, Pl and ES. Despite a trend towards a lower number of non-compliances, the non-compliances related to domestic distribution networks increased from 2010 onwards. This shows that regional (or even national) data and trends derived from this are not necessarily in line with the overall trends observed at EU level.

Since the number of data remaining after screening for complete records is limited, some results are clearly biased (e.g. in case of arsenic) by the number of countries and or (low) number of non-compliances. These data therefore do not allow for an in depth analysis of trends in causes and hence cannot be used to further evaluate the effectiveness of the DWD in relation to the quality of drinking water.

Conclusions

Trends in mean compliance for all parameters and in more in detail for ten selected candidate parameters showed an increase in compliance with time for all parameters. The causes of non-compliances varied from: (i) almost completely *catchment related* for arsenic (combined impact of geology and hydrology) pesticides and nitrate(application of manure, fertilizer and pesticides) to almost completely *distribution network* related for both copper and lead and *mixed sources* for both *Cl. perfringens and E. coli*.

The objective of providing the same minimum level of quality of drinking water in the European Union has not always been achieved due to the following reasons:

1. MS did not always succeed in supplying water that was in compliance with all quality requirements of the DWD. Sometimes non-compliance incidents were short-lived and rapidly addressed but in other cases non-compliance was long lasting and not immediately addressed. Mostly this was related to problems with the treatment and with changes in water quality in the distribution system.
2. In some cases the instrument of derogation was stretched to the limit, not only using the first and second derogation period but sometimes also asking for a third period (of three years). That raises the question if action was always taken to remdiate problems as soon as technically possible.
3. Transparency and reporting on the quality of drinking water is very much linked to the availability and penetration of internet facilities to rach ot to the public. If there is a low degree of penetration this will adversely impact on the communication and transparency.
4. Insufficient knowledge of the location and quality of drinking water supplied by small water supplies is an important factor in achieving the objectives.
5. Even though Article 4 addresses all substances and organisms that might impact on the quality not all water suppliers will (be able to) look for all factors that might adversely affect the quality.
6. There is insufficient knowledge about the many new substances coming on the market and entering the aquatic environment. This includes absence of a total overview of substances, toxicological impacts and analytical methods to detect and quantify.
7. Sampling water at the tap is not always possible due to national legislation that prohibits water suppliers entering private premises. This is an important factor in some countries that does not help to achieve the objectives of this ‘tap water Directive’.

2.4 What results did the DWD achieve beyond its main aim to protect human health, and the Directive cause any other unexpected or unintended changes ? (EQ4)

2.4.1 The DWD has lead to other than human health related results, including unexpected or unintended changes

We have applied a broad scope to put the Directive in a wider perspective and to identify both effects beyond its main aim to protect human health, and unexpected or unintended changes, :

- The awareness of drinking water quality and human behaviour;
- Other EU Directives and pesticides; and
- Wider economic benefits

Awareness of drinking water quality and human behaviour (JC4.1)

A positive unintended effect of the DWD beyond the main aim of the Directive is the creation of awareness at the level of all stakeholders involved, where regulators are most affected. Stakeholders interviewed, who have a position as a regulator or are active within the ministry on this issue, informed the study team that the DWD has put drinking water quality higher on the list of important national policies. The MS that already had relatively good drinking water quality indicated that the importance of consumer information was put higher on the agenda as a result of the increased awareness of water quality. In case of Portugal, a change of national institutional organisation was even indicated as necessary to comply with the new DWD quality standards. The interviewee named the DWD and its indirect effects as an important positive driver to stimulate water companies to comply with the quality standards. The DWD also unintendedly led to more co-operation between MS. Networks of national regulators were formed across the EU to discuss issues that are present in different countries, leading to learning, advice, knowledge sharing and informal discussions. This is a positive unintended result of the DWD, according to a Dutch regulator.

The Stakeholder Consultation revealed two lines of thinking on consumer behaviour related to improved legislation on drinking water. The first line of thinking was that more extensive drinking water legislation, such as the DWD, increases the quality of drinking water and therefore raises the preference of consumers for tap water. The second line supported the hypothesis that drinking water legislation leads to higher awareness on water quality and therefore results in consumers buying more bottled water, which is deemed safer and qualitatively better by consumers. However, none of these lines of thought captures the reality of consumer behaviour on drinking water and much research has been done in the EU on the preferences for either tap water or bottled water.

A number of variables are known to influence the consumer behaviour on drinking water, the most important are: perceived taste (bottled water tastes better), pure quality (bottled water is perceived as pure and of better quality), security (food scandals and waterborne diseases in developing countries negatively influence tap water) and health concerns (bottled water is seen as a healthy alternative to other bottled beverages).[48] However, these concerns do not necessarily reflect reality. For example: a study conducted in Italy, a country known for its large consumption of bottled water, found that there is no reason to believe that bottled water is of better quality than the Italian tap water. The results even indicate that some bottled waters contain concentrations of substances that are significantly higher than normally acceptable in tap water[49].

[48] Ferrier, C. (2010) Bottled Water: Understanding a Social Phenomenon. *Journal of the Human Environment.* 30(2). Royal Swedish Academy of Sciences.

[49] Cidu, R., F. Frau & P. Tore (2010) Drinking water quality: Comparing inorganic components in bottled water and Italian tap water. *Journal of Food Composition and Analyis.*24, 184-193.

The reason that bottled water is often preferred to the tap water is largely assigned to the extensive marketing campaigns of the industry. Large budgets are allocated to marketing, since the bottled water industry is known to be very competitive and dynamic. The tap water companies however, do not allocate similar resources or means to promote their product. The public consultation on the quality of drinking water by Ecorys indicated that there are large differences across the EU in terms of drinking tap water. The percentage of people that drink water directly from the tap ranges from more than 95% in Sweden and the Netherlands to less than 30% in Poland, Latvia and Ireland[50]. It is therefore hard to state what influence the DWD has had on the consumer behaviour relating to bottled and tap water, and whether this is positive or negative.

Other EU Directives and pesticides

A second unintended effect that can be linked to the DWD is that it created the basis for a number of Directives which have been designed and implemented since 1998 (such as the Water Framework Directive (2008/105/EC) and the Groundwater Nitrate Directive (2006/118/EC). There has been a clear link with the levels of regulation of substances between the DWD and those of other Directives, a thorough assessment of other legislation is made in the section on coherence.

The use of fewer and other pesticides is also referred to as an effect of the DWD and other water Directives. In the proposal for a Council Directive concerning the quality of water intended for human consumption the Commission proposed that the previous precautionary parametric value of 0.1 µg/l for individual pesticides and 0.5 µg/l for the total mixture of pesticides should be retained.

Concerning pesticides, the Commission asked the Scientific Committee (CSTEE) for its opinion on whether scientific knowledge available at that time provided the necessary security and reliability to determine, on the basis of a precautionary approach, individual limit values which guarantee safe drinking water on a life-long basis for the population, including sensitive population groups where relevant and what the correct values for individual substances could be.

In the opinion of the CSTEE the limit values of 0.1 µg/l for each compound or 0.5 µg/l in total adequately protects human health, generally providing a sufficient margin of safety. Bearing in mind the inadequacies in the data basis on the toxicity of individual pesticides and uncertainties in the assessment of variables, the CSTEE a revised setting of limit values was not in order. In addition referring to the parameters and data used in the WHO-guideline values for the control of drinking water the Committee was of the opinion that they might not provide a sufficient margin of safety for the EU and that information on the toxicity of mixtures was almost entirely missing. The Commission felt obliged to take a careful and precautionary approach by not proposing any amendment to parametric value for individual pesticides at that stage. For a number of pesticides (aldrin, dieldrin, heptachlor and heptachlor epoxide) the parametric value was set at 0.030 µg/l. This value is based on the examination of the then available technical and scientific information and was fully justified from a human health perspective.

Currently, the strict precautionary thresholds are sometimes referred to as anomalous, given that pesticides form a very broad group of substances with a wide range of properties.[51] Although (drinking) water legislation such as the DWD and the WFD are unlikely to directly affect the authorisation of new pesticides on the market, they are related to the extent to which they are used. Indirectly, drinking water legislation might even change types of pesticides and their development. These developments are being recognised by the Dutch Bureau of Statistics, Wageningen UR and

[50] Ecorys (2015) Public consultation on the quality of drinking water

[51] Shearer, M. and J. Tait (2009) Impact of the EC Water Framework Directive on the Pesticide and Pharmaceutical Industries. Innogen Working Paper No 75.

the Netherlands Environmental Assessment Agency, which state that a reduction of pesticides in ground and surface water is being noticed and can be linked to the use of fewer and other pesticides in agriculture.[52] Additionally, water companies have installed extra treatment steps to avoid water intake stops due to high pesticide levels in surface water. Although both processes are associated with the need for wholesome and clean drinking water, it is hard to attribute this solely to the DWD. Other water related directives, such as the Nitrate Directive and the Water Framework Directive can also be held responsible.

Wider economic benefits

With clean water supplies, new industries are possible, especially those relating to food and drink processing. Such industries use extensive quantities of water. Product standards are exceptionally rigorous, and even small levels of contaminants from water abstraction sources can result in products that fail to meet consumer protection legislation or require the need for expensive water treatment systems. Improved drinking water supplies will significantly reduce these costs and enable the food and drink processing industries to become more competitive.

Main findings on EQ4

The focus on transparency and information to the public achieved that consumers are more aware of the quality of the water supplied in their area. The agriculture related parameters in the DWD have together with other legislation and good agricultural practice reduced the amount of nitrate and of pesticides in the environment. Also the strict values for *Trihalomethanes* have resulted in a more careful use of disinfectants and thereby reduced the usage, production and consumption of these oxidants in the water industry.

The first unintended effect of the DWD can be linked to the creation of consumer awareness and the MSs efforts to promote the consumption of wholesome and clean drinking water supplied within their territory. Even though we have no proof available to support we assume this will contribute to the preference of consumers for tap water.. A second unintended effect that can be linked to the DWD is that it created the basis for a number of Directives which have been designed and implemented since 1998 (such as the Water Framework Directive and the Groundwater Directive) and there is a clear link with the levels of regulation of substances between the DWD and those of other Directives. In the same context, the use of fewer and other pesticides is also referred to as an effect of the DWD. Although (drinking) water legislation is unlikely to directly affect the authorisation of new pesticides on the market, it may have had an effect on the extent to which they are used. Indirectly, drinking water legislation might even change types of pesticides and their development. Additionally, water companies have installed extra treatment steps to reduce the periods that surface water intake has to be interrupted due to high pesticide levels in water. There has been a decrease of metals in wastewater that originates from plumbing installations and an increased awareness about materials in contact with drinking water. Finally, with the availability of drinking water that is both wholesome and clean, industries which use extensive quantities of clean water (such as food and drink industry, will benefit and it will very likely reduce the need to install their own extensive treatment facilities. Some types of industry will be able to restrict themselves to relatively simple additional treatment for their products e.g. hardness of the water.

Even though not all consumers will be aware of the potential impact of materials and substances in contact with drinking water, and their potential impact on human health, there is interest for this issue amongst water suppliers and national regulators. The efforts made by some MS to harmonise

[52] CBS, PBL Wageningen UR (2007) Emissie van bestrijdingsmiddelen in Nederland, 1984-2000. Retrieved from: http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl020003-Emissie-van-bestrijdingsmiddelen-in-Nederland.html?i=

a quality control/certification process has the aim to eventually ban the use of inferior materials from the drinking water supply. Inferior in the sense that they might impact on the quality of drinking water The interest created by Article 10 of the DWD has accelerated this process, perhaps most significantly in MS that do not yet have a testing and approval system in place. Therefor it is likely that in the future this will have a positive effect on the quality of water.

3 Efficiency

Efficiency considers the relationship between the resources used by an intervention and the changes generated by the intervention (which may be positive or negative). As such, any efficiency assessment also necessarily involves a comparison exercise. Efficiency is a relative concept, a method, to compare the current approach to another way of doing things. Moreover, it can assess if it can be argued that some resources could be saved if the process were carried out in a different way. In order to assess if the DWD is efficient, the evaluation looks at the various cost categories related to the provisions of the Directive such as administration, monitoring, providing information to consumers, and reporting and relates these to the (changes in) volume of water supplied or number of people served. The evaluation also looks at the benefits related to providing wholesome and clean water. These benefits are largely indirect (such as avoiding cost of sickness and absence of work) and difficult to quantify. In this section we will look at the costs and benefits associated with the implementation of the DWD, and to the technical or other developments since the elaboration of the Directive that could contribute to achieving the objective more efficiently. Furthermore we assess whether the Directive allows for efficient policy monitoring.

3.1 To what extend are the costs involved with implementing the DWD justified given the benefits which have been achieved? (EQ5)

The Drinking Water Directive has as objective to improve health in Europe through the supply of safe and uniform drinking water across all EU MS. Various articles in the DWD have led to specific actions to reach this objective. These actions have resulted in various benefits, most of them relating to a reduction in diseases due to an improvement of the quality of drinking water, and others, for instance, to a reduction in ecosystem pollution by parameters taken up in an Annex of the DWD. These actions led to costs for regulators, utility providers, the European Commission and in the end for consumers.

In this section we will first identify, and shortly describe the main identified benefits and costs associated with the implementation of the DWD, and explain our method of attributability of cost(/benefits) to the DWD. Following this, in the next section we focus on describing and estimating the cost/benefits by providing a quantitative calculation where possible and if not by explaining the impact qualitative.[53]

During the course of the evaluation we have identified the main provisions of the DWD that lead to benefits and costs for stakeholders. We have taken the main impacts to MS regulators, water utilities, industry and the EC into account. Based on these information sources we find that the main benefits are related to:

- Positive impact on health through a reduction in microbiological outbreaks and/or chemical incidents;
- Increased consumer information and aesthetic effects;
- Replacement of lead pipes in the distribution network
- Structured approach to derogations;
- Development of a regulatory framework at EU level, leading to a baseline for MS legislation;

[53] When drafting EQ6 we took note of recommendations made by the EPA, 2002, study: Assessing the Benefits of Drinking Water Regulations: A Primer for Stakeholders.

- Improved water quality for 'other' water users (ecological benefits for fish and/or recreational users, protection of biodiversity or enhanced nonuse value (the pleasure and trust of knowing that clean water exists/is available).

In addition, we identified the following main cost drivers:

- Administrative costs, such as:
  - the reporting for water utilities to the EC;
  - costs of assessment of derogations by the EC;
  - providing information to consumers;
- Monitoring of parameters by water utilities;
- Replacement of lead pipes in the distribution network and (optional) replacement of lead piping inside housing;
- Costs related to abstraction right, pumping, storing and treatment; and
- Financial issues, in addition to lead replacement, such as other investments, capital consumption and amortisation.

Regarding the health benefits we calculated quantitatively, where possible, the extend of identified benefits. However many benefits of the DWD can not be determined based on the available data/information[54] and as a result these benefits are described qualitatively. We found a range of benefits that are associated to some extent with provisions of the DWD, such as a reduction of contamination on users of public water services. Effects related to removal of lead pipes can to an extent be quantified, where other such as organoleptic effects (improved taste, odor and/or smell) are discussed more qualitatively.

Regarding the cost related to actions of the DWD there are two approaches. A top-down approach, where one looks at total costs for consumers and work out the share that can be attributed to the DWD and a bottom-up approach, where one looks at specific costs components, such as (lead) pipe replacement. This second approach is more accurate, as it is able to take more MS level differences better into account, and is more practical/feasible for stakeholders to provide feedback on, but can not be conducted for all identified cost components (for instance: to what extent is the replacement of a water purifier for an improved version attributable to the DWD and/or what share of imputed costs is DWD related?).

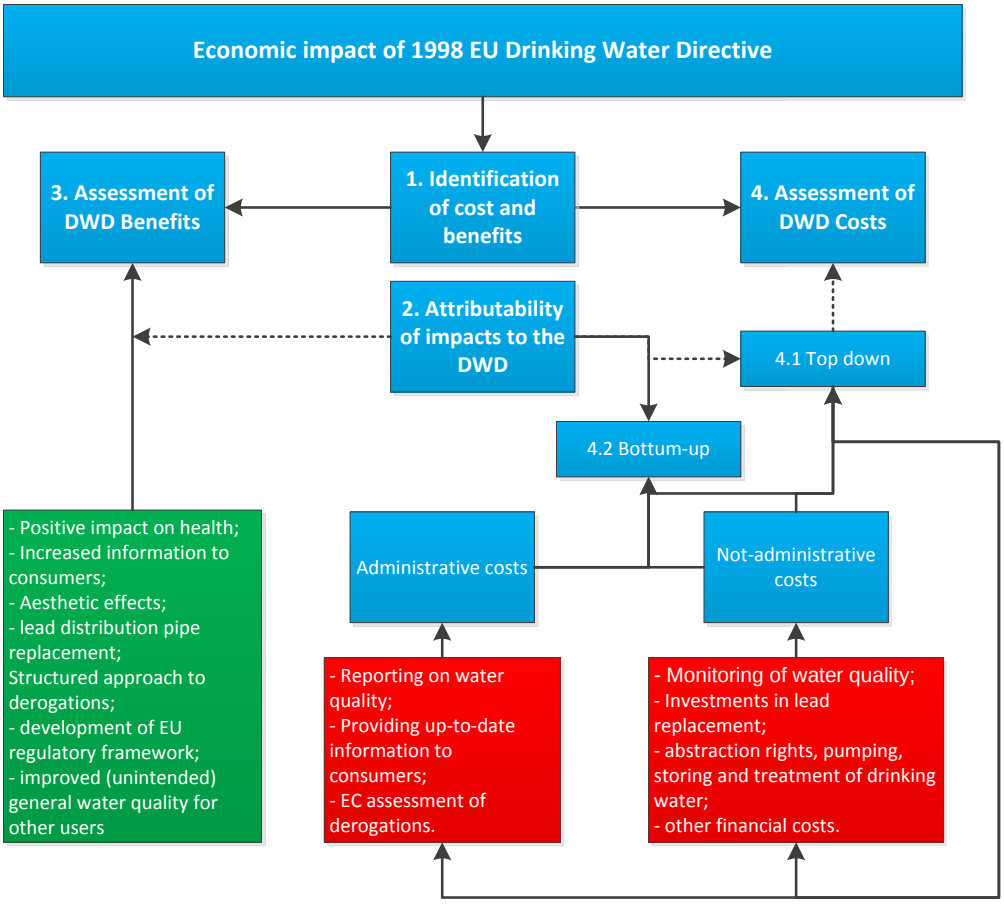
To provide a full as picture as possible we used both approaches. The top down approach provides a more general picture, has some generalizations and as such the outcome should be seen as a rough indication of total costs and DWD attributable costs. To also provide more accurate and in-depth information on some specific and important DWD provisions we calculated bottom-up the cost for reporting, monitoring, (lead) distribution pipe replacement, EC assessment of derogations and costs for providing information to consumers. These approaches can not be linked together, mainly due to possibilities in double counting and differences in statistical approaches, but provide a thorough overview of how the DWD has impacted drinking water supply in Europe from 1998 until 2014.

Figure 3-1 below provides an overview of (some of the) identified costs and benefits and the overall approach to EQ6. Note that there is a loop from 2.1 'top down' to the 'not (administrative) costs' and back to the 'top down and bottom up' assessment. This is done since all costs are assessed in the

[54] An estimation of, for instance, the reduction in number of diseases over 17 years is difficult. When taking into account that without a DWD, MS would have taken also 'some/equal/more' action it becomes near-impossible to calculate per MS these benefits and be therefore highly speculative.

top down approach and some costs are discussed in more detail (depending on available information and importance according to stakeholders) bottom up.

Figure 15 Overview of identified economic impacts of the 1998 EU DWD



3.1.1 Description and estimation of benefits attributable to the DWD

This section outlines our approach with respect to the analysis of the benefits that can be identified due to implementation of the DWD. At its core, the approach combines quantitative methods when data is available and applies qualitative methods in the case that data is missing or impacts are very indirect and as such hard to quantify. In addition to the above quantitative and qualitative approach to assess the DWD benefits we included in-depth analysis on specific important topics in the form of case studies. Case studies are an excellent tool for 'filling the gaps' that are left behind by comprehensive quantitative assessments and general literature reviews. They additionally allow for a focusing on a specific selected issue that deserves closer attention.

Positive impact on health through a reduction in microbiological outbreaks and/or chemical incidents

Apart from the question: has the DWD improved drinking water quality (information in Annex B), there is also the question: has the DWD led to a reduction in health incidents, that are (partly) related to drinking water and if we can identify such cases what would the value be of a reduction in incidents. We will assess the impact (benefit) of the DWD on health by identifying trends in microbiological outbreaks and chemical incidences and try to monetize the outcome of such an analysis.

The input consists of incidents and outbreaks reported in literature and obtained through contacts with drinking water regulators. The information on outbreaks and incidents collected will be judged as being related to drinking water or not as for many microbiological outbreaks there is not always a single cause or the cause is unknown (and could be either drinking water and/or food). As a third step the impact of the DWD on the occurrence and frequency of events and outbreaks will be assessed, where (in general) a distinction is made between microbiological outbreaks[55] and chemical incidents[56].

In the search for chemical incidents (through MS regulators, researchers and WHO), we were told by various experts that unless there is a 'major' event that is reported in the public press most incidents go unnoticed. Water companies are rather hesitant to report on such incidents[57] and also if it is for a short period of time and they can restore the normal situation quickly, such events do not have to be reported to the authorities. No national or European records are kept on chemical incidents. One EU regulator when asked for frequency and details of chemical incidents said that he could not remember any in the last ten years. When asked if that was the result of having the DWD in place he mentioned that that conclusion could not be made, but this was because of better environmental legislation and better practice.

There are some examples of incidents that can be mentioned and the remedial action that was taken to prevent (further) pollution of drinking water. When surface water used for the production of drinking water is polluted as is the case in the River Meuse example below, remedial action is taken by temporarily closing the water intake.

Case study: Remedial Action, closing the water intake of Meuse River

In August 2015 the River Meuse water used for the production of drinking water in the Netherlands did not meet the quality criteria and the intake by the water companies WML, Evides and Dunea was stopped. This remedial action was taken because the source of the pollution the wastewater treatment plant at a chemical factory did not operate properly and pyrazoles were discharged on the surface water and ended up in the Meuse. Temporary closure of the intake of river water is a common remedial action taken by surface water companies to protect the quality of drinking water. Since 2010 there have been five intake stops of River Rhine water due to the too high presence of pesticides.[58] When a borehole is polluted they are often abandoned and alternative sources are exploited. In some cases groundwater does not comply with values for the chemical parameters in the DWD and alternative solutions are not readily available. Such examples are generally addressed through derogations and mostly concern, arsenic in some areas of the EU, fluoride or chromium VI. These are not incidents but structural problems. Here the DWD has an impact as MS have to take remedial actions to comply with the requirements of the DWD.

However with respect to the chemicals incidents, it is, in general, not likely that the DWD has an impact on their occurrence. These incidences are mostly not related to the implementation of the DWD. Something goes wrong and this does not depend on having standards in place. Combined with the fact that no records are kept on occurrence of chemical incidents we have restricted the assessment to microbiological outbreaks.

---

55 Microbiological outbreaks through drinking water include events in which two or more people must be linked epidemiologically by time, location of exposure to water and illness characteristics and the epidemiological evidence must implicate drinking water as the probable source of illness.

56 Chemical incidents include events in which there is unintended (or sometimes deliberate) release to the (aquatic) environment of chemicals with potential to cause harm to human health through drinking water. In the case of a microbiological outbreak the effects on human health are most acute and obvious. Chemical incidents will only become clear when there are acute physical effects or when consumers reject the tap water because of organoleptic aspects (taste, appearance, odour). Chronic effects of chemical incidents are much more difficult to notice.

57 Due to the precautionary principle parameters necessarily have a grey area before risk occur: one thing is a temporary and localised phenomenon, another finding is a persistent pollution phenomenon affecting a large area. Furthermore, water operations also need to avoid unfounded alarmism.

58 Communication with Harry Römgens (Director RIWA Maas, TAPES conference September 2015).

The microbiological parameter trends have been assessed for the following parameters:

- *E. coli* and *Enterococci*;
- *Cryptosporidium*;
- *Campylobacteriosis*;
- *Giardiasis*;
- *Shigellosis*; and
- *Legionella*.

In Annex C a detailed overview of instances per MS and background information for each parameter is included.

Through the use of epidemiological data on the potential microbiological parameters that are discussed we were able to assess, to some extent, the reason of outbreaks and in what way the DWD led to a reduction in (these) outbreaks:

- In most cases outbreaks can be caused by various sources besides drinking water and it is often not clear what source led to a specific pollution;
- The epidemiological data trends indicates an increased number of outbreaks for pathogenic E. coli STEC/VTEC between 2008 and 2012;
- We did not find significant changes in the outbreaks related to Shigella and Giardia;
- Cases related to *Campylobacter* increased in the period 2007-2011 but showed a slight decrease in 2012;
- *Cryptosporidium* related cases showed an increase in 2012;
- The only micro-organism that is most certainly related to (drinking) water and showed significant increase from the start of monitoring in 1987 till 2012 is Legionella. The significant increase in the number of cases can be attributed to increased travel in Europe, through improved analysis possibilities and also somewhat to better reporting by MS; and
- Results for MS may differ, since some MS have seen a huge decrease in E.coli from 2007 onwards (Ireland), where other MS show an increase obscuring the national improvement in the reduction of outbreaks.

In general we find that the epidemiological data is presumably only the tip of the iceberg as water related disease surveillance systems are not necessarily capable to detect waterborne outbreaks due to methodological problems. Comparisons over time are as such currently not very meaningful in terms of assessing an impact of the DWD unless there is convincing evidence that the disease was water borne and reduced due to remedial actions taken because of the DWD. Due to this uncertainty in the data and level of attributability to the DWD no meaningful benefit assessment can be conducted.

Increased consumer information and organoleptic effects

All MS provide information to consumers, see table 2.4, and we found that in general national authorities usually provide some general information on the quality of the drinking water and, in most of the cases, they make their national Drinking Water Directive reports also available to the public.

In spite of the efforts of authorities to provide information on drinking water, the stakeholder survey conducted for this evaluation indicated that consumers are generally dissatisfied with the information they receive on drinking water. Overall, only 16% of the respondents judged the information satisfactory and 58% was of the opinion that the information was unsatisfactory (the remaining 26% did not have an opinion on the subject). Providing (detailed) information, in a similar manner across the EU, is needed to ensure higher transparency and it is important for maintaining and improving public confidence in the quality of drinking water.

Despite the (sometimes) criticized information available regarding water quality provided to consumers, consumers see the provided information as beneficial.[59] In the last 17 years much has been done to increase awareness and knowledge on water quality and water treatment methods under the general public, this effort has seen an incredible boost since the growth of ICT (e.g. smartphones/4G internet). Creating awareness on water quality is an intangible benefit of the DWD and can as such not be monetized. Regarding attributability we attribute the impact of information to consumers similar shares per MS as has been taken up for cost of reporting, see Annex G.

Furthermore we have analysed if there is an increase in aesthetic value (smell, taste and/or smell of drinking water) through the DWD. We interviewed stakeholders on this and set their response against the general outcome of the Public Consultation. We found that, as the DWD is concerned with the aesthetic quality of drinking water, the aesthetic value often, is not taken up in national regulation and as such is not an important issue for drinking water providers. We therefore conclude that the DWD does not lead to (unintended) organoleptic benefits.

Replacement of lead pipes in the distribution network

Lead is historically used in water pipes until it became apparent, around 1970, that there are significant health risk associated with a built up of lead in the human body.[60] In particular at risk are children and infants, as lead can have a negative impact on their mental development.[61] Currently it is worldwide acknowledged that human exposure to lead should be minimised and therefore the levels in water, soil, air and food should be controlled. The '98 DWD has set strict maximum lead occurrence levels to control for lead in the drinking water system. As a consequence MS have (in the case that they had lead distribution pipes and/or did not start replacing distribution pipes to comply with new WHO standards already) replaced many to all public distribution pipes over the years.

When determining the direct benefits that the DWD lead standard had on improving health across Europe it is important to understand from what situation we came and how this situation changed.[62] In the middle of the 20th century (1969-1971) there were 70 reported cases of lead poisoning in the UK, 433 in West Germany, 61 in Sweden and 58 in Finland.[63] Much action to reduce lead poisoning has been taken since and currently the number of (clinical) lead poisoning cases in the developed world are rather uncommon and if they occur they are rather mild compared to the 1970's era.[64] From this we find that the '98 DWD, perhaps contributed, but can not have been the main cause of the reduction in lead poisoning. As such the benefits, and reason for high lead replacement investments, are possibly more indirect. In the case study below we investigate the benefits of a reduction of levels of exposure to lead of minors and set the benefits (although they can not contributed completely to lead pipe replacement) off against the estimated costs in the EU28.

---

59 According to most stakeholders.

60 A too high intake of lead into the human body can lead to lead poisoning (also known as plumbism, colica pictorum or saturnism) and have serious negative impacts on the heart, bones, intestines kidneys and reproductive systems. The treatment methods are the removal of possible lead intake points and chelation therapy. Acceptable levels in the drinking water are set at 10 µg/dl. Acceptable does not mean not harmful, since there has not a safe threshold of lead intake – meaning that any intake is harmful for the human body.

61 DWI, 2010. Lead in drinking water.

62 Lead poisoning could occur through various sources (historically most cases were occupational hazards from factories for instance) and we do not have sufficient information to split between paint or water distribution induced lead poisoning.

63 Hernberg S., 2000. Lead poisoning in a historical perspective. American journal of industrial medicine.

64 Note: during this period the "safe" lead standard was 80/100 µg/dl, which is a huge difference compared to current 10 µg/dl standards, which are not "safe" but acceptable.

Case study: EU health benefits associated with reduced lead exposure to minors (<6)

A reduction in levels of lead exposure to minors are two-fold. We expect a direct effect due to a reduction in cases of lead poisoning and therefore a reduction in the treatment costs thereof and an indirect effect related to avoided social cost, which is related to having in general a 'smarter' population.[65] In this case study we build forward on work by Pichery et al., 2011, who investigated the welfare effect of lead exposure to minors. His work provides some main inputs on benefits associated with lead reduction from which we will derive the EU benefits of lead exposure reduction. The total benefits are split up in reduced treatment cost and societal benefits due to a general higher IQ of the population. For indirect societal costs the lost life-time earnings, cost of special education, crime and special case intangible cost are taken into account. The table below details the main findings and inputs for our simple EU28 expansion.

Table 3-1 Impact of lead exposure to minors (<6 years)[66]

Level of exposure	Percentage of children impacted	Unit cost of treatment	Total treatment benefits (in mln euro)	Total societal benefits (in billion euro)	Total lifetime benefits (in billion euros)
0 to 14 B-Pb	50%	€ 0	€ 0	€ 0	€ 0
15 to 23 B-Pb	35.1%	€ 120	€ 198	€11.8	€ 22.72
24 to 99 B-Pb	14.8%	€ 120	€ 83	€10.2	€ 10.72
100+ B-Pb	0.1%	€ 2.932	€ 16	€0.44	€0.44

Source: Based on Pichery et al. (2011)

We use the information in the above table to provide an estimation of benefits (reduction in costs) if the level of exposure for minors in the EU28 would fall in the range of 0 to 14 B-Pb. In this estimation we made the following assumptions to generalize across the 28 EU countries:

- The share of minors (<6 years old) is equal across all EU countries;
- The share of children in each exposure group is equal across all EU countries;
- Treatment costs are equal across all EU countries and treatment groups;
- Societal benefits are equal across all EU countries for each treatment group; and
- We corrected the benefits if a country indicated to not have lead pipes.[67]

The above approach results in a total lifetime benefits of approximately 413 billion euro. Avoided treatment costs, in the case that all EU minors have low exposure, is estimated to be 2.3 billion euro, whereas the societal benefits are estimated to be in the range of 411 billion euro.

To achieve these benefits investments have to be made. The abatement costs are mainly related to lead-based paint removal, reduction in industrial pollution and lead water distribution pipe replacements (estimated to total 4 public -and 10 billion euro in private investments (IETRE). Making a direct link between the impact that each abatement action has on found benefits is unfortunately not possible and as such a complete CBA, where one focusses on the drinking water and DWD aspects, can not be conducted. However, when comparing the estimated above benefits with the estimated costs of lead distribution pipe replacement (€81 billion euro in total (EU28 between 1998-2014) of this between 1 -and 5 billion euro can be contributed roughly to the

65 Not all lead intake will lead to a case of lead poisoning, but lower intake of lead still has a negative impact on IQ.

66 Pichery et al., 2011. Childhood lead exposure in France: benefit estimation and partial cost-benefit analysis of lead hazard control. Journal of environmental health.

67 Reduction of two thirds as lead makes up 1 of the three abatement benefits (probably the largest). Impact of this correction on benefits at EU level is of low significance.

DWD[68]). One can easily derive from this that replacing lead pipes has had a significant positive welfare and health impact and most probably outweighs the investment costs.[69]

Structured approach to derogations

There are various, hard to quantify, benefits associated with the possibility for having a derogation for MS. These benefits are due to a possibility that a MS can wait with making replacement investments, which reduces or nullifies the share of previous investments that need to be written-off. In addition, MS would have to go to a great length to remove the last percentage of a parameter, for instance Boron, to comply to the DWD standards. A derogation allows them to wait for future techniques, which might achieve the DWD parameter (e.g. Boron) goal at lower costs.

Development of a regulatory framework at EU level, leading to a baseline for MS legislation

The DWD has lead to a baseline for national regulators when drafting national drinking water (and other) legislation for at least water providers and (polluting) industries. Some MS have adopted the provisions of the DWD articles and the Annexes with parametric values directly, where others have for instance stricter than required parametric values. When looking at the benefits of the development of such a regulatory framework one ideally sets the current situation against a situation in which the DWD did not occur. In this hypothetical situation there would not have been a '98 DWD and national regulators would need to develop, or not, their drinking water regulation autonomously using the '80 DWD as a starting point. Developing such a framework is costly, needs to be developed roughly anew 28 times over and is to some extent inconsistent with neighbouring countries, leading to different water standards and possibly 'distrust' of water quality abroad by consumers.

Information on cost related to developing a regulatory framework with the detail and work done as needed for 'a representative drinking water directive at MS level, or costs related to developing the '98 DWD for comparison, is not available and depends on too many external factors to determine. Based on interviews with national regulators it is however easy to find that having a regulatory framework in place at EU level is much-more cost efficient and as such leads to benefits. Furthermore the DWD, being discussed at EU level, became a platform where knowledge between similar/different stakeholders and countries is shared and the baseline for providing drinking water is equal (enforcement might however not be) across all MS, leading to increased trust in drinking water quality by consumers.

Improved water quality for 'other' water users (agriculture, biodiversity, ecosystem services, or nonuse value, food production)

A general observation, when determining benefits, is that the DWD contributed to many areas indirectly. For instance through the indirect assistance of the improved water quality for 'other' water users, such as agriculture, biodiversity, ecosystem services, the tourism industry, food production (cleaning process) and/or recreational users. These benefits are hard to quantify since these systems are impacted by various sources (e.g. water, air, soil) and all of these sources are regulated in Europe through (often) more than one EU and/or national regulation.

3.1.2 Attributability of costs to the DWD

The costs –and benefits of the DWD have a link to the DWD, but in most cases a 100% causal relationship can not be observed. In short this is because the identified actions/ improvements of

[68] See section on cost of lead replacement.

[69] Note: In most EU countries effort is done to replace public pipes. The public pipes are between 5 and 25 percent of total lead pipes, meaning that between 75 and 95 percent is roughly in private use and estimates on actual replacement (DWD does not set this obligatory) are lacking for most MS. Total benefits and costs are for this reason strongly dependent on EU/MS actions to also replace private drinking water distribution pipes (for instance by providing subsidies).

the drinking water system would also occur/ have occurred to a lesser extend through national legislation and/or other EU Directives. Our approach to create a causal link between observed changes in total cost –and benefit and provisions in the DWD is based on attributability. This means that from the total cost and/ or benefit a specific share can (causily) be linked to provisions in the Directive.

The determination of attributability per provision is difficult, since it is dependent on many interlinkages (for some countries there is even a chicken-egg story, because they had already certain parametric values in legislation prior to the '98 or '80 DWD). Attributability thus is difficult to determine, but nevertheless crucial when determining the impact of the DWD (or the impact of any legislation for that matter). To obtain reliable estimates the study team developed, based on available literature and interviews, estimated shares of attributability for reporting-, monitoring –and (lead) pipe replacement costs. Due to the importance of these values and the possible differences between MS stakeholders were contacted to respond on these estimation. The stakeholders provided feedback on MS for which they indicated themselves knowledgeable (often their home country) based on the below definition of attributability and in some cases additional discussions with the evaluators.

Attributability over 17 years DWD

An activity is 100% attributable if this activity would not have taken place without the implementation of the DWD. An activity is 0% attributable if this activity is already implemented by the MS (please take the 'awaremess raised by the DWD' into account). An intermediate impact of the DWD (so a share between 0% and 100%) on an activity could be because (i) the MS implemented already some sort of similar (perhaps less strict) activity and/or (ii) the MS would, in your opinion, implement at a point in time (later then 1998) autonomously a similar activity. The table below assumes that neither 100% or 0% are likely outcomes (chicken – egg problem) and that MS who joined the EU (and adopted the DWD in legislation) at a later stage than 1998 are, in general, more impacted by the DWD compared to the 15 early EU members.

In the case that stakeholders informed us that we over-/underestimated certain shares (and solid information was given as of why we over-/underestimated) we have adjusted the estimations of the attributability of the DWD regarding reporting, monitoring and (lead) pipe replacement. For 20 out of the 28 MS we received one or more responses.[70] Below the outcome of this survey is provided, where the various colors indicate through what method the share has come to be.

[70] Attributability is often based on one response from a MS expert. The outcomes of Annex G should as such be seen as best guess and not as qualitative outcomes. This does not undermine the provided information, as it is not possible to make a qualitative assessment due to lack of data, because contacted experts are very well informed on the national impact of EU, DWD, legislation.

Table 3-2 Attributability of costs to the DWD and overview of average water consumption per MS[71]

Country	Average liter per capita per day water consumption[72]	Share of reporting costs	Share of monitoring costs	Share of lead replacement
Austria	137	25%	25%	10%
Belgium	101	25%	25%	90%
Bulgaria	193	50%	50%	65%
Croatia	184	50%	75%	75%
Cyprus	105	50%	50%	0%
Czech Republic	91	50%	75%	75%
Denmark	99	25%	25%	0%
Estonia	71	75%	75%	0%
Finland	118	50%	50%	0%
France	129	35%	35%	70%
Germany	122	25%	25%	10%
Greece	179	25%	50%	3%
Hungary	92	50%	10%	50%
Ireland	150[73]	0%	50%	95%
Italy	245	15%	15%	20%
Latvia	78	75%	75%	75%
Lithuania	62	75%	75%	75%
Luxembourg	116	25%	25%	90%
Malta	50	75%	75%	0%
Netherlands	128	10%	10%	10%
Poland	98	35%	35%	35%
Portugal	133	33%	75%	15%
Romania	75	75%	75%	75%
Slovakia	84	50%	25%	10%
Slovenia	123	50%	25%	10%
Spain	130	70%	50%	10%
Sweden	160	45%	50%	0%
United Kingdom	150	25%	25%	5%

In the next paragraph it is described which DWD provisions have lead to what costs. First by calculating (roughly) the total costs/income that drinking water companies have and the share that can be attributed to the DWD for 2014 and costs over the course of the 98'DWD lifespan. Second an alternative and additional bottom-up approach is used to determine for selected (based on data availability and importance according to stakeholders and literature) provisions the total –and attributable costs in more detail.

[71] Green: Stakeholders confirm estimates
Red: Stakeholders provide a 'better' estimate
Purple: Stakeholders do not agree with estimate but find it difficult to provide an 'exact' estimation; and Ecorys made a new estimation based on the comments from stakeholders

[72] Average water per capita per day consumption figures are calculated in the following manner: We transposed the average cubic meter abstraction/capita/year into liter/cap/day and corrected these values, using water consumption data for 7 MS (based on BDEW (2015) Civitas and feedback from MS), to obtain the above liter per capita/day/MS water consumption figures. We assume that water consumption per MS stayed equal over the years.

[73] http://www.irishexaminer.com/ireland/150-litres-of-water-consumed-daily-by-every-person-245927.html

Top-down cost estimation

The DWD has led to a more harmonized quality in drinking water supply systems, they are nonetheless different across Europe. There are differences in the country size, and therefore in the length of the piping systems, strictness in legislation, availability of grants and taxes and also in the level of quality and services provided by water supplier. To estimate the total impact of the DWD on this, one first needs to assess the total cost of this sector. Instead of determining costs we used the proxy of total income to define total costs, noting that possible profits are not corrected for (most MS have public water suppliers). To remove discussion on income/costs we use in this section 'effect(s)' to describe outcomes. In the below section we show our methodology to derive the EU28 income for providing drinking water in 2014 and the share that can be attributed to the DWD. In addition we show what the total effect was from 1998 until 2014.

To determine the total effect for providing drinking water we looked at the expenditure ((cost recovery pricing))[74] of water supplied for 6 MS[75] and used the information on total population and differences in income per MS to extrapolate this to the EU. As such the total effect for water providers in 2014 is estimated to be roughly 46.5 billion euro. In total the effect for EU MS water providers between 1998-2014 sums up to 630 billion euro. Note that these numbers also include the 'normal' pipeline network (such as maintenance costs). Total yearly expenditure for Germany in the pipeline network, on average, is for instance around 1.5 billion euro.[76]

The total income of drinking water suppliers can be broken down into cost components, as means to provide more insight in the operation of the sector and to where/what the DWD contributed. The following cost components are used to break the total sector up in smaller pieces:

- Taxes, levies, fees, concession fees, Water abstraction charges (7%)
- Metrology / quality control (3%)
- Building management (5%)
- IT technical support processes (15%)
- Resource Management / Water procurement / Extraction / Processing (18%)
- Treatment of drinking water (18%)
- Imputed Costs, such as the pipeline system and overall amortization (33%)
- Other costs, such as travelling to international events (1%)

For the above breakdown of total costs in the EU we used the shares for main components found in practice by Aquabench for Germany (SWB Regional GmbH, 2015[77]).

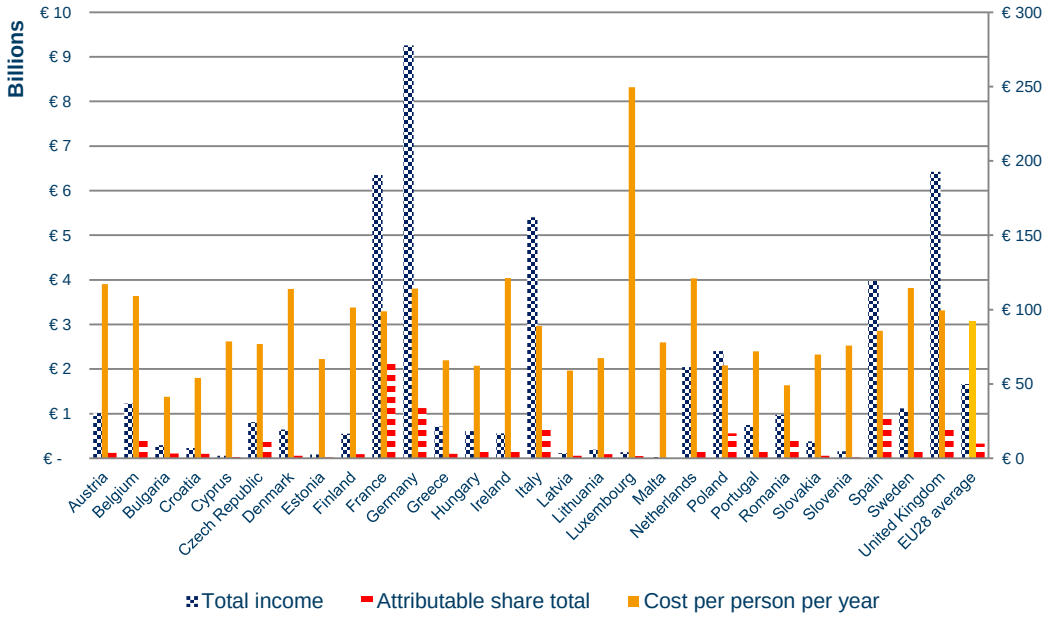
When looking at what share of this effect can be contributed to the DWD we note that calculations enter a grey area. Attributability is based on opinions of stakeholders to some extent and stakeholders have provided feedback on three 'practical' components for which one can provide relatively correct estimates of attributability.[78] For the components resource management, treatment of drinking water and other costs the provided estimates on attributability are averaged to obtain a country average attributability share.[79] For metrology the attributability estimations for monitoring per MS are used. We assumed a flat 5 percent attributability[80] for the components building management and IT technical support. The largest component, imputed costs (interest, amortisation, investments in the system and other), relates partially to the impact the DWD had on lead pipe replacement. We used information on German capital expenditure and the share of investments in the pipeline network to estimate the share of imputed costs related to lead

74 VEWA, 2015. Comparison of European Water and Wastewater Prices. Water price expenditure information for 2007-2012.
75 DE, UK (E/W), FR, NL, AT, PL.
76 WVGW, 2015. Profile of the German Water Sector 2015.
77 http://wasser.rlp.de/servlet/is/8646/ZV_Eifel_Ahr_WV.pdf?command=downloadContent&filename=ZV_Eifel_Ahr_WV.pdf
78 Note: providing close to correct estimates of attributability of total amortization was deemed not practical.
79 The shares are between 0 and 75 percent. Not weighing averages the average for EU28 is 42 percent.
80 This is mainly related to providing more and better information to consumer and other general not specified actions that lead to minor costs.

replacement (49,3% in 2012[81]).[82] The information from MS experts on lead pipe attributability was further used to calculate the attributable share (Annex G). The component taxes and abstraction charges is assumed not to be impacted by the DWD and attributability is set to 0 percent.

Combining all attributable income/costs we find that for 2014 the total attributable effect is 8.3 billion euro and over the DWD lifespan this amounts up to 109 billion euro. When weighted over all EU MS the DWD roughly attributed to just under 16.5 percent of total costs. The picture below shows per MS the total and attributable effect for 2014, where attributable share is slightly higher (17.8 percent). Furthermore, Table 2-6 provides a breakdown of income/costs for the EU28, the EU28 average attributability percentage and the total income/costs that can be contributed to the implementation of the DWD in 2014 and over the course of its existence.

Figure 16 Total income drinking water providers and DWD attributable share per MS, 2014



Source: Ecorys (2015). Note: these figures are based on extrapolations from 6 EU MS and as such might not be a 100% correct representation for each MS. In addition, the method of attributability is very quantitative and should as such be seen as the a best possible estimation. The found effects have been compared to national reports if available. Such reports are not available for all 28 MS.

Table 3-3 Breakdown of income/costs drinking water providers EU28, 2014. Values in billion euro.

Component	Total 2014	Attributable 2014	%	Total DWD	Attributable DWD	%
Taxes, water abstraction, etc (7%)	€ 3.3	€ 0	0%	€ 46.4	€ 0	0%
Metrology / quality control (3%)	€ 1.4	€ 0.5	34%	€ 19.9	€ 6.3	32%

[81] Combination of the difference between found 2012 imputed costs for Germany and 2012 reported CAPEX and the share of 2012 reported pipeline system CAPEX. The found percentage for Germany is used to correct and estimate all other MSs lead pipe replacement imputed cost. In the next step the attributability is taken into account, effectively setting countries without lead pipe replacement investments to zero for this specific component.

[82] WVGW, 2015. Profile of the German Water Sector 2015.

Component	Total 2014	Attributable 2014	%	Total DWD	Attributable DWD	%
Building management (5%)	€ 2.3	€ 0.1	5%	€ 33.2	€ 1.6	5%
IT technical support processes (15%)	€ 6.9	€ 0.3	5%	€ 99.5	€ 4.7	5%
Resource Management (18%)	€ 8.4	€ 2.5	30%	€ 119.4	€ 33.2	28%
Treatment of drinking water (18%)	€ 8.4	€ 2.5	30%	€ 119.4	€ 33.2	28%
Imputed Costs (33%)	€ 15.4	€ 2.1	14%	€ 218.9	€ 28.5	13%
Other costs (1%)	€ 0.5	€ 0.1	30%	€ 6.7	€ 1.8	28%
Total effect	**€ 46.5**	**€ 8.3**	**18%**	**€ 663.5**	**€ 109.3**	**16%**

Source: Ecorys (2015)

Bottom-up cost estimation

Administrative costs

i. Reporting on quality of water supply zones

The DWD prescribes that individual water suppliers who supply more than 1,000 m^3 per day on average or serves 5.000 or more persons should report on their quality to the EC[83]. This can increase in the future if small water suppliers, which are not obliged to report, will report on a voluntary basis. The costs related to the reporting of water quality to the EC relate mainly to the number of person working days.

To calculate the costs that can be related to the reporting on quality of large WSZs we combined information through desk research on the weighted average number of person working days per year and MS, the average of the costs per working day of both high –and normal skilled workers and used the EU HCIP inflation data to estimate costs for other than the base year. The table below gives an overview of used inputs in the base year (2010).

Table 3-4 Reporting on quality of WSZ cost estimation inputs

Theme	Value
Number of person working days large WSZ	230 person days
Costs of normal skilled workers	€230.- [84]
Costs of high skilled workers	€350.-

Source: COWI, 2011.

Based on these inputs the total costs for reporting for large WSZ in 2014 amounts to €2.5 million euro. Total costs for the entire duration of the '98 DWD sum up to slightly over €29 million euro[85]. Furthermore, 43%[86] of reporting costs on large WSZ is attributed to the implementation of the DWD. The share attributable per MS is not 100% since some MS have set stricter parametric values for drinking water and secondly we expect, based on interviews, that most MS would have set up a similar reporting mechanism. Total costs attributable to the DWD for 2014 are then 1.1 million euro and approximately 12.4 million euro over the course of the entire 98'DWD.

83 Article 13 of the DWD.

84 Average hourly labour costs in EU28 are €24.6 in 2014. We assume on average a 7.5 hour billable working day and 25% overhead costs (http://ec.europa.eu/eurostat/statistics-explained/index.php/Hourly_labour_costs).

85 In these calculations we have controlled for the increase/decrease in number of MS, since back in '98 the EU consisted of 15 MS and currently it encompasses 28 MS.

86 See Annex G.

ii. Impact of derogations

Article 9 of the Directive allows derogations from the drinking water quality standards under very strict conditions and for a limited time (3 years maximally per derogation). Furthermore a derogation should not pose a potential danger for human health and can only be established if the supply of drinking water in the area cannot be maintained otherwise by reasonable means. In the case that a MS believes that a longer derogation period is required, it can grant a second derogation for an additional three years and it should communicate the reasoning behind this decision to the Commission. A MS can request a third derogation from the Commission. The Commission will in this case carefully assess the request and will either grant or refuse the derogation for a final additional period of 3 years[87].

The Commission granted three-year derogations to the Czech Republic, France, Italy, Hungary and Germany, referring mainly to the parameters of nitrate and nitrite, fluoride, boron, arsenic and nickel. The request for a derogation by Estonia has been refused[88]. The costs associated with this is estimated to be 167 (5 third time derogations and 33 days per revision[89]) days for an average fee of €750.-. Therefore total costs to the EC for third time derogations in the period 1998-2014 sum up to roughly 100.000 euro.[90]

iii. Providing information to consumers

One of the goals of the drinking water directive is to improve the information on water quality to the general public. In Europe MS and/or individual water supplier have applied three main techniques to better inform consumers on their water quality, namely:

- by conducting a survey in their service area and improve their service if needed[91];
- by providing (more and more) live information on the website of the water supplier (the use of this techniques has increased over the years due to the fact that an increased share of consumers is actively “online”); and
- some countries inform their consumers by notifying them of the water quality by mail at the same time when they send the water bill.

In addition, some MS/water providers also have awareness raising campaigns, training at schools, and/or focussing specific groups for specific information.

The costs associated with this action vary strongly per water supplier and per MS. Based on an expert opinion developed through interviews with various stakeholders in various MS we assume that on average one person has a 1/3 fte job within a water supplier, which service an area that consumes 500.000 m^3 per day and through some outsourcing activities (such as contributing to a regional/national satisfaction survey) another 1/3 fte job. This is further combined with an assumed average European labour costs of €290[92].- (assuming 214 working days in a year[93]) times total DWD regulated drinking water supplied in Europe. Estimated total costs for providing information to consumers is then 2.1 million euro in 2014. Tracking the costs of providing information to consumers back to 1998 is difficult, since actions undertaken are not equally over the various years. We estimate that total expenditure on this action over the course of the entire ‘98DWD is within the range of 10 -to 15 million euro. Furthermore we attribute on average 60% of total costs of providing information to consumers to the DWD leading to 1.3 million euro costs in 2014 and between 6 -and 9 million euro for the entire DWD duration.

87 http://ec.europa.eu/environment/water/water-drink/pdf/report2014/1_EN_ACT_part1_v3.pdf.
88 https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp.
89 COWI, 2011. 33 days per derogation is based on section 4.2, p40, input from DG ENV.
90 This value excludes costs made by national regulators and water providers.
91 For instance: the Baro 2015 Anglais Consosatisfaction, related to drinking water satisfaction in France.
92 See table 2.8 (we assume an even split between high and normal skilled labour for this task).
93 In 2012 the EU average agreed yearly working hours was 1712 hours, or 214 days (assuming an 8 hour work day).

Cost of monitoring parameters

Monitoring of drinking water parameters is, according to the handbook on the Implementation of EC Environment Legislation, the main cost component associated with the implementation of the DWD. Article 13.2 of the DWD states the obligation of reporting on (large) WSZ.[94] This implicitly states that monitoring actions should be undertaken by water suppliers. Water suppliers need to monitor for parameters in accordance with Annex I A, B and C and subject to the notes in part C. Monitoring approaches differ between MS, even between water suppliers in the same MS, which results in different levels and availability of data and costs related to this obligation.[95]

According to a study by Mancini et al (2005)[96] cost for monitoring should be differentiated between small and small WSZ monitoring costs. They found that the costs for monitoring a WSZ smaller than 1,000 m^3 is roughly three times higher then monitoring a normal WSZ (corrected for frequency).[97] In addition to these values, we have estimated the total m^3 water consumption per MS per year, which is done by combining MS population data and average l/day water consumption.[98] In the next step the total drinking water consumption is split between large and small WSZ. Based on various reports the EU average share of small WSZ is 13%.[99] We combined the total cost per m^3 (corrected for possible price differences) with the total m^3 used on a daily basis for each MS for both large and small WSZ[100] to obtain a rough estimate of the total monitoring costs for both large and small WSZ. The outcomes have been extrapolated using inflation data.[101] The results per MS have been cross-checked with available national documentation on monitoring costs and adjusted if countries reported annual costs on reporting. For instance Ireland, who published in 2007 that their presumed annual monitoring costs amounted to €2.5 million in 2007. The estimation method as described above finds for Ireland monitoring costs of €2.8 million in 2007. The applied method, averaging over the EU, leads as such to a good approximation (within 15% range).

The total monitoring costs for large WSZ in 2014 is roughly €67 million and costs for small WSZ are in 2014 €22 million. The costs over the duration of 17 years mount up to €1.3 billion. It is however not realistic to attribute all these costs to the implementation of the DWD. For one, because MS already had a monitoring program in place (irrespective of the previous DWD) and/or second, because MS are expected (according to stakeholders) to also have set up monitoring regulation in a situation without the DWD. The total attributable costs in 2014 are therefore €22.5 million for large WSZ and €6.7 million for small WSZ. In the lifespan of the DWD the monitoring costs for all MS sum up to roughly €400 million euro.[102]

Replacement of (lead) pipes in households and the distribution network

In the past decades large investments have been made to improve the drinking water quality due to the replacement of lead and cement pipes. The replacement of lead pipes has been pushed forward or initiated by the DWD, since the standard for lead in the 1998 EU Drinking Water

---

94 Annex II, Table B1, has been adapted to include obligation of monitoring small WSZ as of 2011, for this reason we expand the cost estimation from only determining costs for monitoring of large WSZ.

95 Many water providers monitor more often then needed for the DWD to ensure a proper level of information to conduct good business. This information is not always provided to the EC, as it is not obligatory to provide all information.

96 Mancini G., Roccaro P., Vagliasindi F., 2005, Water intended for human consumption – Part II: Treatment alternatives, monitoring issues and resulting costs.

97 For calculations we used €0.85 for large WSZ and €2.5 for small WSZ per m^3 per year.

98 See Annex G for methodology on estimation average daily water consumption per MS and capita.

99 Synthesis Report on the Quality of Drinking Water in the EU examining the MS' reports for the period 2008-2010 under Directive 98/83/EC, for instance.

100 If the share of population connected to a drinking water supplier is higher than 87% than, on average, there is a part of the population that is supplied by a drinking water supplier. Based on DG ENV, 2009, we know that 84% of small WSZ operated by a water supplier is monitored.

101 We use the same historic inflation data to extrapolate to both the future and the past around the determined year to determine total (and 2014) costs for all estimations in this chapter.

102 See Annex G for the share of costs attributable to the DWD.

Directive, changed from 50µg/litre in the previous Directive to 25µg/litre in 1998, and was reduced further to 10µg/litre in December 2013.

To estimate the costs associated with the implementation of the 98'DWD on the lead replacement programs we took as a starting point the 95 cost estimation by the EC[103], which predicted costs of reaching the 10µg/litre value for lead in drinking water would costs 70 billion euro over the course of 20 years of implementation. In addition, we looked at the 1998 study by Hayward[104], who estimated that the costs of the lead pipe replacement in the EU would be $100 billion dollar, or 89.7 billion euro[105], over the next 15 years. It is important to take into account that back in 1995/98 the EU consisted of 15 MS and that total costs for (lead) pipe replacement will therefore be higher (in addition to inflation) than either of the estimates in the above studies.
To estimate the total costs of the lead replacement programs we made the following main, to both streamline expected investments per year[106] and to be able to compare outcomes with MS ex-ante studies:

- We assumed that the lead replacement program took 17 years to complete after 1998 ór in the year when a new MS joined the EU (hence only 1 year for Croatia);
- Not all costs of lead replacement can be seen as additional costs. The normal rate of replacement and reduction in costs after replacement due to leakage reduces the additional costs of replacement of lead pipes by 15% (10-20% according to the 95'EC memorandum proposal);
- The 70 to 90 billion euro of lead replacement costs are build up out of two components, namely the distribution pipes and household installations. The obligatory replacement of lead focusses on distribution pipes, whereas the household installations are optional and can not be related directly as an impact of the implementation of the DWD.[107] The share of costs related to the replacement of distribution pipes ranges between 5% and 25%, we will therefore provide the range as outcome of the calculation;[108]
- The costs of lead replacement are divided over the EU15 based on their share of total water consumption. Costs of new MS are added by taking their total water consumption and 75% of the average lead replacement price per m^3 for the EU15 MS;[109]
- In the calculated costs per MS we have not taken specific geographic characteristics or country reports into account. The outcome per MS can therefore deviate from country studies;
- The costs related to (lead) replacements of distribution pipes are not completely attributable to the implementation of the DWD. Based on expert judgment, available country reports and feedback from MS stakeholders we estimated the attributability per MS, see Annex G.

Based on the above assumptions and approach the total cost for (lead) pipe replacement in the EU28 in 2014 is estimated to be 5.1 billion euro, of which between €0.25 and €1.3 billion are

103 Memorandum Proposal, DWD, 1995. COM(94)-612final.

104 https://books.google.nl/books?id=FdHZMwgon3wC&pg=PA2&lpg=PA2&dq=estimated+cost+of+replacement+lead+drinking+water+pipes+EU&source=bl&ots=MfFV8mC24c&sig=co9bVBdXGRbN6utUGlsubHvr6FE&hl=nl&sa=X&ved=0CEAQ6AEwBGoVChMIvM3QiJqSyAIVhuwUCh17HgHG#v=onepage&q=estimated%20cost%20of%20replacement%20lead%20drinking%20water%20pipes%20EU&f=false.

105 http://fxtop.com/en/currency-converter-past.php?A=1&C1=USD&C2=EUR&DD=&MM=&YYYY=1998&B=1&P=&I=1&btnOK=Go%21.

106 According to stakeholder interviews with utilities they invest a more or less equal value in infrastructure every year (which has been higher for the entire duration of the lead replacement period).

107 The share of such an indirect impact would be very imprecise, especially since it is unsure what share of EU housing actually replaced lead pipes in the course of the last 17 years.

108 For France the it was determined that total public lead distribution pipe replacement costs amounted to 4 billion euro and private to an additional €10 billion (IETRE). Our approach, which generalizes more due to a EU28 coverage, provides for France a range for public investments between €0,5 and €2,8 billion euro. In total we estimate €11,1 billion for France, which is around 25% lower than reported by IETRE, which implies that for France more than 25 percent of the distribution network is public compared to the EU28 average.

109 The 75% is a rough estimation to correct for the fact that the 15 EU MS in 1998 are on average wealthier compared to on average the MS who joined the EU after 1998.

directly related to the replacement of distribution pipes.[110] The costs in the duration of the DWD amount to just over 81.5 billion euro, of this between 4.1 and 20.5 billion euro is publicly owned. The attributable costs are however lower. The costs attributable to the DWD of the replacement of lead distribution pipes ranges between 75% and 3%[111]. When adding up the various MS this mounts in total up to 1 billion euro at the low -and 5 billion euro in the high public share replacement scenario.[112]

Other costs associated with the implementation of the DWD

Other costs, hard to quantify in aggregate terms, can be found as a result of the non-harmonised situation of Articles across the different MS. The industry sector reports, for instance, a lot of costs concerning double and different certification schemes and requirements. (See cases A and B in efficiency). According to various stakeholders harmonization of certification schemes and requirements could lead to mayor cost savings.[113]

3.1.3 Benefits of the DWD outweigh the costs (JC 5.1)

The approach to Evaluation Question 5 consists out of two sections. The first section identifies, describes and calculates where possible the positive health and other impacts that can be attributed fully/partially to the implementation of the DWD. Due to the outlined difficulties related to a clear attributability, lack of data, and impossibility to assign clear economic values to the benefits, it is not possible to assert these at this stage in monetary terms In particular, the assessment of the benefits – in this framework – should not be done only against economic and monetary criteria, but also against the political, (public) safety and other hard to assess benefits.

The cost estimation was split up in a top down and (partly) bottom up cost assessment, where the first section focusses on providing a rough first figure on the impact that the DWD had in Europe since its implementation, whereas the second section sheds light on specific important (according to stakeholders) components on which the DWD had a strong direct impact. Based on the top down approach we found that the total value of the EU28 drinking water sector in 2014 amounts to 46.5 billion euro of which 18 percent can roughly be attributed to the implementation of the DWD, this however depends strongly on the method of attributing impacts to the DWD (based for a large extent on stakeholders intrinsic knowledge of the operation of a drinking water supply system). Over the course of the 17 years the costs associated with the DWD has been estimated at 109 billion euro.

3.2 Have there been technical or other developments since the elaboration of the Directive that could contribute to achieving the objective more efficiently (EQ6)?

3.2.1 New technologies for monitoring and analysis of drinking water and new approaches to risk assessment have contributed to a more efficient implementation of the DWD (JC 6.1)

The requirements in the Drinking Water Directive for monitoring (Annex II) and analysis (Annex III) require updating in order to reflect technical and scientific development. This section will provide a

[110] Note: this value is lower than found when looking at the top-down approach. The reason for this is that there is an error margin in both approaches, top-down related to the share of imputed costs related to lead replacement and bottom-up related to two relatively old studies who provide a base estimation for the total EU28 impact and the share of the high-/low public versus private ownership scenario. For this reason the found discrepancy can be expected and shows that there is, as expected, a relatively large error margin when estimating impact taking 28 countries into account.

[111] We exclude MS who reported 0 percent, as they did not have or replace any lead pipes and as such did not have any costs from this.

[112] We are aware that some MS have taken more action than the 25% but stick to the range provided in literature as they provide figure for the EU as a whole and when addressing additional actions of 1 country, one should adjust in a similar method all EU15 countries, and possibly extend to 28.

[113] This statement could hold if you look purely at cost savings, since costs related to lead replacement and monitoring have very significant direct health benefits!

brief overview of some of the identified technical or other developments and describe in what way they contributed to achieving the objectives of the DWD more efficiently.

During the course of the evaluation we have identified some of the main technical and/or other developments, which have had an impact on reaching the objectives of the DWD namely:

- Water safety plans;
- Progress in analysis;
- Progress in ICT;
  - Consumer (up-to-date) information;
  - Smart monitoring of water supply zones;
  - (Smart) Water metering.

Below we will shortly describe what these developments mean for the DWD. Next to that we will describe both the costs –and benefits associated with the development.

Water safety plans

The objectives of a water safety plan (WSP) are to ensure safe drinking-water through good water supply practice, that is:

- to prevent contamination of source waters;
- to treat the water to reduce or remove contamination that could be present to the extent necessary to meet the water quality targets; and
- to prevent re-contamination during storage, distribution and handling of drinking-water[114].

A water safety plan describes the entire water supply system through:

- a System Assessment: including the identification of hazards, determination of existing control measures, assessment and prioritisation of risk and identification of additional or improved control measures;
- by Controlling Hazards: through implementation and maintenance of control measures, establishment of operational monitoring and defining of corrective actions; and
- through Verification and Auditing.

Based on stakeholder interviews with water utility providers a WSP can be applied in addition to regular monitoring. A WSP is a relatively high start investment leading to lower costs in the long run. The stakeholders, generally, agree that a WSP definitely reduces the action time needed if a distortion in the water quality is found (due to a reduction in localizing the source of the disturbance and faster decision making). They however do not think that total costs of monitoring (when placing WSP under the cost category of monitoring) go down. This is for one because they still need to monitor on their entire WSZ and secondly because of the upfront investment to create a WSP.

Progress in analytics

The DWD requires that the quality of the drinking water is high and safe for consumption. Water providers analyse their water using analytic methods to produce reliable and comparable results. For instance chemical parameters need to be analysed with methods that answer to the given performance characteristics in the DWD for trueness, precision, and LoD (DWD, Annex III). For microbiological parameters the method to be used is given in the DWD Annex III, but alternative methods can be used subject to equivalence testing. The applied methods to assess the quality of drinking water have been naturally improving over the years since 1998, creating opportunities for more precise performance criteria, such as trueness and LoD.[115] In terms of microbiological analytical methods, the progress has inter alia resulted in methods beyond culturing. The growth of

[114] WHO, 2005. Definition of a Water Safety Plan.

[115] For example the method for LoD estimation in 1998 was lower than set parameters of AA, VC and ECH.

colonies is routinely used in all microbiology laboratories and is the simplest way to detect and qualify viable microbes. However, the main limitations of these enumeration methods are the lack of discrimination between the targeted microbes and the endogenous microbiota, the time-to-result, false positive counts and the impossibility to recover viable but non-cultivable cells, which are seen as dead.

Recent developments in molecular methods enable faster and more sensitive analyses than classical microbiology procedures.[116] These molecular tools allow a detailed characterisation of cell physiological states and material fitness and thus, offer new perspectives to improve water quality processes. The WHO reaches a similar conclusion in the report on microbial safety of drinking water. Several methods are indicated to give results faster, more sensitive and more specific than current methods based on culturing. The foremost hurdles to the future implementation of these improved methods are the lack of standardisation and automation.[117] This means that the standardisation of methods and of laboratory procedures is of great importance, if criteria for the microbial quality of water are to be uniform in different laboratories and across borders. Keeping in mind that international standard methods should also be evaluated under local circumstances before being adopted.

Since 1998, five additional methods have been approved by the International Organization for Standardization (ISO), allowing for more opportunities in water quality monitoring.[118]

Progress in ICT

Consumer information

The opportunities and possibilities to provide consumers with information on their drinking water have significantly improved with the progress in ICT in the years after the drafting of the DWD. Reports on the state of the European drinking water quality are already being publicised on the internet, easily accessible for consumers. This could potentially also be possible on a smaller scale, where drinking water companies could signal consumers via apps on mobile devices when drinking water shows deviations from normal levels, both in case of positive and negative deviations. This kind of information is currently scarcely available via websites of drinking water companies. Next to this, there are also opportunities in apps that are developed by individuals, for instance an app that aims to decrease bottled water use by showing consumers where all the public tap water points are.[119]

EU citizens very rapidly read about problems with drinking water anywhere in the world and will ask themselves could this also relate to my drinking water. Also Apps are available to inform consumers about the quality of drinking water anywhere in the world e.g. Water Advisor. Another development concerns the ongoing research, development and introduction of new monitoring technologies such as DNA based PCR methods, sensors for microbiological parameters and tools to produce a fingerprint of the water, screening technologies. The latter tow to define the normal baseline situation and to detect any changes that might need attention. Broad screening technology can be used as a first indication of the presence of contaminants that can be further investigated. and developments in sensor technology . Furthermore, the developments and the adoption by some water suppliers/some Member States the introduction of the WHO's health-based target approach to guide the setting of concentration targets and the Water Safety Plan approach to assess the likelihood of them to be met, contributed to achieving objectives.

---

[116] Sohier, D. et al. (2014) Evolution of microbiological analytical methods for dairy industry needs. *Frontiers in Microbiology.*

[117] WHO (2003) Chapter 8: Analytical Methods for Microbiological Water Quality Testing. *In: Microbial safety of drinking water: improving approaches and methods.*

[118] WHO (2011) Guidelines for Drinking-water Quality. Fourth Edition.

[119] The Guardian (2011) Water, Water Everywhere – consumer app of the week. Retrieved from: http://www.theguardian.com/money/appsblog/2011/jun/17/water-water-everywhere-consumer-app-of-week

Smart monitoring of water supply zones

A third technical innovation is the use of sensor devices to conduct remote monitoring of WSZ In recent years various MS have started with the implementation of smart meters, examples are the UK, Portugal and Greece (Athens). These countries are rolling out smart-water systems to provide near real-time water quality information accessible to the provider and to the consumers. These smart monitoring sensors require an upfront investment, but lead in the long run to a reduction in the need for monitoring conducted by a person, leading to a cost reduction and an increase in real-time water quality information.

(Smart) Water metering

Metering of water supplied by utilities to residential, commercial and industrial users is common in most developed countries and perhaps not a technological development. There is however a strong development in the UK, where only about 38% of users are metered[120], since they are planning to increase the share of households metered to 90% in 2030. The UK is also in strong contract compared to other developed countries. According to the OECD, OECD countries meter currently more than 90% of single-family houses. Some EU MS are even expanding their metering into apartments (e.g., France and Germany)[121].

In general the costs and benefits associated with water metering can be described as follows. Water metering is beneficial since it provides an incentive for water conservation, it helps to detect water leaks in the distribution network, hereby reducing the amount of non-revenue water, it can help in the development of more sophisticated tariffs and, more generally, it provides more information to customers and suppliers on water usage and it is a precondition for quantity-targeting of water subsidies to the poor. The estimated benefits for the UK sum up to 16% water savings of the average household demand. The cost of water metering mainly relate to the installing the of meter (financing of the installation costs), costs of replacing the meter when it wears out, costs related to meter reading, and the costs of additional customer billing and services related to water metering. According to the 2009 Walker Report the costs are £30 per household per year[122].

The above benefits can be increased in the future, since metering systems are becoming increasingly more 'smart'[123]. Therefore a further increase in water savings can be expected across Europe, which is partly driven by the DWD through its impact on increased awareness of the importance of quality drinking water and increased consumer information.

Main findings on EQ6

There have been various technical and other developments in the last 17 years that contributed in achieving goals of the DWD. In the above section we have highlighted some of the most influential developments that contributed to achieving the goals of the DWD in very different ways, namely a different approach to monitoring leading to faster decision making if there is a need for remedial actions, new ISO approved methods to improve the analysis of microbial quality of water, consumer communication: among others a technical innovation making users more aware of their water consumption and leading to a culture change of 16% water savings on average for the UK, and also a new method of monitoring related to new sensors.

---

120 Ofwat, Exploring the costs and benefits of faster, more systematic water metering in England and Wales, October 2011.

121 OECD, 1999. The Price of Water: Trends in OECD countries.

122 Walker Report, 2009.

123 Smart: using digital technologies or information and communication technologies (ICT) to enhance quality and performance of services, to reduce costs and resource consumption, and to engage more actively with end users.

3.3 To what extent does the Directive allow for efficient policy monitoring? (EQ7)

3.3.1 Data collection and reporting as specified in the DWD allow for efficient policy monitoring (JC 7.1)

Reporting monitoring is embedded in the provisions of the DWD. Reporting to the European Commission has been set for the parameters, the monitoring frequency and the method of analysis. In the first period also the analytical methods used had to be reported as well as national values set on transposition of the DWD.

Mandatory reporting on large WSZs

Mandatory reporting on tri annual basis on monitoring effort and results applies only to large WSZ. The data and the trends in the data can be used by the EC for assessment of the level of compliance and any improvement or deterioration if the case. The changes in levels of compliance or major changes (both in the positive and negative sense do not vary very rapidly over the years. The tri annual reporting therefor provides the EC with information on the status of the quality of drinking water in Europe and in the MS. If needed the EC can use the information submitted by the MS to ask for more detailed information on current situation and progress. This has been done in the past in case the EC was not satisfied with the quality reported. (note AH I am not sure if the mention of the MS involved is correct. TB has to be asked).

Small water supply zones

For small WSZs there are no reporting provisions in the DWD, but the EC has the right to ask for written statistical information on small WSZ (within the scope of the DWD) on the basis of the Treaty. This has been done a few times in the past and provided the EC with useful information on both the (lack of) monitoring of the small supply zones and the quality. This resulted in political attention for the situation in small WSZs, a number of studies into the small WSZs. In the revision of the DWD policy might well change for the small WSZs.

Reporting on derogations

MS have the right to grant derogations for a limited period under the condition that there is no threat to human health and there is no alternative way to supply water. For any derogation granted (both art 9.1 and 9.2) except cases under 9.4 information has to be send to the EC with the aim to inform the EC. This also is a form of information supply/reporting to the EC, that can be used for policy making.

Main findings on EQ7

The DWD obliges MS to provide information on the quality of their drinking water. Reports have to be produced regularly by all MS, but not all MS always reported on the quality of drinking water in all reporting periods since 1998 (coming into force). Furthermore there are some limitations to the information of these reports related to inconsistency in methods of sampling, methods of analysis and reporting for different MS. Also reporting on small water supply zones has only been actively pursued by the EC quite some years after the coming into force of the DWD. In spite of these shortcomings, the tri-annual synthesis reports based on the MS reports give information on the status of the drinking water quality in Europe. However, the limitations of the MS reporting obviously have their effect on the quality of the synthesis reports limiting their use for (policy) monitoring.

4 Coherence

4.1 To what extent are the DWD provision internally coherent? (EQ8)

4.1.1 The DWD provision are internally coherent (JC8.1)

Internal coherence checks to what extent working towards the objective of one provision of the DWD stands in the way of successfully achieving the objective of other provisions. There are several dilemma's regarding the internal coherence of the DWD, among other provisions regarding radioactivity and Article 10. Furthermore this section evaluates the values set for copper, nickel and lead.

Provisions for radioactivity

The DWD established indicator parametric values for tritium and total indicative dose (TID), excluding tritium, potassium-40, radon and radon decay products. However it did not establish monitoring frequencies for these parameters at the time, with the intention that this was to be done at a later stage. That Directive also notes that Member States are not required to monitor these parameters where there is evidence that the levels are well below the parametric values.

With the new Directive (2013/51/Euratom), the Commission layed down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption. This Directive sets out parametric values, and frequencies and performance characteristics for analytical methods for monitoring radioactive substances in water intended for human consumption. This includes water as defined in the scope of the DWD for drinking, cooking, food preparation or other domestic purposes supplied from a distribution network, tanker or in bottles or containers. It also includes all water used in any food production undertaken for the manufacture, processing, preservation or marketing of products or substances intended for human consumption. The provisions of the new Directive supersede the requirements for monitoring for radioactive substances in water intended for human consumption set out in the DWD.

Based on this, we can conclude that the provisions for radioactivity no (longer a) have place in the DWD .

Parametric values for copper, nickel and lead

The DWD has set values for a number of parameters for copper, nickel and lead and a note in Annex I Part B that the values in the DWD apply to a sample of water intended for human consumption obtained by an adequate sampling method at the tap and taken so as to be representative of a weekly average value ingested by consumers. The sampling method was to be added following the outcome of a study currently being carried out. This study was completed and discussed three possible sampling regimes, 30 minutes stagnation samples (30MS), random daytime samples (RTD) and fully flushed samples (FF). No agreement was reached between the MS on a harmonised approach to the sampling method. Reasons for this were: differences in consumption patterns in various MS, water scarcity issues which did not promote flushing of drinking water and the legal barriers in some MS to enter domestic premises and let the water stagnate in the pipes for 30 minutes. In the end no solution was found at Community level for a representative sample and it was left to the MS. This makes it difficult to compare results for copper, lead and nickel values measured in the various MS. Limited entry into private buildings to take samples at the tap has been seen as a major hurdle by some MS without legal tools for water suppliers or regulators to enter private buildings. The result is that the selection of sampling points

is not purely random and that domestic premises are more often than not excluded. This aspect is not internally coherent for two reasons; first of all the DWD is supposed to regulate drinking water quality at the tap while not all MS actually checks at the consumer's tap in domestic premises and secondly the DWD sets a value for a representative sample and it is not known how samples are taken.

Implementation of Article 10

It is a well-known and established fact that materials for installations used in the preparation or distribution of water intended for human consumption could lead to the deterioration of the water quality and consequently cause a risk to human health. The same holds for chemicals used in water treatment. A number of parameters in Annex I of the DWD are predominantly related to the treatment and distribution of drinking water. These parameters are addressed below:

- Disinfection-by-Products (DBP) should - in accordance with article 7.1 - be kept as low as possible in the drinking water produced without compromising disinfection. The DBP parameter mentioned in the DWD is total *trihalomethanes* being the sum of chloroform, bromoform, *dibromochloromethane* and *bromodichloromethane*. For this sum parameter interim values have been set for five years and ten years after the entry into force of the directive (respective values 150 µg/l and 100 µg/l). Another parameter related to disinfection is bromate also with interim values for compliance of 25 µg/l (after 5 years) and 10 µg/l (after 10 years) of entry into force.
- Three parameters in Annex I are regulated through product specification and the parametric value refers to the residual monomer concentration in the water as calculated according to specifications of the maximum release from the corresponding polymer in contact with water. The parameters are used as substances in the treatment of drinking water (treatment chemicals) and/or in materials used for the distribution of drinking water: acrylamide, vinylchloride and epichlorohydrin. The parametric values are subject to product specification as at the time of the adoption of the DWD the values were below the limit of detection. Due to the advances in analytical methods this has changed. There is a link with the provisions of Art 10 of the DWD.
- Fluoride is another Annex I parameter that can either be from natural sources (present in some groundwaters) but is also added in water treatment. Some MS add fluoride to the drinking water to prevent caries.
- Copper, lead and nickel are parameters in Annex I that mostly relate to materials used in the distribution of drinking water even though nickel can originate from groundwater and copper and lead can also be present in contaminated water sources. The solubility of the these parameters very and much depends on the quality of the products used in distribution and general characteristics of the water. For new materials and installations there is an overlap with the provisions of art. 10. With respect to the general matrix of the water the final concentrations in drinking water at the tap depend on many factors and these factors are different for the types of material used. For instance the use of copper pipes is not recommended in rather soft waters. Plumbo solvency and copper solvency are complex areas, where many risk factors are to be considered such as pH, low concentration of bicarbonate, microbiological growth in systems and stagnation time.

When implementing the Directive, the MS had to decide on the way they transposed this obligation put on them by this provision into national legislation. In 1999 some observations were made by the MS on the implementation of Article 10:

- The scope of Article 10 of the DWD (all materials and substances) is wider than the construction products as defined in the CPD.
- Article 10 of the DWD requires from MS to operate a formalised system for assessment and approval of materials and chemicals in contact with water intended for human consumption (article 3 and 4 of the CPD (Council Directive 89/106/EEC).

- The DWD gives no guidance on the outline and the operation of the approval of materials and substances and this is left to the MS.
- Technical specifications based on the CPD should be in line with the implementation of obligations/requirements of the DWD at national level.
- Given the number of substances and the complexity of test and field conditions, it is a laborious and long term task to harmonise all relevant technical specifications at EU level.
- A main issues with the implementation of Art 10 is the fact that MS operate different approval schemes for materials and chemicals in contact with drinking water. Within the framework if the CPD, working groups of CEN have been attempting to develop harmonised test methods since 1990. Progress is hampered by the fact that harmonising the test methods in this field is not possible without harmonising the acceptance criteria, which is however not in the competence of CEN.

As stated before, the major problem with Article 10 is that the article is difficult to understand and therefore difficult to implement for MS. Unfortunately, this study has not been able to establish the number of incompliances that were the result of MS not being able to deal with this article because of the lack of guidance by the Commission. Neither has it been possible to establish the number of remedial actions which could have been avoided if the Directive had been clear about this issue. The internal coherence is lacking as there is no evidence that MS have actually complied with the provisions mentioned in Art. 10. It is not clear if individual MS do actually have a system in place to approve materials and chemicals before they are used in drinking water supply. Also it is not clear if and how MS meet the requirements of the product specified parameters AA, ECH and VC.

Relevant metabolites, degradation and reaction products of pesticides

Relevant metabolites, degradation and reaction products of pesticides are mentioned in the DWD but no definition of 'relevant' has been available for a long time, not in drinking water and not in plant protection products legislation. It was therefore unclear what 'relevant' meant in the context of the DWD. New regulation on PPPs has now provided a definition of 'relevant'.

Main findings on EQ8

The DWD is found to be internally coherent except in relation to the implementation of Article 10. Here, the main concerns are for substances and materials in relation to the parametric values of Annex I, which are are predominantly related to the treatment and distribution of drinking water and not with materials for installations used in the preparation or distribution of drinking water. However, rather then an issue of internal coherence, this can be seen as a lack of understanding by MS on the outline and of the approval of materials and substances and the recognition of the Construction Product Directive. This is therefore left to MS, resulting in a diversity in approval systems and uncertainty regarding "safe" materials.

4.2 To what extent are the DWD provision externally coherent and which effects had the DWD on areas targeted by other EU legislation? (EQ9)

4.2.1 DWD provisions are externally coherent and new EU legislation has been consistent with the DWD (JC9.1)

For the DWD, water quality as expressed by the concentration of the selected microbiological, chemical (and indicator) parameters is the key controlling factor. To some extent water quality, including both ground- and surface water is also regulated directly or indirectly by various other EU Directives and by national policies. National policies will not be considered here.

In general, quality of water bodies is regulated on the basis of (i) protection principles (to maintain or achieve a desired quality related mostly to ecological targets, often not related to specific emissions), (ii) emission control principles (to avoid unwanted excessive levels in water, mostly related to emissions from industry, agriculture and households) and (iii) accident related policies. The main types of legislation that directly or indirectly regulate water quality via EU-Directives outside the DWD are:

1. Legislation *targeting water quality* as such, e.g. by setting standards in the water bodies itself, which includes both surface water systems as well as groundwater bodies or even bottled water;
2. General legislation concerning the *use of dangerous substances*, in construction or otherwise, that are being used in technical provisions related to the abstraction, preparation and distribution of drinking water.
3. Legislation *targeting emissions to the water system*, e.g. existing legislation that limits emission of compounds from industry directly to the water bodies (mostly surface water);
4. Legislation *targeting emission to adjacent terrestrial systems* that are linked to water bodies via leaching and runoff. This includes among others all legislation related to emission to soil or air in agriculture (use of fertilizers, pesticides);
5. Legislation that *indirectly regulates the emission to soil or water* via e.g. control of food quality;

When assessing the impact of the five main categories listed here, the direct control or influence on the actual quality of drinking water decreases from 1 to 5 where legislation in group 1 and 2 have a comparable impact on the regulation of the water quality as the DWD itself, through the setting of standards in the water body itself. Legislation in group 3 and 4 also has a direct (emission to water) or indirect (emission to soil) effect on the ultimate quality of water, but the final concentrations as affected by this type of legislation is as such not addressed.

In order to compare the DWD with other Directives targeting, directly or indirectly, several options are available depending on how adjacent policies regulate the ultimate water quality:

- A direct comparison of standards set by the DWD and EU Directives from group 1. This obviously is the most consistent since it allows for the assessment to what extent the DWD poses more stringent or more lenient targets to the water quality;
- An indirect comparison to compare water quality standards set by the DWD and emission related standards. To assess the relation between quality standards set by the DWD and emission control oriented Directives from group 2 and 3 additional assessments need to be made to relate the allowed emission concentrations to final concentrations in the water bodies to be used for drinking water purposes. This involves mixing models in case of emission to (surface) water systems but can include combined emission and transport models in case of emission to soils;
- An indirect comparison of allowed levels of substances in food and other consumable products via exposure modelling (group 4). The level of specific substances in the DWD is related partially also to a maximum daily intake (e.g. Cd).

In this context coherence can be defined in two ways which can be complementary:

- Based on what substances are regulated. This requires an analysis of substances regulated by adjacent policies compared to that of the DWD. This then illustrates to what extent the DWD regulates substances not covered by other Directives (if any), and subsequently;
- Based on a comparison of the absolute value of the standards set for various water bodies. Coherence (of adjacent policies relative to the DWD) would then imply that standards set by adjacent policies are at least equal to or stricter that those set by the DWD.

In this case basically two situations can occur:

- Quality standards in water set in policies are similar or use a stricter standard setting (group 1) or emission regulations to air, water and soil (group 2, 3 and 5) and product standards (group 4) are such that resulting concentrations in water are expected to be equal or below the criteria as set by the DWD. In this case, the EU directives are coherent. Standards set by the DWD are theoretically not limiting or do not require additional actions in so far as it concerns the water quality prior to treatment and transport;
- The criteria set by the DWD are more strict than those set by adjacent policies, either directly (group1) or indirectly (group 2 and 3). In this case, the DWD is the ultimate directive in control of drinking water quality and for these substances additional measures may be required to achieve the desired quality before water can be supplied to consumers.

What needs to be kept in mind is that the adjacent policies addressed here primarily address the quality of the water prior to treatment, i.e. the water quality as it would be observed in the different water bodies (surface, groundwater) and do not target the impact of the treatment. For substances particularly related to the presence in drinking water during or after treatment (e.g. during transport from the treatment facility to the tap, such as lead), the DWD will be the main driving instrument.

Below we list the most relevant EU Directives that either directly or indirectly control the quality of water bodies used for drinking water purposes (Table 4-1). In order to evaluate the coherence we used the following criteria to judge whether a directive or regulation is coherent:

- Coherent: This is the case when the related directives include standards in either surface water or groundwater or bottled water, which are equal or lower than the DWD;
- Not coherent: This is the case when the adherent directive includes standards in either surface water or groundwater or bottled water, which are higher than the DWD;
- Unknown: There is an upper limit to the emission of elements to water or to elements in food, but it is not clear whether the resulting concentrations in ground and surface water equals the concentration below DWD standards.

These criteria where defined during in the stakeholder meeting for the DWD revision, held in Brussels on May 26, 2015.

Table 4-1 Overview of relevant EU Directives or Regulation and modes of action (group 1 – 5)

Type	Directive / Regulation	Directive / Regulation #	What is regulated relevant to DWD	Likelihood of exceeding DWD regulations in case of load	Coherence
4	Nitrates Directive	1991/676/EEC	Standard for nitrate similar to that of DWD		Coherent
1	Water Framework Directive	2000/60/EC 2008/105/EC	Standards in surface water largely lower than those regulated by DWD[124]		Coherent
1	Groundwater Directive	2006/118/EC	Standards in surface water largely lower than those regulated by		Coherent

[124] WFD: Environmental Quality Standards are not based on the exposure route via drinking water as not all surface water is intended for the production of drinking water. MS could set more stringent levels when necessary for surface water intended for the use of drinking water. In most cases this is not necessary because aquatic organisms or the exposure routes for human via fish leads to more stringent EQS

Type	Directive / Regulation	Directive / Regulation #	What is regulated relevant to DWD	Likelihood of exceeding DWD regulations in case of load	Coherence
			DWD		
1	Pesticides directive; Directive[125]	(EC) No 1107/2009 2009/128/EC	Standards in surface water and groundwater similar to that of DWD		Coherent
1	Urban Waste Water Directive	91/271/EEC	Standards in place for limited number of parameters (N, P)	Note: 15 mg/L for NO3 exceeds 50 mg/L for NO_3 but due to mixing with surface water final concentration will meet DWD standard	Coherent for a number of parameters
2	Radioactive substances in water[126]	2013/51/Euratom	Standards for radioactive substances in water intended for human consumption. Are equal to those regulated (i.e., tritium and total indicative dose) by the DWD.		Coherent
5	Food contact material legislation[127]	EC) No 1935/2004	All water (including water put into bottles or containers) after the point of compliance as defined in Article 6 of Directive 98/83/EC and without prejudice to the requirements of Directives 80/778/EEC and 98/83/EC.		Coherent[128]
3	Sludge Directive	86/278/EEC	Regulation of *load* to soil, depending on conditions this leads to lower or higher concentrations as regulated by DWD	Not likely	Unknown
4	Fertilizer regulation	REGULATION (EC) No 2003/2003	Regulation of quality of fertilizers (revision)	Proposed revisions most likely do not affect water quality beyond standards set by DWD. For cadmium assessment is not clear	Unknown

[125] See also EQ4/EQ5 for a more thorough description of pesticides directive
[126] See also EQ9 on Euratom
[127] See also Extension to EQ14
[128] Explanation of assessment: Water is ingested directly or indirectly like other foods, thereby contributing to the overall exposure of a consumer to ingested substances, including chemical and microbiological contaminants. However, as the quality of water intended for human consumption is already controlled by Council Directives 80/778/EEC (5) and 98/ 83/EC (6), it suffices to consider water after the point of compliance referred to in Article 6 of Directive 98/83/ EC.

Type	Directive / Regulation	Directive / Regulation #	What is regulated relevant to DWD	Likelihood of exceeding DWD regulations in case of load	Coherence
4	Undesirable products in animal nutrition	2001/102/EC	Regulation of quality of fodder and other animal feed products	Not likely due to low acceptable levels in fodder and feed	Unknown
4	Landfill of Waste Directive	1999/31/EC	Regulation of emission from waste collection site	Not likely due to emission control regulation	Unknown

Main conclusions in view of our definition of coherence regarding the degree of coherence between the DWD and related Directives are:

- A direct comparison of quality standards for parameters (i.e. in water) as set by the DWD and the corresponding parameters in adjacent Directives (notably Nitrates Directives, WFD, Pesticides Directive, Radioactive substances in water) shows that levels as set by the DWD are equal to those set by adjacent Directives (in casu nitrate, pesticides, tritium and total indicative dose);
- Most environmental quality criteria for concentrations in surface water or groundwater are equal to (e.g. Cd, Pb, As) or (much) lower (notably Cu) than those set by the DWD;
- The two previous conclusions imply that the DWD is coherent with a number of relevant Directives but has little or no added value in regulation of these compounds since adjacent Directives already regulate the level as required by the DWD;
- For most Directives targeting water quality, however, the emission is regulated through a restriction of the load and are not so much based on maximum concentrations in water itself. This makes a direct comparison of concentration based standards difficult or impossible since this would require a conversion of load to concentration;
- In addition, there is a considerable time lapse for load-based emissions before entering the aquifer used for water abstraction. This requires complicated transport modelling which is, currently not available for the complete list of substances;
- Whether or not such load-based emissions eventually lead to exceedance of concentration based standards furthermore depends on the nature of the pathway which may lead to complete removal of the substance from the water phase as such due to retention or biological decay;
- For a number of load-based Directives (e.g. the Sludge Directive) maximum loads however are defined such that the likelihood of concentration based limits as set by the DWD will be exceeded is small. This is a result of additional requirements in e.g. the Sludge Directive that states that soil quality (expressed as the concentration in soil) is not allowed to increase beyond levels that would lead to excessive leaching losses;
- For most Directives regulating food quality (both in view of consumption and unwanted substances) and other agricultural products, acceptable standards (in food or fodder, thus indirectly regulating animal food) are also such that the likelihood of corresponding loads to the soil (via fertilizer or otherwise) leading to excess concentrations in groundwater or surface water is low. In general other environmental Directives are more limiting in this regard than the DWD (e.g. in case of copper emissions to ground- and surface water).

The coherence of the DWD with the Water Framework Directive (WFD) is especially important as the protection of drinking water resources is established as indispensable part of the plans and measures under the WFD, as is information and consultation of the public including citizens, municipalities and water suppliers. A Commission report on the assessment of the 1st River Basin Management Plans was published in 2012, and was update recently. Article 7 of the WFD makes

special reference to surface water intended for the production of drinking water. The quality of the surface water should be such that relatively simple treatment is needed to produce drinking water that meets the requirements of the DWD.

Article 7 WFD: Waters used for the abstraction of drinking water

1. MS shall identify, within each river basin district all bodies of water used for the abstraction of water intended for human consumption providing more than 10 m3 a day as an average or serving more than 50 persons, and those bodies of water intended for such future use. MS shall monitor, in accordance with Annex V, those bodies of water which according to Annex V, provide more than 100 m3 a day as an average.
2. For each body of water identified under paragraph 1, in addition to meeting the objectives of Article 4 in accordance with the requirements of this Directive, for surface water bodies including the quality standards established at Community level under Article 16, MS shall ensure that under the water treatment regime applied, and in accordance with Community legislation, the resulting water will meet the requirements of Directive 80/778/EEC as amended by Directive 98/83/EC.
3. MS shall ensure the necessary protection for the bodies of water identified with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water. MS may establish safeguard zones for those bodies of water.

Regarding plant protection product regulations the issue of 'relevant' metabolites, degradation and reaction products of pesticides, has been the subject of long discussions in the Council during the negotiation process. Unfortunately no solution or consensus was reached on what 'relevant' was. Reference was made to the legislation on plant protection products. However, no further definition of 'relevant' was found. The 2009 regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market has 33 definitions and under nr.32 a reference is made to 'relevant' metabolites: *metabolite' means: any metabolite or a degradation product of an active substance, safener or synergist, formed either in organisms or in the environment. A metabolite is deemed relevant if there is a reason to assume that it has intrinsic properties comparable to the parent substance in terms of its biological target activity, or that it poses a higher or comparable risk to organisms than the parent substance or that it has certain toxicological properties that are considered unacceptable. Such a metabolite is relevant for the overall approval decision or for the definition of risk mitigation measures*.

A consistent definition of non-relevant metabolites of plant protection products is asked for by the manufacturing industry , as well as their uniform regulation in drinking and groundwater in the EU, is important to achieve legal clarity for all stakeholders and to establish planning security for development of plant protection products for the European market.

Radio-activity parameters in the DWD

In the 98/83/EC Directive provisions are made for the radio-activity in drinking water (Annex I). Two parameters are mentioned and parametric values have been set for tritium and total indicative dose. At a later stage it was decided that radio-activity is covered by the Euratom Treaty and had no place in the Directive (Article 31 (expert group) of the Euratom Treaty). The provisions on radioactive substances and radioactivity parameters are addressed in the developments in EURATOM legislation (Directive 2013/51/EURATOM). These provision and references to radioactivity are still in the DWD but no longer valid.

Water used in food undertakings

The DWD covers (Article 2.1.b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water

cannot affect the wholesomeness of the foodstuff in its finished form. In the legislation of food and feed safety reference is made to the provisions in the DWD. Regulation (EC) No 178/2002 of the European Parliament and the European Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. Article 2 in the directive on the definition of 'food' : for the purposes of this Regulation, 'food' (or 'foodstuff') means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans. 'Food' includes drink, chewing gum and any substance, including water, intentionally incorporated into the food during its manufacture, preparation or treatment. It includes water after the point of compliance as defined in Article 6 of Directive 98/83/EC and without prejudice to the requirements of Directives 80/778/EEC and 98/83/EC. Other types of water covered by the DWD as by Article 2.1.a are all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker or in bottles or containers.

Main findings on EQ10

The DWD is coherent with Directives relevant for drinking water such as the Water Framework Directive and the Nitrates Directives. Both Directives set values for the protection of water sources intended for the production of drinking water. The Urban Waste Water Treatment Directive for improving the quality of receiving waters. The coherence of the DWD with the Water Framework Directive (WFD) is especially important as the protection of drinking water resources is established as an indispensable part of the plans and measures under the WFD. Water managers and water boards in many MS therefore work jointly with water supply companies to achieve the high quality in water resources and to protect these water supplies.

5 Relevance

In this chapter we discuss the extent which the DWD can (still) be considered relevant, in view of the ongoing scientific developments and new approaches.

5.1 To what extent is the DWD approach still appropriate and are provisions not directly related to actions still relevant? (EQ10)

5.1.1 Overall objective and scope of the DWD is still appropriate (JC10.1) and citizens expectations go beyond what is currently regulated in the DWD (JC10.2)

Generically speaking, the main need of EU citizens regarding drinking water is obvious: it is universally accepted that access to safe drinking water is essential to hunan health. Safe drinking water is considered a basic human right and a component of effective policy for health protection and improving access to safe drinking water can result in tangible benefits to health.[129] More specifically, failure to ensure drinking water safety may expose the community to the risk of outbreaks of intestinal and other infectious diseases. Outbreaks of waterborne disease are particularly to be avoided because of their capacity to result in the simultaneous infection of a large number of persons and potentially a high proportion of the community.

The importance of safe drinking water is underlined by both global and European authorities. In April 2011 the Human Rights Council of the United Nations adopted, through Resolution 16/2, access to safe drinking water and sanitation as a human right: a right to life and to human dignity[130], international treaties, such as the Charter of the United Nations (1945) and the ILO Convention No.161 on Occupational Health Services (1985) also refer to the right to safe water. In the European context, the right to safe drinking water is enshrined in the European Convention for the Protection of Human Rights and Fundamental Freedoms (1950), the Revised European Social Charter (1996) and in the recommendations from the Council of Europe (2001) in which they asserted that everyone has the right to a sufficient quantity of water for his or her basic needs.[131] In the publication “Health and Environment in Europe” of the WHO Regional Office for Europe, it is mentioned that people in Europe are aware of, and concerned about, the importance of good water quality. Finally, the importance of water quality is also reflected by the many different measures which have been taken in Europe to supply people with safe water and good sanitation.[132]

In assessing the relevance of the DWD in addressing these needs, we discern between 1) the extent to which needs of EU citizens are addressed and 2) the scope of EU citizens whose needs are addressed.

The relevance of the *extent* of the DWD’s intervention depends on whether the chosen indicators represent the most relevant barriers for the safety of drinking water. The safety of drinking water is determined by a number of biological and chemical contaminants, which have been shown to cause adverse health effects. Relevance of the DWD in this respect is determined by the extent to which the DWD safeguards and promotes removal of these contaminants removed.

---

129 World Health Organization & Unicef (2011). Guidelines for drinking-water quality. Fourth edition: volume 1 Recommendations. Geneva.

130 United Nations. Media brief. The Human Right to Water and Sanitation. UN-Water Decade Programme on Advocacy and Communication and Water Supply and Sanitation Collaborative Council.

131 Recommendation Rec(2001)14 of the Committee of Ministers to MS on the European Charter on Water Resources.

132 World Health Organization (2010). Health and Environment in Europe: Progress Assessment.

Throughout the interviews with stakeholders (industry, regulators, academics and utilities), the following observations are relevant for evaluating the extent of to which needs are addressed:

- The DWD has caused an increased attention for drinking water policies;
- In the past twenty years, the regulatory framework throughout Europe has become much more consistent, especially in the case of connection rates and water quality levels in new MS;
- Overall levels of contaminants have been reduced;
- The parameters in the DWD still largely address the needs. Residues of drugs and hormones were identified as possible omissions (which is addressed under question 2 below). Conversely, several respondents identified that some parameters need not be monitored (this issue is addressed under section 2.2 on effectiveness).

Additionally, the Public Consultation which has been conducted in the context of the evaluation of the DWD includes the following relevant observations:

- The respondents expect that EU legislation should provide minimum levels of common standards in drinking water throughout Europe;
- The majority of the respondents (53%) indicated that new and emerging parameters should be considered, even if this leads to a significant increase in the price of water.

The relevance of the *scope* of the Directive considers whether the Directive cover the needs of all EU citizens. In this respect, it is important to note that the Directive does not include an obligation to supply water. The DWD concerns the quality of the water supplied to citizens and the coverage of water supply across the population. However, the requirements and obligations in the DWD do depend on the size of the water WSZ.

With respect to covering the needs of all EU citizens there is compliance with the DWD in case of areas where no water is supplied at all. This is one of the key issues of the ECI R2W. Smaller water suppliers have a monitoring obligation set in the DWD but no obligation to report to the EC. Very small water suppliers are either monitored at a frequency decided by the MS (subsidiarity principle) or are completely exempted from the coverage of the DWD. Experience and Treaty based requests for information have shown that both monitoring and information on the quality of smaller WSZ (< 1000 m3 a day) does not always cover the needs of all EU citizens (also refer to the reports on small WSZs from the EC and from the WEKNOW network). With the recent revision of Annex II and III of the DWD, this issue has now been addressed.

Furthermore, the Directive has no specifically adapted requirements to address needs for the very small suppliers, for example how to manage and monitor them appropriately. For these type of WSZs, the relevance (and effectiveness) of the DWD could be further improved by being more prescriptive.

5.1.2 Provisions of the DWD follow the latest guidelines of the WHO and are (still) relevant given the latest scientific developments (JC 10.3)

To answer this question we have looked at the specific provisions selected in Chapter 1.[133] In assessing their relevance we have also identified those provisions that have become less relevant.

Quality standards (Art. 5): Setting parameters - a relevant approach

The Directive lays down the essential quality standards at EU level. A total of 48 microbiological, chemical and indicator parameters must be monitored and tested regularly. In general, WHOs guidelines for drinking water and the opinion of the Commission's Scientific Advisory Committee are

[133] We exclude a discussion on Article 10 under Relevance. We instead link back to the inclusive and extensive discussion on Article 10 provided under effectiveness.

used as the scientific basis for the quality standards in the drinking water. In accordance with Article 11. The Commission assesses whether or not a revision of Annex I of the DWD on parameters and parametric values is needed every five years. For amendments to Annex I to be made a full co-decision procedure is required. This has not been done since the adoption of the DWD. Annexes II and III on monitoring and specifications for the analysis of parameters can be adapted by the Commission every five years and this can be done through the Committee procedure (article 12).

Setting parameters for the quality of drinking water has a positive effect on human health because there is a standard which needs to be complied with by drinking water suppliers. It contributes to the Directive's objective it offered minimum drinking water quality standard in all EU MS. If parameters would not have been provided, regulators would have had difficulties to convince the water suppliers of the need for monitoring some substances.[134]

> "The introduction of DWD has significantly contributed to having a solid and stable reference framework both for the list of pollutants (and their parametric values) and the control system. This has helped water operators to streamline monitoring procedures and increased users' confidence. Major current problems with drinking water quality derive precisely from the uncertainties related to those pollutants that are not covered by the Directive."

It has been necessary to set individual parametric values for substances which are important throughout the Community at a level that is strict enough to ensure that the Directive's purpose can be achieved in large parts of the EU and is the result of the long negotiation process between the MS. The DWD does not include parameters that are potentially a threat to human health in the EU but could not be included for various reasons, mostly the state of the art of science at the time. This comment relates to emerging substances including endocrine disrupting compounds, for which there is not sufficient evidence to include individual substances (e.g. as key indicator parameters), to set a parametric value or to have a suitable analytical method available. A complicating factor here is the unknown cocktail effect of emerging substances.

While a regular review of the Annex I has taken place, this has not lead to a revision the Annex.[135] MS have added other parameters to this list they deemed appropriate (thus respecting the principle of subsidiarity)[136] and this has led to a differentiation of uptake of additional monitoring amongst the MS. Examples for additional parameters (for which no values have been set in the DWD) are virus, parasites (e.g. legionella), calcium/magnesium, *chlorophenols*, cadmium, *trihalomethanes*, *microcystin*, uranium and chlorite. In other cases, MS (such as AT, NL and UK) have more strict values for parameters already included in the DWD.

According to the EU Survey, the respondents from all MS indicated to be in favour of revision of the list of parameters set in the DWD in line with the latest scientific developments and evidence. This result was also true even if it would lead to an increase in the price of the drinking water, although it is preferable to achieve expansion of the list of observed parameters without the need to recur to price increases. Many new parameters have been suggested by the respondents to be included in the list included in Annex I of the DWD. However, the majority of the respondents agreed that the substances used in the consumer products, pharmaceuticals and endocrine disrupting substances are the most important to be considered. It has been pointed out that the joint effect ("cocktail" effect) of the substances in the drinking water on human health has to be studied both in terms of their presence or absence (over-purification). The water should be regarded as a source of

---

134 Stakeholder consultation on the evaluation of the DWD. (May 2015) Brussels.

135 Based on an interview with a stakeholder from West Europe; not revising Annex I leads to the outcome that parameters are at a minimum e.g. when it comes to micro pollutants.

136 European Commission (1998). DWD. ANNEX II. MONITORING, TABLE A.

elements that are important for human health and therefore kept clean and natural as far as possible.

In the context of the Public Consultation, which has been a separate exercise next to the EU survey, a number of position papers have been submitted. On the basis of these papers it is noted that respondents from BE, CZ, FR, NL, and UK see a need to revise the list of parameters in the DWD to reflect new pollutants and new scientific developments. In the paper from the UK it is suggested that the Annex I of the DWD is reviewed no less often than every 5 years for keeping standards up to date and in line with technical progress and new health information. The papers from Belgium (BE) and Scotland specify the parameters to be added: uranium, Cr6, perchlorates, disinfection by-products (BE) and viruses, naturally produced toxic substances and pharmaceutical substances including birth control chemicals (Scotland). Other institutions as well as companies also support revision of the parameters list in the DWD based on scientific evidence and risk based approach.

Contrary to the above, some public bodies opinioned that the current list of microbiological and chemical parameters, as well as the indicator parameters and corresponding limit values in the DWD should be maintained and all further provisions should be left to the MS, or the competent bodies in the MS. There are also opinions from stakeholders in agriculture, saying that the limits of pesticides and nitrates in the water are unnecessary stringent and should be revised based on scientific evidence and actual risk on human health.

With respect to the analytical methods pre-defined in the DWD new and more rapid methods have now been developed and implemented since the coming into force of the Directive. It is possible to deviate from the defined methods but comprehensive equivalence testing is required. Many MS have done this testing to be able to use the Colilert method, but as far as known rapid molecular methods have not yet been introduced for mandatory monitoring. This because equivalence testing is not cheap and not easily done and needs expert judgement before they are approved for mandatory purposes.

Emerging substances

Additional parameters that are currently discussed as posing risks to human health are chromium$_{VI}$, perfluorinated substances and nanoparticles.

Chromium is currently a parameter in the DWD, but it does not distinguish between total Chromium and Chromium$_{IV}$.. However, the problem of chromium$_{VI}$ is considered more serious than that of chromium. At a meeting on drinking water dedicated to the problems and the standards for chromium$_{VI}$[137], it was discussed that there was not only a need for this substance to be included in Annex I of the DWD, but also for a much stricter value. Experts from the US-EPA clarified that the this organisation was planning to lower the value for Chromium$_{VI}$ by a factor 100 because of the impact on human health.[138] Experts from areas in Europe where volcanic chromium is present and mined reported the significantly higher occurrence of various cancers in those areas.[139]

Perfluorinated substances (PFCs) is included here as these substances have often been mentioned by MS drinking water experts as causing potential health related risks. This was e.g. the subject of

[137] The Greek Ministry of Environment, Energy and Climate Change in collaboration with the Greek Ministry of Health in order to provide updated answers to the problem of Hexavalent Chromium in drinking water is organizing an INTERNATIONAL EXPERTS WORKSHOP ON "HEXAVALENT CHROMIUM IN DRINKING WATER"

[138] For a discussion on Chromium in the USA see: https://www.epa.gov/dwstandardsregulations/chromium-drinking-water

[139] See for example: *Papillary Thyroid Cancer Incidence in the Volcanic Area of Sicily* by Gabriella Pellegriti, De Vathaire, F; Scollo, C; Attard, M; Giordano, C; Arena,S; Dardanoni, G.; Frasca, F; Malandrino, P; Vermiglio,F; Massimo Previtera, D; D'Azzò, G; Trimarchi, F; and Vigneri. R. (downloaded from http://jnci.oxfordjournals.org/content/early/2009/11/05/jnci.djp354.full)

many presentations and discussions in the so-called ENDWARE group, that meets twice a year to discuss common issues related to the DWD. The quote below from a paper from the Global Health and Safety Initiative gives evidence of this concern:[140].

'PFCs are extremely persistent and bioaccumulative chemicals. Studies of the persistence of PFOS, for example, show that under no conditions does the chemical show any evidence of breaking down in the environment. Analysis by the Organization for Economic Co-operation and Development found that PFOS does not 'hydrolyse, photolyse or biodegrade in any environmental condition tested. 'Human and wildlife exposure to PFCs is nearly ubiquitous. Studies by the U.S. Centers for Disease Control (CDC), and others, have detected PFCs in humans throughout the U.S. and the world. PFCs are known to cross the placenta, directly exposing the developing foetus. Scientific studies finding PFCs in humans are causing increased focus on reducing the sources and transmission of PFC chemicals'.

The water sector is concerned about the increased use in various applications of **nanomaterials** and the potential impact on the quality of drinking water. The study: Evaluating nanoparticle breakthrough during drinking water treatment[141] found that *'Although a majority of aggregated or stable NPs were removed by simulated conventional and advanced treatment, NP metals were detectable in finished water. As environmental NP concentrations increase, we need to consider NPs as emerging drinking water contaminants and determine appropriate drinking water treatment processes to fully remove NPs in order to reduce their potential harmful health outcomes'.* Nanotechnology is also increasingly used in drinking water treatment. Reason for the establishment of NanoNextnl a consortium, including government, companies and knowledge institutions that conduct research into nanotechnology's applications and risks. KWR is developing analytical methods within the framework of the Environmental Risk programme. The researchers are also studying the behaviour of nanoparticles and the risks they might represent.[142].

According to the EU Survey, the respondents from all MS indicated to be in favour of revision of the list of parameters set in the DWD in line with the latest scientific developments and evidence. This result was also true even if it would lead to an increase in the price of the drinking water, although it is preferable to achieve expansion of the list of observed parameters without the need to recur to price increases. Many new parameters have been suggested by the respondents to be included in the list included in Annex I of the DWD. However, the majority of the respondents agreed that the substances used in the consumer products, pharmaceuticals and endocrine disrupting substances are the most important to be considered. It has been pointed out that the joint effect ("cocktail" effect) of the substances in the drinking water on human health has to be studied both in terms of their presence or absence (over-purification). The water should be regarded as a source of elements that are important for human health and therefore kept clean and natural as far as possible.

In the context of the Public Consultation, which has been a separate exercise next to the EU survey, a number of position papers have been submitted. On the basis of these papers it is noted that respondents from BE, CZ, FR, NL, and UK see a need to revise the list of parameters in the DWD to reflect new pollutants and new scientific developments. In the paper from the UK it is suggested that the Annex I of the DWD is reviewed no less often than every 5 years for keeping standards up to date and in line with technical progress and new health information. The papers from Belgium (BE) and Scotland specify the parameters to be added: uranium, Cr6, perchlorates,

[140] Downloaded from: http://healthybuilding.net/uploads/files/perfluorinated-compounds-pfcs-and-human-health-concerns.pdf

[141] Environ Health Perspect; DOI:10.1289/ehp.1306574 Talia E. Abbott Chalew, Gaurav S. Ajmani, Haiou Huang, and Kellogg J. Schwab. Evaluating Nanoparticle Breakthrough during Drinking Water Treatment.

[142] Bäuerlein, P. S.; Floris, R.; Hofman, J. A. M. H., CeO2 nanoparticles in drinking water (sources) - How much do we know? 2012.

disinfection by-products (BE) and viruses, naturally produced toxic substances and pharmaceutical substances including birth control chemicals (Scotland). Other institutions as well as companies also support revision of the parameters list in the DWD based on scientific evidence and risk based approach.

Contrary to the above, some public bodies opinioned that the current list of microbiological and chemical parameters, as well as the indicator parameters and corresponding limit values in the DWD should be maintained and all further provisions should be left to the MS, or the competent bodies in the MS. There are also opinions from stakeholders in agriculture, saying that the limits of pesticides and nitrates in the water are unnecessary stringent and should be revised based on scientific evidence and actual risk on human health.

With respect to the analytical methods pre-defined in the DWD new and more rapid methods have now been developed and implemented since the coming into force of the Directive. It is possible to deviate from the defined methods but comprehensive equivalence testing is required. Many MS have done this testing to be able to use the Colilert method, but as far as known rapid molecular methods have not yet been introduced for mandatory monitoring. This because equivalence testing is not cheap and not easily done and needs expert judgement before they are approved for mandatory purposes.

Monitoring actions (Art.7)

The MS have the obligation to perform country-wide monitoring of the water quality intended for human consumption based on the parameter groups described in the Annexes of the DWD. In order to do so, they have to collect samples and analyse these data (in different ways for the different parameter groups). Where there is a potential danger to human health from the presence, of substances and micro-organisms in drinking water for which no parametric value has been set, MS are to ensure that additional monitoring of these substances and micro-organisms is carried out, on a case by case basis.

The setting of quality standards is relevant if accompanied by an appropriate monitoring system. The monitoring systems and laboratories set up as a result of the DWD are is considered relevant by all stakeholders contacted for this study. The Synthesis Report on the Quality of Drinking Water in the EU for the period 2008-2010[143] highlighted information gaps but also acknowledged that if reporting on small supplies were mandatory, the resulting reporting system would put an enormous (administrative) burden on those MS which have many small water supplies within their territories. The report therefore urged policy makers to seek an adequate solution which, on the one hand, supports the Commission and the MS in their objective to provide safe drinking water to all European citizens, and, on the other hand, allows for compliance checking by the Commission without putting an unreasonable administrative burden on the MS.

The risk-based approach

The concept of a **risk-based approach** (RBA)[144] all along the production and distribution of drinking water was introduced by the WHO in 2004 into the Guidelines for Drinking Water Quality under the header “Water Safety Plans“, and further developed in the 4th edition (2011) of Guidelines for Drinking Water Quality.[145] Such an approach aims at shifting drinking water surveillance from the control at the tap towards quality management along the production and

[143] Synthesis Report on the Quality of Drinking Water in the EU for the period 2008-2010.

[144] The issue of Risk Based Approaches has been on the agenda of the Commission for some time and is expected to result in the formalisation of including this option in Annex II (expected before the end of 2015). Some of the statements in this section may therefore have less relevance for the actual situation.

[145] http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/index.html and http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/index.html.

distribution cycle from capture to tap. The result of a survey carried out in 2010 by COWI in the preparation of an impact assessment indicated that almost one-third of the MS had legal requirements for risk based approaches to management of the drinking water safety, even though this approach was not (yet) included in the DWD.

The position papers from Belgium, Czech Republic, France, the Netherlands, Norway and the UK state that monitoring should be based on a risk-based approach and take into account the local peculiarities. In addition, the position paper from France states that monitoring should cover the entire supply process (including water storage, treatment, distribution), which has an impact on the final quality of the water distributed. France also considers it necessary to set a minimum check frequency for all parameters.

Risk-based monitoring is also supported by water suppliers (such as United Utilities, Dwr Cymru Welsh Water, CC Water, all based in the UK), the Health Partnership for Wales (WHP), and associations of water suppliers such as Eureau. The latter expressed its opinion to revise Annex II of the DWD to formalise the common principles of the Water Safety Plans. Acqua Publica Europe (APE) is of the opinion that the source control approach needs to be encouraged as the most cost-effective way to reduce the impact of hazardous substances.

Contrary to the above perspective is that the quantity and efficiency measures should not be within the scope of the DWD but rather additional legislative instruments should be used.[146] This process has since taken place and the recent Commission Directive (EU) 2015/1787 follows up on this. The directive is focussed on flexible monitoring frequencies, stating that "*MS should (…) be allowed to derogate from the monitoring programmes they have established, provided credible risk assessments are performed, which may be based on the WHO Guidelines for Drinking Water Quality and should take into account the monitoring carried out under Article 8 of Directive 2000/60/EC.*"

On the **point of compliance**, there is some discussion regarding the ability of water companies or authorities to access private property. We quote from two interviews:

> "Almost all MS use the tap as a point of compliance in accordance to Article 6. However, in some countries it has created problems to convince water companies to do so according to some regulators. In Germany, for example, the sampling point is the water meter, which is also possible according to Art. 7. Nonetheless it seems that this was not clear enough in the Directive and leads to confusion."[147]

> "The responsibility of the DWD usually ends at the water meter. The rest is the responsibility of the water owner. Mostly the property owners are not aware that it is their responsibility to ensure water quality from the water meter to the tap and monitoring will not take place".[148]

Although there is no evidence of any confusion on the side of MS authorities or water companies regarding the point of compliance, there is evidence that different MS have different interpretations of Article 6, and this is mostly caused by difference in legislation regarding the access to private properties by water companies. However, Article 6 explicitly states that "MS shall be deemed to have fulfilled their obligations under this Article (…) where it can be established that non-compliance (…) is due to the domestic distribution system or the maintenance thereof" as long as "MS shall nevertheless ensure that: (a) appropriate measures are taken to reduce or eliminate the

146 Opinion of water provider from Western Europe.
147 Interview. Regulator and Utility sector. Central Europe.
148 Interview. Academics sector.

risk of non-compliance (…); and (b) the consumers concerned are duly informed and advised of any possible additional remedial action that they should take".

The fact that owners of private buildings are not aware of their responsibility regarding water quality also has bearings on Article 10 which regulates materials in contact with drinking water. For a discussion on the relevance of this Article, we refer to the discussion on materials in contact with drinking water in the chapter on effectiveness.

The provision for monitoring is relevant for verifying the quality standard set in Annex I of the DWD. Although monitoring practices differ between MS, the resulting data have been essential to maintain the quality of drinking water throughout the EU. The different monitoring requirements for small WSZ is seen by most stakeholders as a hindrance to guarantee the water quality for a sizable proportion of the EU population[149]. The emergence of the Risk Based Approach was fuelled by the desire to cover the complete chain of production and, more importantly, to be pro-active in identifying possible sources of contamination. This approach has now been included in the DWD (Annex II), but there is on ongoing call for a more integrated approach (both monitoring based on sampling and based on RBA), and an inclusion of this concept in the main body of the DWD. A closing remark on monitoring would be that there is some confusion regarding the point of compliance according to stakeholders, but this is not seen as an issue of the Directive itself, but rather a point of attention for MS to properly inform owners of private homes.

Remedial actions

According to the interviews conducted for this study, MS authorities would be significantly less powerful without the remedial actions incorporated in the Directive. Also, they would probably be less effective in coercing drinking water producers to improve their water quality to comply with the set parameters, which could form a potential danger to the health of European citizens. Remedial actions are therefore of significant relevance to the DWD since the competent authorities are required to take effective measures in case of non-compliance by the drinking water producers. When drinking water providers fail to comply with the standards set in the DWD, the overall aim of achieving drinking water for human consumption which is wholesome and clean becomes unattainable.

In the current situation, remedial actions come into play when an undesirable situation is already in existence; water quality is already below acceptable levels. It is therefore argued by some that additional preventive measures are implementated as a supplement to the remedial actions. These could include measures such as water safety planning and risk analysis. The opinions expressed by other institutional stakeholders note that the response to any deterioration in water quality should be proportional to the event and to the health related risks involved. This approach is also known as a risk-based approach. This approach is in contrast to the prevention based approach, currently applied in the DWD. The risk based approach is widely supported by stakeholders as a more proportional approach to the health risk involved in the production of drinking water.

The remedial actions form an essential link in the DWD by coercing water suppliers to improve deviating water quality, and MS would have less enforcement authority without the remedial actions incorporated in the Directive. Remedial actions are therefore crucial to the DWD since the competent authorities are required to take effective measures in the case of non-compliance by the drinking water producers. Our evaluation of the reported monitoring data and performed remedial actions prove that it is very likely that the performed remedial actions has improved the drinking water quality in the period 2005-2013. Given that remedial actions come into play when an

[149] Note: Since the evaluation is backward looking the COMMISSION DIRECTIVE (EU) 2015/1787 of 6 October is not taken into account.

undesirable situation is already in existence, many stakeholders plead support implementation of additional preventive measures to supplement the remedial actions. These could include measures such as water safety planning and risk analysis.

Information and reporting to consumers and to the Commission

Article 13 of the DWD requires that all MS are to ensure compliance with the Directive by providing adequate and up-to-date information on water quality for human consumption to the consumers. In addition to the information to the consumers the MS have a reporting obligation to the European Commission. The reporting to the EC covers three year periods, on the basis of which the EC publishes a synthesis report on the quality of drinking water in the Community.

The information to the consumers is handled in different ways in the various MS of the EU. Information to consumers can be send for individual WSZ together with the water bill. Other means used are publication in local newspapers and or at the city hall. Both water supply companies and national governments make use of the internet to inform the consumers. In these cases the information can be found on the national websites and or at the water companies' website. An increasing number of MS produce and make available in the public domain annual reports on the quality of the water supplied often also showing trends in water quality. Monitoring data are assessed in relation to national and European legislation and drinking water standards. A few examples of information supply are Ireland[150] and the United Kingdom[151]. In many MS the information is only available in the national language, which excludes people that do not understand the national language as e.g. tourists. The majority of MS do not use comprehensive maps or other visualisation techniques. A list of national websites with drinking water information can be found in the 2005-2007 synthesis report.[152]

Reporting to the European Commission

The reporting obligation to the European Commission is based on a three-year reporting cycle. At the time of the adoption of the Directive, a reporting format was not yet available. Besides, there were no templates for the exchange of information for various water related directives such as Fresh Water Fish Directive, Bathing Water Directive and the DWD. The format for the reporting was developed together with the MS in accordance with article 13(4). The objective of the reporting to the European Commission is to monitor the implementation of the DWD in the various MS. The reporting allows the EC to monitor the policy with respect to the implementation of the sampling and monitoring requirements, the remedial actions in the case of non-compliances, and the information to the public. The reporting on derogations is done separately using the format in Art.9.

There is an ongoing debate between stakeholders regarding the necessity and right to consumers to be well informed about the quality of the supplied drinking water. Where some stakeholders believe that consumers have this right[153], and they are furthermore of the opinion that consumers should receive more simplified information on the main parameters,[154] there are also contradicting voices in this debate. At the stakeholder meeting for the DWD revision, held in Brussels on May 26, 2015, it was acknowledged that insufficient information does not necessarily result in people turning to other sources of drinking water, as consumers take water for granted and are generally not interested in information on the quality of water. In a position paper from the UK it is furthermore stated that information provided at the local level (supply zone) should be sufficient and that there is

150 http://www.epa.ie/pubs/reports/water/drinking/dwreport2014.html#.VkXbz3arRdg
151 http://dwi.defra.gov.uk/about/annual-report
152 https://circabc.europa.eu/sd/a/b580866d-8eb7-4937-9a97-d3d3485d046e/2005-2007%20SynthesisReport.pdf
153 This reflects the positions submitted by Belgium, Czech Republic, Germany, France and the UK.
154 Although the stakeholders have noted that, if consumers require this, they should also be entitled to receive detailed information about the results of the analysis, the values of every parameter and whether these values comply with the required standards.

no need to provide information at the EU level. However, the view of the French authorities was that the choice of ways to inform consumers must belong to each MS.

The Critical Analysis Report (EC, 2013) presented the results of an analysis of the reporting process under the Drinking Water Directive, and it concluded that although Article 13 of the DWD dictates that all MS are to ensure compliance with the Directive by providing sufficient, up-to-date information on water quality for human consumption, it only mentions a reporting obligation of once every three years. The Guidance Document on Reporting under the DWD indicates further that although the data is required to be prepared annually, it only needs to be submitted with the general report every three years. Most importantly, the report concluded that the DWD does not indicate a clear objective in the reporting procedure, which has lead to the sutauation that each synthesis report is different, and the whole reporting exercise is somewhat incoherent and arbitrary.

6 EU added value

6.1 What has been the EU added value of the DWD? (EQ11)

6.1.1 The DWD has achieved objectives that could not have been achieved through national legislation (JC11.1)

The positive contribution of the DWD towards better quality of drinking water for the vast majority of EU citizens has been discussed under the heading of effectiveness (see 2.1). In this section, we argue that without drinking water legislation in place at EU level, it would have been unlikely that the improvements described in previous chapters would have been as widespread as we witness today. We identify added value of EU legislation at several levels: i) all MS aiming for the same level of drinking water quality; ii) building up a body of knowledge around water quality parameters and monitoring techniques based on common rules and agreements; iii) improved information to consumers; and iv) an opportunity to optimize processes and share resources, resulting in improved efficiency and cost savings; and v) the efficiency gains for firms using tap water in their production process.

Although differences in drinking water quality still exist between MS and even among regions within the larger MS, we noted a gradual improvement over the last decades and have identified the DWD as a major contributor to this improvement (see section 2.1 and Annex B for a more extensive discussion on trends in water quality). Especially for those MS that joined the EU in 2004 or later, the standards provided water authorities with clear goals and – even more important – with the opportunity to source for the financial means within the EU to upgrade their drinking water management systems.

To reach an agreement on a common set of parameters and the applicable limit values, water quality experts throughout the EU participate(d) in various fora, at both national and international level, which resulted in scientific and non-scientific articles and reports. This process continued after the adoption of the Directive and a wide body of knowledge on this topic was built up in the process. Without the EU, this process would have lacked a clear focus and would have been less efficient.

The obligation to provide consumers with information on drinking water quality increased the awareness of consumers on the need for high quality drinking water and improved their position viz-á-viz water companies in price/quality discussions. However, as has been set out in Section 2.1 on effectiveness, the present situation is very diverse throughout the EU with some MS providing detailed information on a regular basis, whereas others would only release limited information on an infrequent basis. Some MS, for example, conduct benchmarking reports.

With the exception of Article 10, the DWD has provided MS with a clear set of rules on how to manage the process of guaranteeing good quality drinking water. This has increased the efficiency of the management throughout the EU according to stakeholders across Europe. The DWD has further avoided duplication in the development of methods and approaches, from which national legislators have benefitted. Moreover, companies operating in more than one EU country and those exporting to one or more EU countries benefit from the minimum levels of drinking water quality in all EU countries and the standard approaches to determine this quality.

Besides asking the question how EU regulation has brought change that would otherwise not have taken place (or not taken place at the same pace), we have also asked the question whether the

DWD continues to have an added value, especially for those countries which have already enjoyed high quality drinking water for several years. Here, the most compelling argument for EU added value came from an interview with a representative of Dutch utility companies who stated that not only did the DWD help and still helps to maintain the quality standard of water and the related water services, but if this piece of EU legislation was taken away, national legislators would not feel as obliged to uphold the laws and regulations now in place in their respective countries which are needed to maintain these high standards. This was confirmed by the national regulators, who stated that discussions on necessary investments are easily hampered without a good European regulatory framework that reflects responsibilities. The interviewees from the national regulator furthermore indicated that it is good to have another body at European level that regulates the national regulators.

Overall, the DWD provided MS who joined the EU before the DWD became effective with a regulatory framework which allowed them to adjust their water policies and procedures and assign budgets for necessary adjustments. Next to this, the DWD provided MS who joined the EU after the DWD became effective with guidelines for water quality standards and appropriate regulation. New MS were also able to channel EU funds for Accession Assistance towards large scale investments in water treatment and distribution systems, monitoring laboratories and capacity building.

Main findings on EQ11

It is argued that without drinking water legislation in place at EU level, it would have been unlikely that improvement in water quality would have been as widespread as we witness today. There is a high level of EU added value through existence of the DWD. The main issues leading to benefits are:

- MS are all aiming for the same level of drinking water quality;
- MS/EU efforts build up a body of knowledge around water quality parameters and monitoring techniques based on common rules and agreements;
- Improved information to consumers has increased awareness of the importance of high quality drinking water;
- The DWD was and is an opportunity to optimize processes and share resources, resulting in various efficiencies and cost savings; and
- There are serious efficiency gains for firms, either through using tap water in their production process and/or through harmonization of production processes across borders.

6.2 Is there any possibility to compare EU legislation on drinking water with what is in place in other regions? (EQ12)

To answer this evaluation question we have looked at two issues: i) the situation outside the EU where large parts of the population is confronted with high rates of waterborne diseases due to poor drinking water quality; and ii) a comparison of the EU legislation on drinking water with four selected regions with comparable economic development (USA, Canada Australia and New Zealand).

6.2.1 Countries at lower levels of development have more health problems caused by polluted drinking water (JC12.1)

Contaminated water serves as a mechanism to transmit communicable diseases such as diarrhoea, cholera, dysentery, typhoid and guinea worm infection. WHO estimates that in 2008 diarrhoeal disease claimed the lives of 2.5 million people worldwide[155]. Although consumption of

[155] WHO (2011a). Cause-specific mortality: regional estimates for 2008. Geneva, World Health Organization (http://www.who.int/healthinfo/global_burden_disease/estimates_regional/en/index.html).

contaminated water represents the greatest risk, other routes of transmission can also lead to disease and contribute to the disease burden and the WHO estimates that more than 200 million people are affected by schistosomiasis and around 800 million more were at risk of infection[156]. WHO further estimates that the total global economic losses associated with inadequate water supply and sanitation are US$ 260 billion/year.

An interesting study by the World Bank makes cost estimates for achieving universal access to basic and safely managed water, sanitation, and hygiene (WASH) services[157]. For this purpose, a cost model was run at country level for 140 low- and middle-income countries. We have selected two large countries in Asia to illustrate how far the EU has progressed in terms of safe water supplies and the costs involved to reach a comparable level in these two countries. Both countries are making progress in terms of access to improved drinking water sources. In India, the share of population with access to improved drinking-water sources increased from 81% in 2000 to 93% in 2012, and in Indonesia, the share increased from 78% to 85%[158]. To provide the remaining urban and rural populations with safely managed drinking water services in India countries involves investments per capita of €18 and €9 respectively[159]. For Indonesia, these costs per capita are €32 and €16 respectively.

6.2.2 *The EU can learn from legislative approaches in countries at comparable levels of development (JC12.2)*

We place the descriptive analysis in perspective by matching the differences across the five countries with challenges within the European context, as identified through this report. We do this for a selection of challenges where we identify relevant learning potential from the selected regions. The extensive descriptive analysis of the situation in the selected regions is provided in Annex D. An outline of the legislative regulations and general approach to drinking water is addressed in the text box below.

Legislative regulations and general approach to drinking water management

All four studied countries have legal requirements set with regard to provision of drinking water for human consumption which is wholesome and clean, although arrangements vary. The USA and New Zealand have legislation at national level, whereas in Canada and Australia the approach is closer the European DWD. In Canada, provinces should in their legislative documents implement the requirements of the GCDWQ. In Australia, the legislative arrangements are done by the Australian states, while at national level there are only guidelines which are not legally binding.

The integrated water management approach, multi-barrier approach and preventive management approach are in the basis of the drinking water management philosophy of the studied countries. In the USA source water assessment is made and measures taken to protect water sources. In Canada the multi-barrier approach comprises an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water, from source to tap. The preventive management approach in Australia includes elements of HACCP, ISO 9001 and AS/NZS 4360:2004. In New Zealand the Multiple barriers approach includes minimising the extent of contaminants in the source water, removing undesirable soluble and particulate matter, disinfecting to inactivate any pathogenic organisms present and protecting the treated water from subsequent contamination. In contrast the DWD focuses primarily of the

[156] Steinmann, P., Keise, Rr. J., Bos, R., Tanner, M. and Utzinger, J. (2006). Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. Lancet. Infect. Dis., 2006; 6, 411–425.

[157] Hutton, G,, and Varughese, M. (2016) The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene.

[158] WHO, World Health Statistics 2015 (http://www.who.int/gho/publications/world_health_statistics/EN_WHS2015_Part2.pdf)

[159] Advanced or safely managed drinking water services corresponds to a population using an improved drinking water source (piped water supply), available when needed, and free of fecal and priority chemical contamination.

drinking water quality while the issues related to integrated water management are part of other legislation (Water Framework Directive)

Monitoring strategy

In the European context, variation exists amongst MS with respect to the stringency of monitoring of substances, where some MS move beyond the requirements of the DWD. In parallel, a large number of MS is in favour of revising the list of parameters as set in the DWD. Additionally, introducing more year-round monitoring and risk-based monitoring are discussed.

While the DWD sets minimum requirements to monitoring, the legislation in the studied four countries is more flexible with regard to monitoring. In general, decisions about the frequency of the monitoring is left to the respective authorities in order to allow them to take into account various characteristics of the drinking water supply systems.

Several interesting approaches to sustain high water quality have emerged:

- In the USA, the central authority (EPA) is responsible for evaluating the analytical methods for determining standards and assessing drinking water quality. Moreover, States or the EPA certify laboratories who centrally conduct testing of samples. The requirements vary depending on the contaminant group, the type of source and number of people served. For large populations, more monitoring is generally required.
- In Canada, the monitoring programme for all federal drinking water systems should be developed based on a sanitary survey, combined with a vulnerability assessment and a baseline chemical analysis. This analysis should be revised every five years. The actual monitoring frequency of microbiological parameters, recommendations are made based on a.o. the size of the population served, the monitoring history, the type and quality of source water and type of treatment. For populations of more than 5,000 people, minimum intervals are prescribed.
- In Australia, sampling and analysis are required most frequently for microbial parameters and less often for organic and inorganic compounds. When after investigative research the parameters and sampling locations are identified, these are documented in consolidated monitoring plans. The procedures for sampling and testing are also documented.
- In New Zealand, water suppliers need to follow the relevant sampling and testing programmes detailed in Drinking Water Standards. Contaminants are divided in four priority classes, where priorities one and two must be monitored and three and four at the suppliers' discretion. The sampling frequencies are set to give 95% confidence that the medium to large suppliers comply for at least 95% of the time. Larger suppliers are required to monitor more frequently. Accreditation of laboratories is done centrally by the Ministry of Health.

Safety of new materials

The use of new materials could significantly affect drinking water quality. In the European context, questions have been raised whether the DWD is the correct place to regulate materials, considering that the Construction Products Directive has recently been repealed and replaced by the Construction Products Regulation (EU No 305/2011).

The legislation in Canada and Australia poses requirements to material in contact with drinking water. Both approaches consider the materials in a broader sense including treatment chemicals and additives into the water. In Canada the internal building distribution systems within federal buildings and in First Nations communities must be designed and constructed to meet the National Plumbing Code of Canada. There are no recommended specific brands of drinking water treatment devices, but it is recommended that the devices are certified by an accredited certification body to meet the NSF/ANSI health-based performance standards. In Australia materials used should

comply with Australian Standard AS/NZS 4020 Products for use in contact with drinking water. The products used in water systems should be subject to an audited system of quality control.

Certification is required in Australia and recommended in Canada. In both cases, the safety of new materials is embedded in legislation related to construction standards and not in specific legislation for drinking water.

Consumer information and involvement

For the European context, several challenges have been identified;

- according to the EU-survey, there is general dissatisfaction with the information received on water quality and water service and the provisions of the DWD in this regard.
- the provided information from the MS in many cases does not have the required quality for EU policy reviews.
- consumers would like to receive information in the context of accountability: issues such as water losses in the network, cost of supply and profit margins, investments made and monitoring activities.

The information provided to consumers and the consultation of consumers varies from country to country. This also holds for the requirements to take this up. More specifically, the following approaches are taken:

- In the USA it is required that the information is provided to the public about public health effects which is comprehensive, informative, and understandable. The public can be involved in developing source water assessment programs, state plans to use drinking water state revolving loan funds, state capacity development plans, and state operator certification programs.
- The consumer information provided by the national authorities in Canada is scarce. There are no nation-wide requirements for the provision of information and reporting. This is regulated at provinces based on their legislation.
- Development of a comprehensive strategy for community consultation is recommended in Australia as well as a consumer complaint and response programme. However this is not obligatory and how it is implemented by the states is unclear.
- In New Zealand a Drinking Water for New Zealand web portal has been developed which provides the most important information to the consumers with regard to drinking water.

Main findings on EQ12

In many developing counties contaminated drinking water serves as a mechanism to transmit communicable diseases, which in one year alone (2008) claimed the lives of 2.5 million people. It is estimated that the total economic loss associated with inadequate water supply and sanitation are US$ 260 billion/year. It is further estimated that in order to provide both the urban and rural populations of these countries with safely managed drinking water services would require investments per capita of €18 and €9 respectively in India and €32 and €16 respectively in Indonesia.

The evaluation compared some of the specific provisions with the approach of these provisions in the USA, Canada, Australia and New Zealand. Although comparing water legislation is challenging due to differences in legislation in general,the EU can draw inspiration from these countries on i) the monitoring approaches (ex-ante methodology-based approach to determine standards, risk-based approach based on local characteristics and use of the so-called ‘95% confidence’ approach) and ii) the role of consumers (in the USA consumers are actively involved in the various stages of water management).

7 Conclusions

Effectiveness

EQ1 To what extent has the Directive achieved its objectives?

Based on an analysis of the rates of compliance for the period 2005 to 2013, it is concluded that the DWD has contributed to a better protection of human health from the adverse effects of any contamination in drinking water and has ensured wholesome and clean drinking water for citizens in the EU. A significant effect of the DWD was seen in the increase in compliance for the microbial parameters (*E. coli*, *Cl. perfringens*) and lead. Less convincing evidence for a Directive induced increase in compliance exists for several agricultural/catchment related parameters, such as pesticides, nitrate and arsenic. It is likely that the main drivers of change in this area are other relevant directives.

EQ2 Which provisions have been the most appropriate for protecting human health?

Parameter requirements: The Directive gives provisions for setting parameters, monitoring, remedial action, granting derogations, reporting and for dealing with materials in contact with drinking water. Although each of these provisions is important for the protection of human health, there is widespread agreement that setting parameter values for microbiological parameters (*E. coli* and *Enterococci*) in conjunction with monitoring for compliance for these parameters and the requirement to take remedial actions in the case of non-compliance has reduced the likelihood of microbiological contaminiation of drinking water and the possible impact on human health through illness e.g. diarrhoea and gastroenteritis.

Monitoring activities: Although the monitoring systems and laboratories set up in Member States have been effective in collecting and analysing information on water quality, it was found that in one-third of the Member States the frequency of monitoring was below that what is required to detect possible contaminants and to allow for a proper analysis (at MS and EU level).

Remedial action: Most of the remedial actions performed as reported by the MS are related to the microbiological parameters and to a lesser extent to chemical parameters. The remedial actions for *E. coli* are mainly treatment-related, for lead mainly domestic distribution network related and for nitrate mainly catchment related.

Option of derogation: The provision of derogation was included in the DWD as a means for Member States to achieve compliance. has been found to be effective as it allowed a limited and conditional extention period for achieving compliance as the provision ensured compliance at the end of the derogation period without causing a potential danger to human health.

Materials in contact to drinking water: Article 10 of the DWD regulates the impact of materials and substances in contact with drinking water. Much effort was put into the development of a harmonised testing and approval system for materials by experts, Member States and the European Commission. Even though the harmonisation of testing and approval is not directly an issue for the DWD, it would have made the protection of human health in the EU easier, as the quality of the materials and thus the protection of the water quality would have been better guaranteed. In other words if all materials used in the Member States would have been tested and approved in a harmonised way this would have meant a more equal level of protection to EU citizens than is the case now. We therefore conclude that Article 10 has not been effective as it did not provide a regulatory framework at EU level and as such MS regulators were not able to develop

an effective national approach and many MS experienced problems with the implementation as no further guidance was offered.

Reporting:

Information to consumers, Regarding information provided to consumers we note that all MS provide information to consumers and in general national authorities provide some general information on the quality of drinking water and, in most of the cases, they make their national Drinking Water Directive reports also available to the public. In spite of this observation, 51% of consumers who responded to the stakeholder survey carried out for this study indicated that information provisions are inadequate and only 17% judged that information provisions are adequate, with a somewhat higher percentage of satisfied consumers in "old" MS compared to "new" MS. Of the 27 countries included in the survey, in three countries the share of unsatisfied consumers is more than 75%, in nine this percentage is between 50% and 75%, in four this percentage is between 25% and 50%, and one the percentage is lower than 25%. The main reasons of unsatisfied consumers is that they can't find information on the quality of water and it is often not clear to them what is paid for. Apart from providing information through water bills, consumers would like to receive information through social media.

Reporting to the Commission, The compliance with the requirement of reporting to the Commission is high if somewhat irregular and in general provides a good overview of the quality of drinking water supplied in the MS. Screening on the continuity of the reported data for all MS resulted in just 12 MS having delivered a continuous record of analyses. Furthermore, the quality of reporting is variable and did not provide the Commission with adequate information to perform a thorough synthesis of drinking water quality developments in the EU.

Review process: Article 11 requires a full procedure (involving the Eurepean Parliament and the Council) to make any changes to Annex I. Given the technical complexity and far reaching implications of changes to the list of parameters and their values, this process is justified, even though some stakeholders have argued in favour of amending Annex I on a more regular basis. The procedure to make changes to Annexes II and III is quicker and simpler and allows more flexibility to respond to scientific and technical progress.

EQ3 What main factors, in particular related to water bodies, agriculture and distribution networks, have influenced or stood in the way of achieving the objectives of the DWD?

The contribution of catchment-related sources and treatment plant sources combined contribute to approx. 45% of all non-compliances. A further 29% of non-compliance was related to distribution networks. This observation, in addition to our assessment of the effectiveness of the Directive's provisions points to three main factors that have stood in the way of (fully) achieving the objectives of the DWD:

i) the limits of measuring compliance at the tap in detecting virusses and parasites (for which samples of approx. 100m^3 are needed);
ii) the variety of substances not included in Annex I that can have negative effects on human health; and
iii) the uncertainly relating to the approach to materials and substances in contact with drinking water.

EQ4 What results, if any, has the DWD achieved beyond its main aim to protect human health?

The DWD puts drinking water in a wider context and the DWD can be linked to a number of effects that go beyond the protection of human health. The main additional (positive) effects are:

- The first unintended effect of the DWD can be linked to the creation of consumer awareness where an increased quality of drinking water raises the preference of consumers for tap water,

although at the same time higher awareness of water quality standards may result in consumers buying more bottled water;

- A second unintended effect that can be linked to the DWD is that it created the basis for a number of Directives which have been designed and implemented since 1998 (such as the Water Framework Directive and the Groundwater Directive) and there is a clear link with the levels of regulation of substances between the DWD and those of other Directives. In the same context, the use of fewer and other pesticides is also referred to as an effect of the DWD. Although (drinking) water legislation is unlikely to directly affect the authorisation of new pesticides on the market, it may have had an effect on the extent to which they are used. Indirectly, drinking water legislation might even change types of pesticides and their development. Additionally, water companies have installed extra treatment steps to avoid water intake stops due to high pesticide levels in surface water. There has been a decrease of metals in wastewater that originates from plumbing installations and an increased awareness of form materials in contact with drinking water; and
- With clean water supplies, industries which use extensive quantities of clean water (such as food and drink industry, stand to gain from the removal of even small levels of contaminants from water abstraction sources which result in products that fail to meet consumer protection legislation or require the need for expensive water treatment systems. Improved drinking water supplies will therefor significantly reduce the costs for these industries and enable them to become more competitive.

Efficiency

EQ5 To what extent are the costs involved with implementing the DWD justified given the benefits which have been achieved?

The approach to Evaluation Question 5 consists of two sections. The first section identifies, describes and calculated when possible the positive health and other impacts that can be attributed fully/partially to the implementation of the DWD. Due to the outlined difficulties related to a clear attributability, lack of data, and impossibility to assign clear economic values to the benefits, it is not possible to assert at this stage where the balance stays in terms of costs-benefits. In particular, the assessment of the benefits – in this framework – cannot be done only against economic/monetary criteria, but it is also necessary to involve political, general safety and other hard to assess implications.

The total cost for supplying drinking water to inhabitants in Europe in 2014 amount to roughly €46.5 billion of which around 18% (€8 billion in 2014 or €16 per capita) can be attributed to the DWD. The roughly €46.5 billion of cost are determined by taking the expenditure (pricing according to cost recovery principle) of water supplied for 6 MS and extrapolated this information to each MS using population and differences in income. As a second step the total cost/expenditure has been split over the main cost components of a drinking water supplier using percentages found by the German benchmarking system. In a third step the attributable share of each component has been taken, through a combination of interviews with MS experts and expert judgement, to obtain the weighted attributable share of 18%, or €8 billion for 2014.

The benefits of clean drinking water have been assessed using a quanitiative (when data with a causal relationship was available) –or qualitative approach (often causal relationships can not be made (i.e. lack of available data on avoided sickness)). It was found that the lead standard set by the DWD probably has led to significant health benefits across Europe. Other notable benefits that can be attributed to the DWD are the organoleptic improvements with respect to drinking water, having an EU baseline regulatory framework in place that sets an equal minimum standard, a reduction in pre-treatment of cleaning water for preparing food and the increase in compliance for

most parameters leading to an overall improvement of the quality of drinking water both for consumers and other users. Based on these arguments and supported by a majority of stakeholders, it is concluded that the benefits of the DWD regulation outweigh the costs of implementation.

EQ6 Have there been technical or other developments since the elaboration of the Directive that could contribute to achieving the objective more efficiently?

There have been various technical and other developments in the last 17 years which contributed in achieving goals of the DWD. Some of the developments which contributed to achieving the goals of the DWD are:

- use of water safety plans to describe the entire water supply system which can lead to faster decision making in case a distortion in water quality is found;
- new methods to improve the analysis of water quality such as molecular tools, which give results faster, more sensitive and more specific compared to the current methods based on culturing; and
- progress in ICT has allowed innovations in informing consumers (through various new media tools) but also tools such as smart metering which assist consumer in making more informed decisions on water use.

EQ7 To what extent does the Directive allow for efficient policy monitoring?

The DWD obliges MS to provide on the quality of their drinking water. Reports have to be provided regularly by all MS, but sopme gaps in reporting exist. Furthermore there are some limitations to the information of these reports related to inconsistency in methods of sampling, analysis and reporting for different MS. In spite of these shortcomings, the tri-annual synthesis reports based on the MS reports provide the EC with valuable information on the status of the drinking water quality in Europe. However, the limitations of the MS reporting obviously have their effect on the quality of the synthesis reports limiting their use for (policy) monitoring.

Coherence

EQ8 To what extent are the DWD provisions internally coherent?

The DWD is found to be internally coherent except in relation to radioactivity, parametric values for copper, nickel and lead and the implementatuion of Article 10.

Although the DWD set indicator parameters for some radioactive substances, it did not establish monitoring frequencies. These were later included in a new Directive (2013/51/Euratom) making the provisions in the DWD redundant. Regarding copper, nickel and lead, Part B Note 1 of Annex I to the Directive states that the values set in Annex I for these substances apply to a sample of water obtained at the tab. However, there has been no agreement on the method for sampling, leaving it to MS to determine the method, and some MS do not have legislation in place that authorise entry to private premises, leading to bias or even exclusion of these premises from the sample.

As for Article 10, the main concerns are for substances and materials in relation to the parametric values of Annex I, which are are predominantly related to the treatment and distribution of drinking water and not with materials for installations used in the preparation or distribution of drinking water. However, rather then an issue of internal coherence, this can be seen as a lack of understanding by MS on the outline and the operation of the approval of materials and substances and the recognition of the Construction Product Directive. This is therefore now left to MS, resulting in a diversity in approval systems and uncertainty regarding “safe” materials.

EQ9 To what extent are the DWD provisions externally coherent?

The DWD provisions have been evaluated on the extent of external coherency and the effect the DWD has had on other areas of EU legislation. The main findings are that the DWD is coherent with Directives relevant for drinking water such as the Nitrates Directives that sets the same value for nitrate as in the DWD, the Water Framework Directive as it aims to portcet water sources intended for the production of drinking water, the UWWTD for regulating and improving the quality of receiving waters. The coherence of the DWD with the Water Framework Directive (WFD) is especially important as the protection of drinking water resources is established as an indispensable part of the plans and measures under the WFD. This has made the WFD very relevant for the quality of drinking water, as it aims to protect water sources with the ultimate goal to provide water companies to extract water of relatively good quality. Water managers and water boards in many MS therefore work jointly with water supply companies to achieve the high quality in water resources and to protect these water supplies. As stated before, the DWD is not internally coherent with criteria for materials and substances used in the preparation or distribution of drinking water.

Relevance

EQ10 To what extent is the DWD approach to protect human health from the adverse effects of any contamination of drinking water still appropriate?

It is found that the DWD was and still is highly relevant when considering its overall objective of providing wholesome and clean drinking water to improve and/or safeguard human health. Having in place a directive with requirements that set an overall minimum quality within the EU ensures consumers that there is at least a basic equal level of protection from any adverse effects drinking water might have on consumers. It is a minimum as some Member States might have opted for stricter values and thus an even better quality of drinking water. Additionally, the DWD has caused an increased attention for drinking water policies and led to a more consistent regulatory framework on water compared to 20 years ago. This is because a number of issues were made more clear and transparent e.g how MS should deal with non-compliace, better regulation and guidelines on reporting, requirements for the information supply to the public, better guidance on monitoring and sampling.

The judgement criteria regarding expectation of EU citizens are split in three parts (Jc10.2).
1) Are the needs of EU citizens taken into account by the DWD?;
2) Do citizens feel that they are provided drinking water of high quality?; and
3) Is information on drinking water provided on time and of decent (understandable) quality?
Based on views of citizens (the Public Consultation report and several (EU and MS) consumer satisfaction surveys (e.g. Eurobarometer), it was found that the DWD takes the need of EU citizens into account, although there is a growing demand to better link EU legislation on drinking water with the needs of citizens regarding information provision and participation. According to the Public Consultation survey EU citizens feel that water provided is of good quality (some difference per MS, but no negative outliers) and generally affordable. An interesting outcome here is that consumers feel that water in other EU countries is of much less quality. According to water quality reports between 2005-2013 the water quality in all, excluding some regions and relatively newer MS, MS is safe. Apparently there is gap between consumer perception on and reality of water quality abroad.

To assess the relevence of the provisions in the DWD (JC10.3), the evaluation looked at the main provisions of the Directive, i.e. setting parameters, monitoring, derogations, remedial action, and information and reporting.

- **Quality standards** as presented in Article 5 of the DWD concern microbiological, chemical and indicator parameters. Microbiological parameters included in the DWD are considered the most

relevant indicators of water quality, and are used as indicators for the quality of drinking water as a first line of protection of human health although incidences and outbreaks of specific pathogenic micro-organisms have also been reported in the absence of both microbiological parameters.

- Since the DWD came into force, **analytical methods** have improved and new methods have been developed. These new or improved methods can be applied, provided sufficient equivalence testing with the methods mentioned in the DWD is performed.
- The indicator **parameters** such as colour, odour, taste, and turbidity do not have numeric values in the Directive, and acceptable levels differ between Member States and perhaps even between water supply zones dependent on what consumers are used to. The organoleptic parameters are very important for the consumers as they are often the first thing consumers notice about their drinking water and any changes in the organoleptic quality. Indicator parameters as the organoleptic ones but also other indicator parameters are for first and for all an indication for water suppliers and operators to monitor the performance of the drinking water production process from source to tap. Any changes in these parameters are best for them to judge and take action upon, either at water suppl zone level and or at national level.
- **Monitoring** actions (Article 7 of the DWD) are relevant for the verification of the quality standards set in Annex I of the directive. However, as monitoriong depends amongst other on the size of the water supply and general quality of the water (reduction possible if parameters are not exceeded or very low), and the type of treatment (e.g. use of coagulants, disinfectants etc.) it is not always clear if the requirements moniting offer the same level of protection to all European citizens.
- **Derogations** (Article 9) by the Commission have been granted only six times in the history of the Directive, but most stakeholders consulted for this evaluation agree that Article 9 has become less relevant over time and that the few cases occuring could be dealt with on a case-by-case basis.
- **Remedial** actions form an essential link in the DWD by coercing water suppliers to improve deviating water quality, and MS would have less enforcement authority without the remedial actions incorporated in the Directive. Remedial actions are therefore crucial to the DWD since the competent authorities are required to take effective measures in the case of non-compliance by the drinking water producers. Our evaluation of the reported monitoring data and performed remedial actions prove that it is very likely that the performed remedial actions has improved the drinking water quality in the period 2005-2013.
- The **reporting** process is important as it provides a regular overview of the level of compliance with the parametric values in the DWD at EU level and also makes it possible to see any trends in compliance. The reporting process has in the last years also been extended (through the Treaty Based request for written evidence) to the smaller water supply zones that until then were rather invisible. Since the written requests for information, more is known about the water quality of small water supplies and even more importantly, more attention is now given to these supplies by both MS and the EC. However, the DWD does not indicate a clear objective in the reporting procedure, which has lead to the situation that each synthesis report is different, and the reporting exercise is somewhat incoherent and arbitrary.

Added value

EQ11 What has been the EU added value to the Directive?

There has been a notable improvement in the quality of water for selected parameters, that can be linked directly to improvements in the distribution networks. Furthermore, without drinking water legislation in place at EU level, it would have been unlikely that improvement in water quality would have been as widespread as we witness them today for a number of reasons:

- All MS are progressing towards the same level of drinking water quality;

- Efforts at EU and Member State level to build up a comprehensive body of shared knowledge around water quality parameters and monitoring techniques;
- Improved information to consumers has led to an increased awareness of the importance of high quality drinking water;
- The DWD is an opportunity to optimize processes and share knowledge between MS, EU institutions and WHO, resulting in various efficiencies and cost savings; and
- Efficiency gains for firms by providing clean water for production (especially in the food industry), and/ or through harmonization of production processes across borders.

Based on these findings we can conclude that, if this piece of EU legislation would fall away, there will be serious negative health effects, for one because the current awareness of the importance of drinking water could fall away, the regulatory framework needs to be developed by MS separately (leading to double costs and investments) and quality differentiates between MS negatively impacting consumers perception of the quality of drinking water abroad. In addition, the platform to discuss and harmonize would fall away if the DWD is repealed and currently unresolved issues (product harmonization for instance) will continue to hamper economic growth. Moreover for some MS, and especially those with a federal structure such as Germany and Austria, EU regulation is seen to be helpful by the national government to achieve compliance. Federal bodies often have a high level of independence and are more likely to comply with regulation coming from the EU or regulation based on EU legislation.

EQ12 Is there any possibility to compare EU legislation on drinking water quality with that in similar regions?

To answer this evaluation question we have looked at two issues: i) the situation outside the EU where large parts of the population is confronted with high rates of waterborne diseases due to poor drinking water quality; and ii) a comparison of the EU legislation on drinking water with four selected regions with comparable economic development (USA, Canada Australia and New Zealand).

It has not been possible to link cases of polluted drinking water in the EU to the number of people fallen ill with waterborne diseases, but the numbers involved are far lower than in less developed countries. Benefit-cost ratios of investing in drinking water in other regions therefore are much higher than in the EU. For example, providing urban populations in India and Indonesia with safely managed drinking water services requires investments per capita of €18 and €32 respectively. In comparison, in the EU the cost per capita is estimated at €91.

Comparing legislative approach towards drinking water in the EU with that in the USA, Canada, Australia and New Zealand it was found that monitoring approaches are somewhat similar although most of the other countries have already adopted a risk-based approach. A second difference is that in the USA the public (consumers) is more actively involved in the various stages of drinking water management. Thirdly, certification for products in contact with drinking water is required in Australia and recommended in Canada. In both cases, the safety of new materials is embedded in legislation related to construction standards and not in specific legislation for drinking water.

P.O. Box 4175
3006 AD Rotterdam
The Netherlands

Watermanweg 44
3067 GG Rotterdam
The Netherlands

T +31 (0)10 453 88 00
F +31 (0)10 453 07 68
E netherlands@ecorys.com

W www.ecorys.nl

Sound analysis, inspiring ideas