UN WATER

Compendium of Water Quality Regulatory Frameworks: Which Water for Which Use?

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UNEP

IWA
the international
water association

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Preface

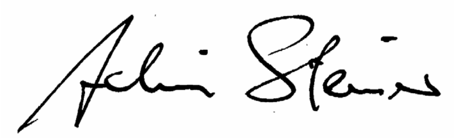
Water quality issues are complex and dynamic in nature, presenting challenges to water security that demand urgent solutions from the local to the global level. As human populations grow, industrial and agricultural activities expand, and climate change threatens to cause major alterations in the hydrological cycle. Declining water quality is a growing concern, one that will impact human well-being, environmental sustainability and economic performance.

In 2050, overall water demand is expected to have increased by 55 per cent. A balanced mix of water supply and water demand management strategies is required to ensure water security. Making water management more efficient through innovative and wise policies and regulations is one way to achieve this goal.

Improving efficiency of water use requires regulatory frameworks that better reflect how different water uses require different water qualities. Water from industrial processes, for example, can be reused in agriculture. Whilst existing literature and regulatory frameworks have long addressed the importance of water quality, regulatory instruments that consider the interactions and interdependencies between water uses and ecosystems are still insufficient.

By providing an overview of selected laws and policies and supporting case studies, this Compendium aims to improve the guidelines for managing water quality globally. It provides a platform to engage and inform policy and decision makers on these critical issues, as well as guidance on how regulatory frameworks can promote wise use, innovation and efficiency in water management.

The Compendium presents an opportunity for countries to make their water quality regulatory frameworks and management instruments "fit for purpose", improving water security and delivering better services for all.



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Acronyms and Units of Measurement

ADI	Acceptable Daily Intake
CONAMA	Brazilian National Environmental Council
EQS	Environmental quality standards
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GPA	Global Programme of Action for the Protection of the Marine Environment from Land -based Activities
HRIV	Health-Related Indicator Value
IAH	International Association of Hydrogeologists
IDC	Indicative Dose Criteria
IWA	International Water Association
IWQGES	The International Water Quality Guidelines for Ecosystems
NHRMC	National Health and Medical Research Council of Australia
PoM	Programme of Measures
PMU	Project Management Unit
RBD	River Basin Districts
RBMP	River Basin Management Plans
RIVM	National Institute for Public Health and the Environment (Netherlands)
RfD	Reference Dose
RQO	Resource Quality Objectives
SAWQG	South African Water Quality Guidelines
TDI	Tolerable Daily Intake
TPA	Thematic Priority Area
UNEP	United Nations Environment Programme
UNESCO-IHP	UNESCO International Hydrological Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
US EPA	US Environmental Protection Agency
WFD	Water Framework Directive
WHO	World Health Organisation
WSP	Water Safety Plans
WWQA	World Water Quality Assessment

Introduction

This document consists of several components: the Introduction (this section), which outlines the rationale of developing the Compendium; an overview of the methodology; how instruments were selected; and a user guide for the overall Compendium.

Part I of the Compendium provides an overview of selected laws and policies regulating water quality for different uses in geographical scales. The information about each instrument has been consolidated into a database organised into chapters: (1) Scope of law and policy instruments; (2) Management frameworks; (3) Parameters, indicators and thresholds adopted for different uses; (4) Implementation of water quality guidelines. A narrative in this document accompanies each chapter in the database and facilitates its navigation. Part I also contains Criteria for Assessment, which is a checklist of what makes a particular law or policy a good instrument to regulate water quality.

Part II of the Compendium contains case studies, which showcase best practices and different methodological approaches to regulate water quality requirements for different uses. A Glossary of Terms is provided to clarify the meaning of a certain approach or analysis, especially where there is contradictory information or different approaches.

Annex I provides an in-depth description of the methodology used to develop the Compendium and analyse the law and policy instruments. This annex includes details on the working groups, which consisted of water quality experts from developing and developed countries, as well as policy makers and practitioners. Annex II contains the templates used to collect and analyse information from the experts. Annex III has a list of the regulatory instruments that have been analysed in depth as part of the Compendium. The details of these instruments are in the database and references are made throughout the Compendium narrative. Annex IV has a list of complementary reports and projects, some of which are under the umbrella of the UN-Water Thematic Priority Area on Water Quality (as is the Compendium).

Background and Rationale

Declining water quality is a global issue of concern as human populations grow, industrial and agricultural activities expand, and climate change threatens to cause major alterations to the hydrological cycle (UN Water, 2014). 'Over the last hundred years, global population has quadrupled, while water use grew by a factor of seven', thus challenging current and future water security (UNDP, 2006). Furthermore, global water demand is expected to increase by an overall 55% by 2050, including a 400% increase in water demand for manufacturing, 140% for electricity and 130% for domestic use (OECD, 2012); yet, agriculture will remain as the largest user of water. *Figure 1 (see below)* shows the total percentage of freshwater abstraction by major use (OECD, 2014a).

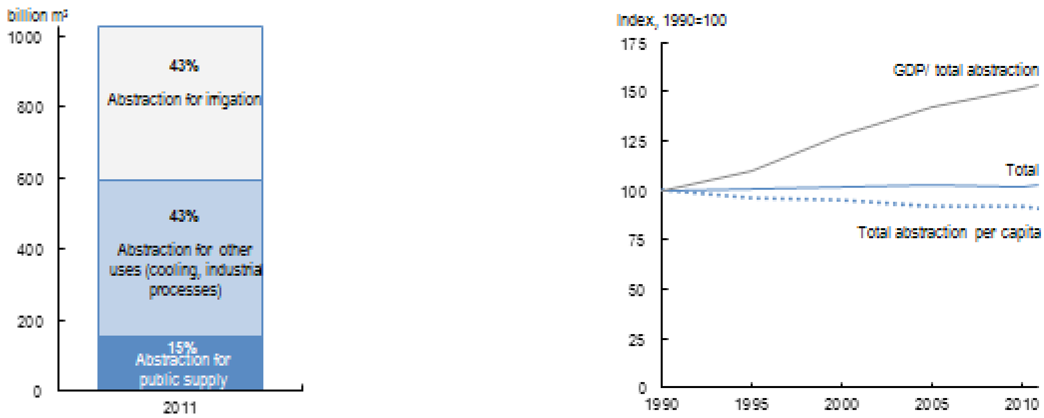

Figure 1 Freshwater abstraction by major use and graph showing total abstraction, abstraction per capita and amount of GDP relative to total abstraction (OECD, 2014b)

NOTE: According to the OECD (2014b) trends in water abstractions since the 1990s have been generally stable. In some countries this is due to increased use of alternative water sources, including water reuse and desalination. Also, trends since 2000 indicate a relative decoupling between water use and GDP growth in many OECD countries.

Ensuring water security will require a balanced mix of water supply and water demand management strategies. Without more efficient, innovative and wiser policies and regulations, it is expected that the relative importance of water uses will shift by 2050, increasing competition irrigation and other uses (OECD, 2012).

Water quality issues are complex and dynamic in nature and require urgent attention and action. Addressing these issues requires exhaustive, up-to-date information on the quantity and quality of water resources and their current regulatory frameworks to inform the global and local dialogues on water security.

More efficient management requires regulations and policies that better reflect the water cycle. Assessment of available water resources entails improved understanding of return flows and downstream water quality that is fit for purpose, while taking into account the requirements for ecosystem services.

There is extensive literature on water quality with regard to issues such as water scarcity and the amount of water required for ecosystems 'compounded by the impact of climate change on available resources' (WWAP, 2012). While existing literature and regulatory frameworks have long addressed sectoral water quality requirements, instruments that consider the interactions and interdependencies between water uses and ecosystems are still insufficient.

Understanding that different water uses require different qualities provides an opportunity to increase efficiency. Drafting of regulatory frameworks to better manage water qualities that are 'fit for purpose' can, therefore, benefit from the wide range of standards and guidelines currently available.

The Compendium is a UN-Water initiative developed in collaboration with the International Water Association (IWA) and the United Nations Environment Programme (UNEP). It aims to fulfil the objectives of UN-Water's Thematic Priority Area on Water Quality, by supporting governments and other stakeholders to address water quality challenges that contributes to water quality targets defined through successive World Water Forums and several key objectives in the Rio+20 Communiqué. The compendium will provide relevant information for the preparation of a framework that guides the use of water quality that is fit for purpose.

Scope and Objectives

The Compendium is an overview and analysis of a variety of selected water quality guidelines, standards and regulatory frameworks for different uses and geographical regions. Its aim is to provide an overview of instruments and policies regulating water quality to enable the preparation of frameworks for water qualities that are 'fit for purpose'.

To achieve such an aim, the development of this Compendium undertakes the first steps to identify laws and policies regulating water quality, case studies and examples at multiple geographical scales and from multi-disciplinary perspectives on all major water uses (e.g. agriculture, ecosystems, energy, domestic and industry).

The Compendium also provides an integrated and descriptive analysis of each selected law and policy, while considering complementary instruments, management approaches and lessons learned on implementation.

The development of this Compendium responds to the following objectives:

- To facilitate access to information on state-of-the-art water quality requirements for different uses and multiple geographical scales, with input from relevant practitioners;
- To contribute towards improving access to information on water quality requirements for different uses, with the purpose of promoting efficient water use and ultimately, reducing water use conflicts;
- To identify the elements and different regulatory approaches for efficient water quality management;
- To raise awareness among governments and stakeholders to incorporate water quality dimensions into water resource planning and management;
- To enable an informed science and policy dialogue on water security among stakeholders, considering the use of different water qualities to address increasing challenges caused by water quality deterioration;
- To be a source of information for the development of the international water quality guidelines for ecosystems.

What is the Compendium?

The output is a reference tool of laws and policies regulating water quality for different uses at a variety of geographical scales. The Compendium is a living document that will be continuously updated as information about instruments and their implementation is added by users.

This initial report provides the basis to assess policy and regulatory instruments, identifying the main characteristics of efficient instruments, also facilitating the continuing development of the Compendium tool.

Who will use the Compendium?

The immediate target group of the Compendium are public officials and regulators: decision makers at large. The development process of the Compendium has also established a network of water quality experts and practitioners promoting the wise use of water of different qualities for different purposes.

The Compendium can also be used by a wider audience of water quality experts, practitioners, academia and the general public, with the purpose of promoting efficient water use and, ultimately, reducing water use conflicts.

Overview of Methodology

A detailed description of the methodology used to develop the Compendium is available in Annex I. The collection and analysis of laws and policies regulating water quality was undertaken with water quality experts from developing and developed countries, policy makers and practitioners. This was followed by a verification process with country and regulatory bodies' representatives to ensure accuracy in primary sources and the relevance of the criteria for assessment.

Annex I explains in detail the involvement of water quality experts through a task force and two working groups.

The IWA Task Force on Water Quality initiated through the IWA member network provided initial technical advice and suggestions on water quality guidelines, the criteria used to analyse the selected water quality guidelines and the methodological approaches in terms of process and content.

Two working groups were created to support the Compendium by inviting high level experts and decision makers in the field of water quality from different sectors and from developed and developing countries.

Working Group 1 (Development) provided technical input into the Compendium, including advice on the final criteria to gather and analyse standards and guidelines; suggestions for the selection of innovative guidelines and standards to be included in the Compendium; as well as guidance to the content of the necessary reports and assessments to be included in the Compendium.

Working Group 2 (Review) reviewed the documents produced in collaboration with Working Group 1 and provided technical input and feedback on the application of the Compendium at national and regional levels, so that relevant officials have improved access to information on water quality requirements for different water uses, which will promote efficient water use.

Annex II provides further details of the input forms to collect information from the task force and working groups.

The laws and policies in this document are duly referenced and online sources – such as institutional websites – are included whenever possible. Secondary sources and opinion analysis are also referenced to allow the inclusion of different points of view.

Selection of instruments

An initial selection process produced a list of more than 80 suggested law and policy instruments. A condensed list of 46 instruments for deeper analysis was then extracted from this long list. The condensed list took into account the inputs and suggestions provided by working group members and the following criteria:

1. Type or nature of the document - Documents that were not of legal or policy nature, or did not provide a clear set of recommendations or guidance were removed; for example: environmental status

reports and enforcement decrees. These latter documents were still included in the overall Compendium as complementary instruments wherever appropriate.

2. Region - In addition to global instruments, documents were shortlisted aiming for an equal representation of all regions, namely West Asia, Africa, Europe, North America, Asia and the Pacific, and Latin America and the Caribbean.
3. Document accessibility - The availability of official supporting information or reliable translation was essential.
4. Regulated water use - The selection aimed to address a variety of economic sectors and water uses including industrial, domestic, agricultural, mining, recreational, environmental and power generation.
5. Current status of implementation - The selection of instruments focused on those implemented for many years and those currently in force. This criterion aimed to collect lessons learned to determine what instruments are effective, practical and better promote the wise use of water resources.
6. Working group expertise - An additional criterion took into account the expertise of working group members, including the availability of case studies and implementation experiences associated with particular instruments.

For each regulatory instrument (guidelines and standards, laws and policies), information was compiled following the Compendium chapter structure and the guiding questions of the criteria for analysis *(see Table 1)*. Where available, complementary materials, related regulatory instruments and case studies were also included *(see Part II: Case studies).*
The information about each instrument has been consolidated into a database organised into the 'chapter' structure. Additionally, a narrative has been developed to accompany each chapter in the database and facilitate its navigation. The narrative chapters are drafted to explain the methodology and scope of each chapter, highlighting key findings and referencing case studies where possible to illustrate the topics covered.
The draft database chapters and accompanying narrative were shared with the working groups for inputs and review. The members provided technical input and feedback over successive drafts, adding sources and case studies where possible.

The Compendium will continue to be improved and developed while simultaneously being disseminated to promote water use efficiency and contribute to global water security. A summary of the contributions from working group members and the comments and additions that resulted from the verification process is available in Annex II of this document.

Users' Guide

What can be found in this document?

The main part of this Compendium (Part I: Water Quality Regulatory Instruments) comprises a database of compiled instruments and its accompanying narrative. Both database and narrative are divided into four descriptive chapters to reflect the analysis of the instruments, namely scope, management frameworks, parameters and thresholds, and implementation.

Each narrative chapter opens with an overview of the methodology and a summary of key findings, illustrated with summary examples and case studies. These chapters conclude with a set of lessons learned or recommendations extracted from current information in the database. Detailed information on the key findings and examples can be found in the database and case studies available in Part II.

Part II of the Compendium has a selection of case studies to illustrate information throughout the chapters. Currently, examples include experiences from Australia, Belgium, Brazil, Canada, China, Russia, South Africa and the

United States. These case studies highlight efficient policies or regulations (past or present) with a regional representation.

A Glossary of Terms is included at the end of the Compendium providing definitions of key terms. This section unifies the terminology from different sources used in the Compendium and contributes to further harmonisation in the broader dialogue on water security.

The annexes provide a set of templates for collection of feedback and inputs to be included in the Compendium. This is provided to enable the continuous development of this tool and its permanent update.

How to use this document?

The user can choose to explore the Compendium following the order established in the narrative. The different sections of the text will guide the reader from descriptive and generic topics in Chapter 1 towards more analytical aspects and experiences in Chapter 4.

The chapters are designed as stand-alone documents to facilitate the reader to access the type of information that is most relevant for a given case. The reader can access a particular section in the narrative directly by clicking the respective heading in the table of contents.

Case studies can be accessed directly, in alphabetical order, by reading Part II. Additionally, the reader can access a particular case study by clicking the link 'read full case'. Access to the database is given through hyperlinks within each chapter. To display the database, the user can download the complete list of instruments and the tables for each chapter by clicking the box under the main heading. The respective section of the database will then appear as a Microsoft Excel file, where each row corresponds to an individual instrument.

Additionally, the database can be accessed separately, using Microsoft Access. This version of the database allows the reader to search for specific information and focus on one instrument at a time.

The column heading 'ShortName' is repeated in each chapter of the database to indicate that the information belongs to the same regulation or policy instrument. Each section or chapter will contain information in text format but also hyperlinks to attached materials (Microsoft PowerPoint presentations, Adobe Acrobat PDF files, Microsoft Word files, etc.) and websites accessible by clicking the respective cell.

Summary of Key Findings

1. Local and specialised instruments provide sound guidance for using different water qualities for different uses. There still needs to be coherence between sectors and geographical levels. Reference to global guidelines in local regulatory implementation provides a consistent framework.
2. Effective regulations require that the implementing authority acts with independence and sufficient powers to enforce regulations whether the authorities are centralised or delegated to the regional or local level. However, compliance is better achieved when users trust the implementation and enforcement processes. This can be promoted with transparency and access to information. The IWA Lisbon Charter can be used as a point of reference for institutional and regulatory framework development. It provides a set of guiding principles for sound public policies and regulation for water services including water quality (IWA, 2015).
3. At a local or catchment level, guidelines and standards are only good as the capacity of those implementing and controlling them. Investing in adequate training makes the difference between a good regulatory text and actually controlling water quality. Developing practical and user friendly tools for implementation can facilitate the task.
4. The enabling environment of the different water quality regulations is important. When deciding on an approach to regulate water quality for different uses, decision makers need to take part in cross sector/cross boundary dialogues. A clear definition of roles and competencies is pivotal to involve all relevant stakeholders in such dialogue.
5. Economic affordability and feasibility can be compatible with better water quality standards. Nonetheless, to support enforcement, financing and investments in implementation of water quality instruments are needed during the drafting process.
6. Rapidly evolving technology and infrastructure for improving water quality requires flexible and responsive regulators (e.g. when validating new water treatment technologies). An overarching framework for validating new innovations can support the replication of good practices and capacity building. The role of regulators is crucial to provide timely and effective responses, and thus institutional and management settings need to be coherent with such a framework.
7. Drafting and implementation processes can benefit from lessons learned in similar geographies. Reference to other jurisdictions by decision makers can identify opportunities for replicating best practices or possibilities for inter-institutional cooperation or institutional strengthening. The Compendium provides a starting point for this type of collaboration.

Part I: Water Quality Regulatory Instruments

Part I of the Compendium provides an overview of selected laws and policies regulating water quality for different uses across geographical scales. Terminology used to describe the instruments is clarified. This is followed by a summary of the instruments listed in the Compendium and their main characteristics. The narrative of each chapter is presented along with access to the database. Following the chapters, the 'Criteria for assessment' are outlined. These criteria provide a checklist of what makes a particular law or policy a good instrument to regulate water quality.

Terminology

Water quality guidelines and standards can adopt a wide variety of instruments; from non-binding policy documents to treaties and regulations. Additionally, different countries, languages and legal systems use different terminology.

The Compendium uses the generic term 'instruments' to enable the user to easily compare the wide range of regulatory tools such as guidelines, laws and regulations. For the purpose of the Compendium, the term 'instrument' means the laws and policies regulating water quality. They constitute the 'enabling environment' or the framework of policies, legislation and regulations covering the effects of pollutants or the requirements with regard to a particular water use.

A Glossary of Terms is provided to clarify the meaning of a certain approach or analysis, especially where there is contradictory information or different approaches.

Regardless of their binding power (such as laws or regulations), these instruments can be categorised as follows (Helmer & Hespanhol, 1997):

- Water quality criterion: numerical concentration or narrative statement recommended to support and maintain a designated water use; providing basic scientific information about the effects of water pollutants on a specific water use.
- Water quality objective (synonyms: water quality goal or target): a numerical concentration or narrative statement that has been established to support and to protect the designated uses of water at a specific site, river basin or part(s) thereof, taking into consideration water quality criterion and a critical assessment of national priorities. A water quality objective is therefore a management decision and not a scientific statement.
- Water quality standard: an objective that is recognised in enforceable environmental control laws or policies. The term is used in this Compendium to designate a general water quality rule that can be binding for users (when established by law or regulation) or non-binding (as when established by policy such as guidelines) in which case they are aspirational.

Overview of water quality regulatory instruments

The Compendium contains a selection of recent water quality guidelines and standards for different uses. These are both binding and non-binding with common characteristics and approaches that make them innovative, practical and effective to promote wise use of water resources.

The selected instruments are from a variety of sectors including drinking water, agriculture, bathing water, ecosystems and hydropower. Examples from each region provide an overview of current water quality instruments applicable at different geographical scales.

To date, the Compendium comprises 46 law and policy instruments which have been analysed in more depth covering a comprehensive range of water uses.

These are presented in *Figure 2* according to geographical scale.

List of guidelines and standards

Annex III contains the list of instruments analysed in the Compendium narrative chapters and provides core information including name of the regulation, year, country, region, main outcome they are working towards and the available online source.

The Compendium database includes guidelines and standards that are not yet incorporated in the chapters. They will be incorporated in future editions as sufficient analysis and information is gathered to provide sound references to the Compendium user.

Direct download:

List of Selected (analysed) Guidelines

List of Guidelines for future analysis

Complete Database

[Excel] | [Access]

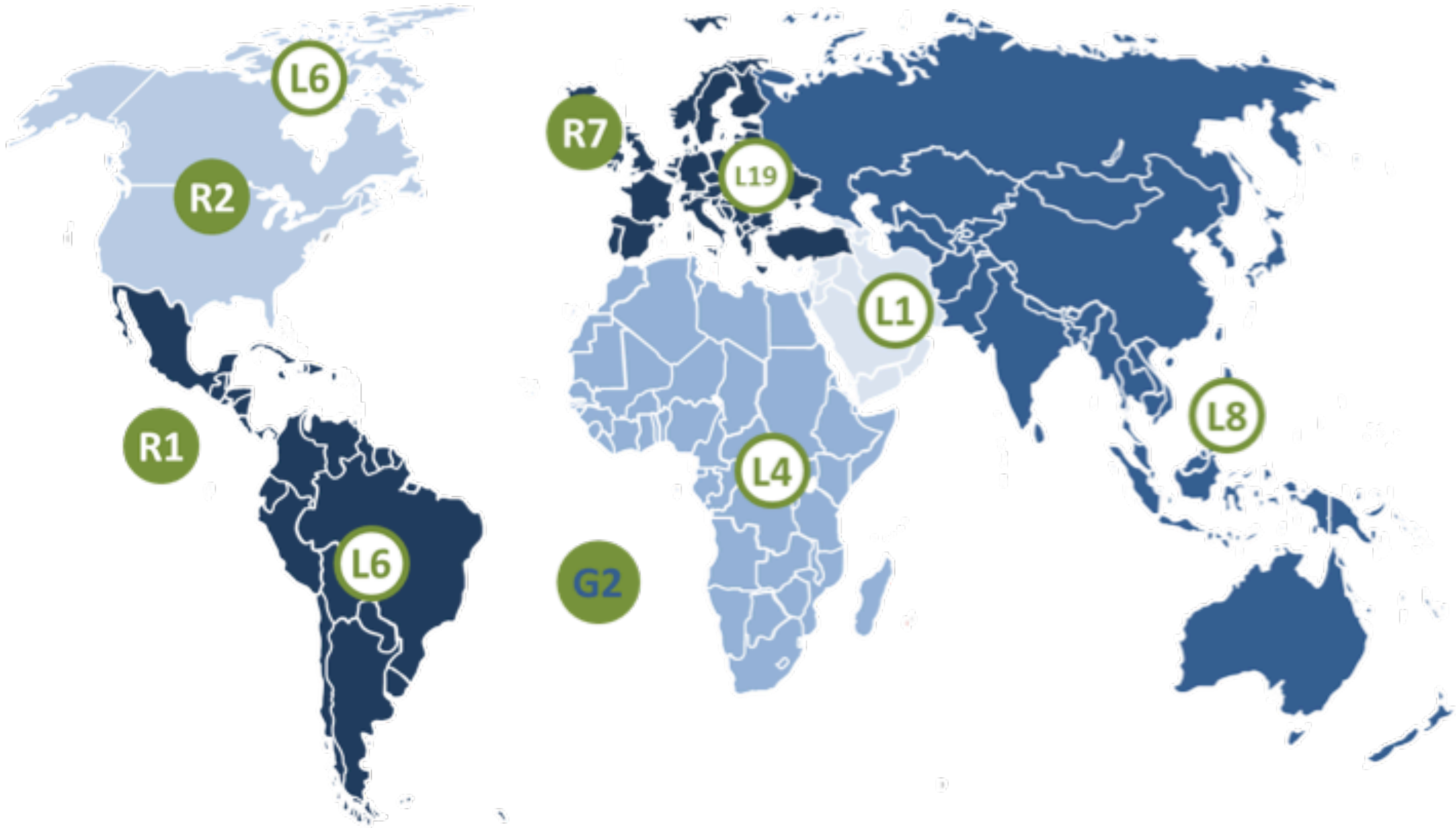

Figure 2 Regulatory instruments and case studies included in the Compendium according to geographical scale (G: Global; R: Regional; L: Local)

Overview of Compendium Chapters

The Compendium divides the analysis of water quality regulatory instruments into four descriptive chapters with their respective methodologies and key findings. Each chapter has criteria for analysis described in Table 1 (see below), and concludes with a set of conclusions or lessons learned extracted from the instruments currently available in the

Table 1 Criteria for analysis or guiding questions

CHAPTER	CRITERIA FOR ANALYSIS
Chapter 1: Scope	• What is the scope of the instrument? • What is the background of the law or policy instrument? How were they developed; what is their history? • Towards what outcome are the water quality instruments working? • For what type of water use is the instrument developed? • What is the geographical scope of reference: global, regional, catchment, local or national? • What are the pre-conditions of application? What is needed for it to be implemented? • What type of legislation is usually in place? What capacity is required for implementation?
Chapter 2: Management framework used to apply the instruments	• Who is applying the instruments? What is the involvement of public or private entities relevant to management and application of the instruments? • What is the involvement of public or private entities relevant to related policies for the application of the instruments? • Which public or private entities are subject to the instruments? • What methods or approaches are used to apply the instruments? • Do the instruments refer to aquatic freshwater ecosystems? What are the specifics? • What other guidelines need to be considered? • Why do other guidelines need to be considered?
Chapter 3: Parameters, Indicators and Thresholds	• What parameters do the guidelines cover? • To what type of source are the guidelines applicable?
Chapter 4: Implementation	• What are the gaps in the application of the instruments regulating water quality (i.e. insufficient provisions, scope or lack of regulation)? • What measures are taken to enforce these instruments? • What are some emerging issues (e.g. suggestions of changes, harmonisation)? • What are some of the challenges (e.g. inadequate rules) and opportunities regarding their implementation?

Chapter 1: Scope of the Law and Policy Instruments

Download Chapter 1 from the Database

This chapter provides a description of the scope of the laws and policy instruments regulating water quality that have been included in the Compendium. Each instrument has been classified according to geographical scope and outcomes, namely Public Health, Aquatic Health and Resource Efficiency (see *below*).

The selection of instruments covered global, regional and local or national areas. Publicly available information about guidelines regulating water quality in catchment areas proved to be scarce. Instead, catchment provisions within national and regional instruments were more common, usually referred as a method for implementation.

For example, the South African Resource Quality Objectives (RQOs) regulations make provision for catchment-level implementation (see *Box 1 below*). The RQOs are designed to apply to Resource Units, which are portions of catchments with similar ecosystem conditions or settings (Department of Water and Forestry, 2006).

The European Water Framework Directive (WFD) is an international instrument that has river basins as the main unit for managing water quality. The countries implementing the WFD define river basin districts (RBDs) as one or more neighbouring river basins together with their associated aquifers and coastal waters (Article 3.1 WFD). The Directive is then implemented through measures according to characterisation of these RDBs and the results of an assessment of their status *(see Chapter 3 for details)*.

The selected guidelines were divided into two categories: single, for those that regulate one single category of water use; and multiple, for those that regulate two or more categories of water uses. Both categories have instruments that regulate or provide guidance for a variety of uses, which are specified within the following main outcomes or categories of public health, aquatic health and resource efficiency.

Box 1 The South African Water Quality Guidelines (SAWQG) of 1996

The SAWQG are a full suite aimed to address the three categories mentioned above:

Public Health

- SAWQG: Domestic Water Use
- SAWQG: Recreational Water Use

Resource Efficiency

- SAWQG: Industrial Water Use
- SAWQG: Agricultural Water Use: Irrigation
- SAWQG: Agricultural Water Use: Livestock Watering
- SAWQG: Agricultural Water Use: Aquaculture

Aquatic Health

- SAWQG: Aquatic Ecosystems

The guidelines are currently being amended to adopt a risk-based methodology, which will take into account the risk to receptors or users (for example humans, crop yield). The amendment will also differentiate the guideline values in terms of spatial scale depending on the application.

Conservative use, which can be adopted as a national range, will form part of tier 1 while the specific use at a localised level will form part of tier 2. Tier 2 will take into account the most vulnerable user, who should not be put at risk by the quality of the water.

The main outcome of many of the selected instruments is to benefit public health. At the same time, instruments that improve or protect the environment often have indirect health and resource benefits. However, the classification applied in this Compendium responds to the immediate objective of each instrument, namely public health, aquatic health and resource efficiency as follows.

Public Health: Most of the selected water quality instruments within the Compendium ultimately aim to protect public health or have a public health component. However, indirect health benefits are often a result of regulating water quality for the environment. In addition, water quality guidelines for resource efficiency are designed to protect water quality for different uses (including consumption).

For example, agricultural water use is indirectly linked to human health owing to possible bioaccumulation of chemicals in humans, as consumers of agricultural products. Nonetheless, in the Compendium only law and policy instruments that directly address the protection of human health are classified under the category of 'Public Health'. Within this outcome, the Compendium includes 28 instruments and the following uses:

- Domestic uses, comprising drinking water (tap and bottled) and sanitation (comprising toilet flushing and floor cleaning);
- Recreational, comprising waterfalls and fountains, swimming, bathing, surfing and similar.

Aquatic Health: This category contains all laws and policy instruments that contribute towards improving the health of ecosystems and the services they provide. This is the least populated category, with a total of 13 instruments out of which only three were exclusively dedicated to aquatic health.

Most water quality provisions relating to aquatic health are actually part of industrial and food production or recreational water quality instruments. The aquatic health category comprises the following uses:

- Ecosystem health, including environmental uses, such as wetlands and aquifer recharge;
- Aquatic habitats, including wildlife, fisheries and shellfish.

Resource Efficiency: Although resource efficiency requirements generally comprise water quality requirements for different industries, this category of the Compendium comprises law and policy instruments that contribute towards improving the delivery of services or products such as food, energy and other resources.

This category has 24 instruments of which most (16) account for multiple uses, including those in which water is used for production that can impact public health (e.g. food). The instruments included as part of the resource efficiency outcome include the following uses:

- Industrial, comprising air dispersion (air conditioning, air cooling or industrial cooling), impoundments (for mining activities as in ponds and artificial rivers), and food and beverage production;
- Irrigation, which includes agriculture (livestock watering as well as irrigation), and landscape irrigation (including gardens and sprinkling);
- Aquaculture and fishing;
- Firefighting;
- Urban cleaning (including, but not limited to, all types of roadway cleaning practices and techniques); and
- Navigation.

Box 2 World Health Organization/ United Nations Environment Programme (WHO/UNEP) Guidelines for the Safe Use of Wastewater, Excreta and Grey water in Agriculture and Aquaculture 2006

The 2006 WHO/UNEP Guidelines for the Safe Use of Wastewater, Excreta and Grey water in Agriculture and Aquaculture are a major update of their predecessor, the WHO 1989 guidelines. The old guidelines were more focused on water quality guideline values for reused water to be safe; the 2006 guidelines are more flexible.

However, the 2006 guidelines are also more complex than their predecessors. These guidelines are based on health-based targets and not only water quality targets. Health-based targets can be achieved through treatment and non-treatment options along the food chain. Health-based targets establish a defined level of health protection for a given exposure, which can be based on a measure of disease or the absence of a specific disease related to that exposure. According to WHO, 'after the health target is defined, a combination of health protection measures that could achieve the target is specified' (WHO, 2006).

The complexity of the guidelines, however, may create difficulties when being transposed into national or local legislation. Although the guidelines are innovative and flexible, they may be less practical. Actual implementation of these guidelines is very limited. For broader implementation, operational approaches such as through Sanitation Safety Plans are currently being developed by WHO and IWA.

The scope and content of the guidelines is usually inspired by other regulatory instruments. Many laws and regulations regulating water quality at a national and regional level are derived from older regulations and general policy instruments.

For example, WHO guidelines are usually referred to as a baseline for local instruments, such as in the Australian National Health and Medical Research Council (NHMRC) Drinking Water Guidelines 2011, which refers to the 2011 WHO Guidelines for Drinking-water Quality (4th edition). Another example is the Brazilian National Environmental Council (CONAMA) Resolutions of which the defined limits are based on regulations from different countries. In addition, the French regulation on irrigation with reclaimed water refers to the 2006 WHO/UNEP Guidelines for the Safe Use of Wastewater, Excreta and Grey water in Agriculture and Aquaculture (WHO, 2006) *(see Box 2 above).*

Key findings and recommendations

1. For global and general policy instruments to be accepted, they need to be incorporated into regional and local water quality instruments. Working with national and local governments to test new global guidelines provides evidence of their applicability.
2. When incorporating global or general provisions into local water quality instruments, it is important to consider the local context and requirements.
3. An indicator of the effectiveness of a global guideline can be determined by whether it is being translated into local regulations.

Chapter 2: Management Frameworks

Download Chapter 2 from the Database

This chapter showcases the different management frameworks and institutional settings that guide the implementation of the instruments included in the Compendium.

Most instruments are issued and controlled by centralised administrations and ministries, whereas only a few depend on implementation through specialised agencies or local administration.

Examples of regulatory bodies that issue and implement the guidelines are the South African Department of Water and Sanitation (formerly the Department of Water Affairs and Forestry) and the Jordanian Water Regulatory Commission (to be established). In the case of Jordan, the Commission will be established as part of the process of institutional reform that brought in a new water law, policy and planning strategies.

Box 3 Canada's Drinking Water Quality Guidelines

An example of guidelines issued by one authority but implemented by another can be found in Canada's Drinking Water Guidelines. These guidelines contain a detailed analysis of contaminants, valuable for water regulators, and make up an important component of the multi-barrier approach to safe drinking water used by the federal and provincial governments.

The guidelines are developed by the Canadian government (through Health Canada) in collaboration with representatives from provincial and territorial departments responsible for drinking water quality gathered in the Federal-Provincial-Territorial Committee on Drinking Water.

Canada has maintained a decentralised approach to drinking water quality. The guidelines are then published by Health Canada and implemented by each province or territory. Finally, municipalities participate in the implementation by overseeing operations of the treatment facilities. The Canadian government thus plays a scientific and research role to determine the content of the guidelines whereas the local authorities are in charge of using the guidelines as a reference in implementation and control.

The competent administration in each province or territory can use the guidelines as the basis for their local water quality requirements: for example, incorporating them into their local legislation, referring them in new ones or including them as requirements for licenses and permits.

This method for implementation can be an opportunity and a challenge for local authorities (*see comments for these guidelines in the database*). Provincial, territorial governments and municipalities have flexibility to adapt water quality requirements to their needs within the consistency of a national framework. They also have the sole responsibility for risk management and training.

A possible disadvantage is that different jurisdictions with different standards may not take advantage of economies of scale when developing new technologies and duplication of efforts, which limits the overall effectiveness of measures taken to protect water resources. Secondly, devolved administrations need to be technically and financial prepared to apply and control approved standards. This also requires transferring sufficient skills to the operators in charge.

Complementary tools, such as water safety plans provide a comprehensive risk assessment and risk management approach to address the need for training and communication protocols needed. Canada has developed a national approach similar to Water Safety Plans to be used by the provinces and territories when drafting their strategies (Health Canada, 2013).

Methods and approaches used for implementation

Implementation of water quality instruments can be fairly complex. International instruments global and regional are implemented in different ways depending on their nature. Binding instruments, such as international agreements and regional legislation (like the European Union (EU) Directives), need to be incorporated into the national framework and implemented through adapting mechanisms using national or local regulations. Non-binding instruments are implemented when drafting institutions voluntarily refer to them in local binding instruments (laws or regulations). Currently, the Compendium includes ten regional instruments, of which the European regional framework is perhaps the most illustrative of the complexity around implementation *(see Box 4 below).*

Implementation is often complemented by sectoral regulations and management tools. For example, municipal standards and local policies, issuing licences and permits are different methods for implementation. These can be established by different regulatory instruments and even overseen by different authorities. In the international regional context, for example, the WFD establishes River Basin Management Plans (RBMPs) and Programme of Measures (PoMs) developed and applied by the local authorities in each implementing state *(see Box 4 below).*

In the United States, the Safe Drinking Water Act provides national authority for the US Environmental Protection Agency (US EPA) to develop Maximum Contaminant Levels for drinking water. States or local entities can then develop their own standards as long as they are the same or more protective than the federal standards. The same is true for ambient waters, where under the Clean Water Act, the US EPA sets water quality standards that can then be adopted or made more protective than the federal standards.

Institutional issues may arise between different levels of government, such as the US and Canadian cases mentioned above, where the federal and state governments may have different approaches to implementation and enforcement of these standards. For example, in the case of Canada's Drinking Water Quality Guidelines, there are challenges and opportunities at the provincial and municipal levels. Implementing authorities can benefit from the flexibility to adapt water quality requirements to their local needs but they also need to maintain consistency within the national framework, risk management and training *(see Box 3 and Canada's Water Quality Guidelines in Part II).* As an additional step, both federal and provincial agencies in Canada recommend moving beyond national guidelines, and developing river-specific water quality objectives.

Box 4 The EU framework for water quality

In the EU, the framework for regulating water quality is set by Directives. Directives are regional legislation that 'set out general rules to be transferred into national law by each country as they deem appropriate' (European Commission, 2015a). Therefore, these instruments are binding to all Member States but require a national process to be applied. Member States of the EU have the responsibility for the correct and timely application of the directives.

The EU Water Framework Directive (WFD) establishes an overarching set of rules to protect and restore water across Europe, including the following directives:

- Bathing Water (76/160) (now replaced by 2006/7);
- Drinking Water (80/778, as amended by 98/83);
- Urban Wastewater Treatment (91/271);
- Nitrates (91/676);
- Integrated Pollution Prevention and Control – IPPC (96/61), codified as Directive 2008/1/EC, repealed by Directive 2010/75/EU on Industrial Emissions, since 7 January 2014); and,
- Sewage Sludge (86/278).

Box 4 The EU framework for water quality (continued)

- Article 17 of the WFD establishes strategies for controlling pollution of groundwater, further developed by the Groundwater Directive (2006/118/EC).

In addition to the Nitrates, Urban Wastewater Treatment and IPPC Directives, the groundwater regulatory framework includes directives (European Commission, 2015b):

- Plant Protection Products Directive (91/414/EEC);
- Biocides (98/8/EC);
- Landfill (99/31/EC); and,
- Waste Framework (2006/12/EC).

The EU system establishes objectives to protect water quality, which includes general protection of the aquatic ecology, specific protection of unique and valuable habitats, protection of drinking water resources, and protection of bathing water. In the WFD these objectives are condensed into 'good ecological and chemical status for surface waters and good quantitative and chemical status for groundwater'.

To achieve these objectives, the main implementation tool of the WFD consists of the establishment of RBMPs every six years. This management tool must integrate the measures to implement the various directives in a PoM which sets out the response to identified pressures in the basin to reach the water quality objectives (European Commission, 2015c).

*F*or surface water, the system for ecological protection of the WFD is complex given ecological variability across the EU community and the number of parameters considered, which includes the following:

- biological quality, based on three or four biological groups;
- physical/chemical quality, based on eight parameters;
- quality of chemical substances, divided in two groups;
- the river-basin-specific pollutants, a list of substances specific for the catchment;
- chemical quality of the priority hazardous substances.

Environmental quality standards (EQS) applicable to surface water are established by Directive 2008/105/EC, to limit the concentrations of certain chemical substances or groups of substances that pose a significant risk to the environment or to human health (i.e. priority pollutants).

The European Commission and the Member States, together with stakeholder groups, take part in a Common Implementation Strategy (European Commission, 2015d) to enhance uniform implementation. Although the WFD is implemented in all countries of the EU, the standards of a substance or biological quality can differ between countries and exceptions can be made for each water body.

For example, in the Netherlands information on the implementation of the WFD can be accessed through an online compendium (Planbureau voor de Leefomgeving, 2015). For detailed information, please visit the website or the following links by topic:

- Water Framework Directive – General information about decision system WFD;
- Quality surface water – The Ecological and Chemical Quality of the WFD in 2009;
- Chemical quality – The substances which sometimes exceed the standard are listed;
- Biological quality – The biological quality of the WFD with maps of the four biological groups;
- Physical-Chemical – The eight parameters and maps of nitrogen and phosphorus;
- River-basin-specific pollutants – The most important substances are given;
- Fish migration – A map with the possibility of fish migration in streams and rivers;
- Eutrophication in lakes – Information of all lakes is presented
- Eutrophication in streams, ditches and canals;
- Eutrophication of main rivers.

Standards can be found at the government website (van het Koninkrijk der Nederlanden, 2009) and at the National Institute for Public Health and the Environment (RIVM website).

Complementary instruments

Some of the challenges, such as consistency and translating policy and legal instruments to the local level, can be addressed if complemented by certain instruments that aim at improving water management and the capacity of operators.

In the case of the WHO Drinking Water Quality Guidelines (2011), additional guidance is provided through a preventive management framework – Water Safety Plans (WSPs) –, health-based targets and surveillance. Although there are global guidelines for the development of WSPs, each context-specific WSP is developed by the respective water supply plant.

A WSP 'comprises system assessment and design, operational monitoring and management plans (including documentation and communication)', aiming to protect safe drinking water through 'good water supply practice' (WHO, 2005). The approach of using WSPs is a practical solution to improve drinking water quality as the WHO Guidelines can be complex and difficult to fulfil.

Another example of a complementary approach is the Green Drop program in South Africa. South Africa's municipalities face many challenges in providing effective water services to consumers, especially management of wastewater treatment plants. Any wastewater treatment plant that is not operating properly discharges effluent that damages the receiving water resource.

The Green Drop certification programme was designed to serve as stimulus for change through improving management of wastewater services. The aim of the Green Drop programme is to create a paradigm shift of how wastewater operations, management and regulation are approached. It promotes incentive-based regulation by establishing excellence as the benchmark for wastewater services. The criteria focus on the effective management of wastewater services instead of the continuation of end-point monitoring and subsequent reactive operations *(see full case study in Part II)*.

Common challenges: ecosystems

Challenges can also arise from the many interactions and interdependencies of water uses and the environment. Reference to complementary guidelines and other regulatory instruments can help water managers to identify synergies between the approaches for regulating water quality for different uses.

The Compendium has analysed ten instruments that refer directly to freshwater ecosystems, most of them focusing on surface water. For example, the Turkish guideline provides for the creation of catchment plans, outlines procedures for water quality classification and sets standards for the water environment. The Brazilian framework for surface water quality (approved in 2005) establishes a water quality classification based on water uses and environmental standards for freshwater, salt water and brackish water ecosystems, providing important tools for the management of these water resources *(see Box 7)*.

Regulation of groundwater quality specifically for ecosystem health is not common. The examples of groundwater regulation in the Compendium do not include provisions to protect ecosystems that depend on groundwater. For example, the Turkish guideline for water pollution control 1998, amended in 2010; the Kenyan water quality regulation of 2006; and the Jordanian Water Strategy of 2009. The European framework – under the umbrella of the WFD – also protects groundwater as a resource without providing specific protection to groundwater-dependent ecosystems (European Commission, 2015b).

In Brazil, CONAMA Resolution 396 approved in 2008 establishes a classification of groundwater bodies into six subcategories with regard to predominance of use and quality (Patole, 2009). This includes a Special Class, which is an aquifer (or part of an aquifer) needed for the preservation of ecosystems in protected areas, as well as groundwater bodies contributing directly to surface water that is also in a protected area. In addition, the resolution identifies areas of groundwater recharge and important surface zones needed for maintaining groundwater quality, as well as the necessary procedures such as zoning to manage these areas (Patole, 2009)

The South African Domestic Use Guidelines 1996 is an example that refers to both surface and groundwater to be used for potable supplies, focussing on fitness for use instead of the type of water source.[2] The South African water quality guidelines for ecosystems are comprehensive but do not specifically provide for groundwater-associated ecosystems.

There are initiatives on groundwater that aim to identify and promote best practices in groundwater governance as a way of achieving sustainable management of groundwater resources *(see Box 5 next).* This includes consideration of groundwater for a variety.

Box 5 Groundwater governance: a global framework for action

"Groundwater governance: A global framework for action (2011–2014) - Regional diagnosis for the Sub-Saharan Africa Region" is the first phase of a project to address insufficient regulatory mechanisms for groundwater and associated ecosystems for the Sub-Saharan Africa region.

The project is supported by the Global Environment Facility (GEF) and implemented by the Food and Agriculture Organization of the United Nations (FAO), jointly with UNESCO's International Hydrological Programme (UNESCO-IHP), the International Association of Hydrologists (IAH) and the World Bank. The project is designed to raise awareness of the importance of groundwater resources for many regions of the world, and to identify and promote best practices in groundwater governance as a way of achieving the sustainable management of groundwater resources. As a final result, the project will develop a global "Framework of Action", consisting of a set of effective governance tools that include guidelines for policies, legislation, regulations and customary practices. The first phase of the project consists of a review of the global situation of groundwater governance and aims to develop a Global Groundwater Diagnostic that integrates regional and country experiences with prospects for the future (Braune & Adams, 2014).

2 Note that the South African Domestic Use Guidelines 1996 regulate water to be taken into water treatment works to be made potable, not for treated tap water. Tap water in South Africa has to comply with SANS241 (South African National Standard)

Key findings and recommendations

1. Whether instruments are enforced and controlled by a centralised administration and ministerial bodies or specialised agencies, the enforcing authority needs to have sufficient powers and capacity to implement the regulations with independence.
2. Investment in the human resource capacity of regulatory authorities is needed for effective control of water quality.
3. There needs to be an institutional and legal framework that ensures independence of the agency overseeing water quality controls.
4. Development of complementary approaches for implementation of water quality instruments can provide a practical solution when regulations are complex or difficult to fulfil. For example, Water Safety Plans provide a risk management framework, which can be tailored to a local water supplier to improve drinking water quality.

Chapter 3: Parameters, Indicators and Thresholds adopted for Different Uses

Download Chapter 3 from the Database

This chapter describes the different types of criteria (i.e. parameters, indicators and thresholds) used by the instruments in the Compendium. It also describes the types of water and water sources that are being regulated. A definition of these terms is outlined in the *Glossary of Terms*. Additional reference to complementary instruments and norms is made when they are needed for effective implementation of the instruments.

According to the type of criteria adopted by each guideline or regulation, instruments may be divided into two major groups:

- Instruments with prescribed standards (e.g. EPA reuse guidelines) including numerical standards (e.g. maximum concentration of pollutants), treatment standards (specified treatment processes) or standards for materials used for water treatment and distribution.
- Instruments based on risk assessment and risk management (e.g. WHO 2006 reuse guidelines and the WHO Drinking Water Guidelines 2011). This is a holistic approach that addresses the risk to water quality from source to user.

Which parameters are the most useful?

Water quality objectives are management decisions. Thus, not only do they rely on scientific statements but also on policy decisions that consider factors such as enforcement capacity and costs. Parameters that provide the highest protection are those with scientific evidence that are directly related to public health, including faecal coliforms, *Escherichia coli (E. coli)*, helminth eggs and organic matter. For environmental protection, strong parameters are those that measure nutrients and refer to ecotoxicology standards.

The Compendium provides a description of the number of parameters contained in each selected instrument. These include chemical (nutrients, inorganic and organic compounds, including metals, pesticides and emergent compounds), physical (temperature, pH, dissolved oxygen, oxygen saturation, total dissolved materials, suspending solid material, colour, etc.), biological (cyanobacterial, chlorophyll-a), ecotoxicological (chronic and acute toxicity) and microbiological (faecal coliforms or thermotolerant coliforms, *E. coli*, enterococci, protozoa, helminths, enterovirus) parameters.

An increasing number of instruments also reference radiological parameters. These parameters indicate the guidance levels for radionuclides present in a water sample. The instruments generally refer to Indicative Dose Criteria (IDC is the WHO term also known as TID or Total Indicative Dose in the case of the EU Drinking Water Directive) instead of indicating levels for specific radionuclides.

In the case of microbiological parameters, water quality instruments traditionally use bacteria as indicator organisms that demonstrate presence of faecal contamination (human and animal). The criteria are designed to protect people from illness due to accidental ingestion or any direct contact (primary contact in recreational uses) with the polluted water environment. However, it has been stated that there is no direct correlation between numbers of these indicators and enteric pathogens (Ashbolt, et al., 2001). Additionally, waterborne illness can also originate in viruses and parasitic protozoa. Thus, regulatory agencies use these indicators for the potential they represent to demonstrate faecal contamination and consequently that of ‘pathogens capable of causing human illnesses’ (US EPA, 2004). In this context, it is necessary to tailor the choice and number of indicators to local circumstances to provide adequate protection.

Key faecal indicator micro-organisms include coliforms, thermotolerant coliforms, *E. coli*, faecal streptococci, enterococci, sulphite-reducing clostridia, *Clostridium perfringens*, bifidobacteria, bacteriophages (phages), coliphages and Bacteroides fragilis bacteriophages (Ashbolt, et al., 2001). *E. coli* and enterococci levels are usually chosen for drinking and recreational waters.

The Compendium makes special reference to enterococci as a key faecal indicator. *E. coli* is usually the indicator with more traditional applicability and is included in water quality regulations for marine and fresh waters with thresholds set as *E.col*i per 100 ml volume. However, recent regulations demonstrate that measuring enterococci levels is preferred over E. coli and faecal coliforms, as it is a 'more stable indicator' and thus 'more conservative' under brackish water conditions (Jin et al., 2004). For example, the US EPA has recommended the use of enterococci for marine recreational waters because levels of these organisms more accurately predict acute gastrointestinal illness than levels of faecal coliforms (US EPA, 2012).

Comparison of standards and limits

An interesting exercise is the comparison of indicator limits and standards applied by different instruments for similar uses. For example, the current version of the Compendium includes a comparison of two guidelines regulating water quality for freshwater ecosystems (South Africa and Turkey). The comparison shows the specific parameters measured in different types of water sources (e.g. inland protected areas, coastal areas and sea water, and all freshwater aquatic sources). The exercise provides details of a broader policy decision that considers factors such as level of protection and economic affordability or technical capacity (*see further discussion in Chapter 4*). *Download the comparison example here.*

Common challenges and opportunities

A common challenge when regulating water quality parameters is that guidelines are often based on the ability to analyse for a constituent and reflect the level of detection of a substance rather than a critical concentration in the environment. Some common challenges and their respective opportunities with the use of particular parameters are described below.

Box 6 The German Drinking Water Ordinance (2001)

The German Drinking Water Ordinance (2001) established Acceptable Daily Intake (ADI), Tolerable Daily Intake (TDI) or Reference Dose (RfD) values as the bases for evaluation. If these values are not available, information on biological endpoints such as genotoxicity or neurotoxicity is taken into account. Depending on the amount of toxicological information available for specific substances, Germany has developed a Health-Related Indicator Value (HRIV), which assumes drinking water consumption is 2 litres per day per person for 70 years. Consuming drinking water under these conditions will not lead to health-related concerns, because the precautionary principle is the basis of the evaluation. A new HRIV will always be higher than the previous one because a worst-case scenario is assumed. This also avoids the obligation to set more restrictive cut-off values when additional information becomes available. *Figure 3* explains how HRIV are determined per substance.

However, there may also be simplifications. In the German Drinking Water Ordinance, all plant protection products (such as pesticides, insecticides, herbicides) are treated equally, e.g. they all fall into the same cut-off value (0.1 µg/l). The guideline does not take into account how toxic plant protection products really are. This makes the guideline easy to use, but can cause problems once the limit is exceeded. Identifying how toxic a substance really is and determining a cut-off value based on toxicological considerations might not be easy.

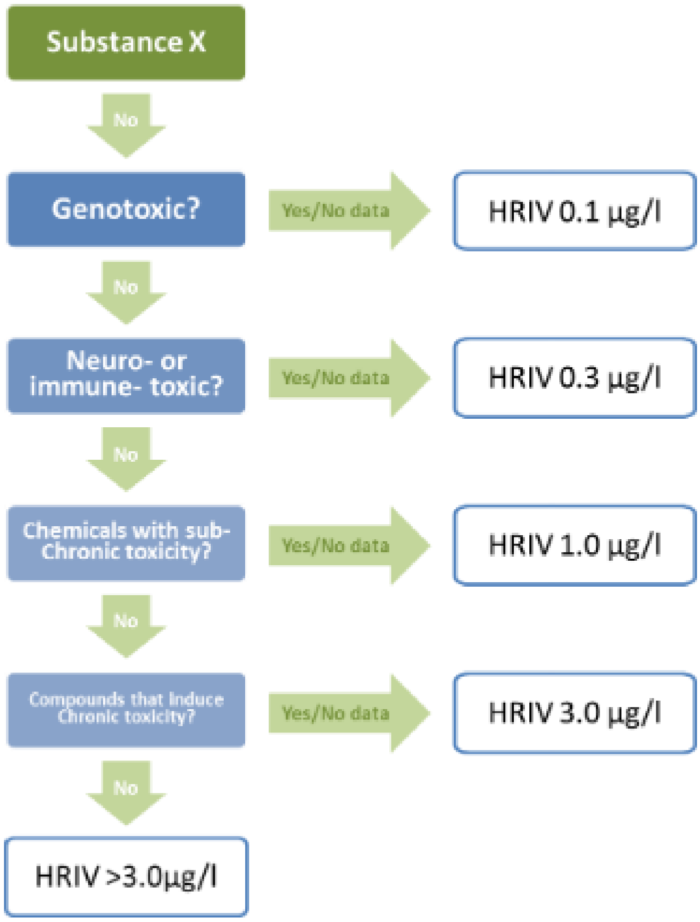

Figure 3 Determination of Health-Related Indicator Value (HRIV)

Note. For substances with known genotoxicity and metabolic relevance in humans, the HRIV is set to 0.01 µg/l. Three HRIVs can be allocated to non-genotoxic substances: 0.3 µg/l for neuro- or immune-toxic compounds, 1.0 µg/l for chemicals with sub-chronic toxicity and 3.0 µg/l for compounds that induce chronic toxicity.

Owing to the large number of different chemicals that might be found in drinking water, it is virtually impossible to regulate all compounds. This is because only limited or no toxicological data are available for most substances. For instance, the German Drinking Water Ordinance (2001) established Acceptable Daily Intake (ADI), Tolerable Daily Intake (TDI) or Reference Dose (RfD) values as the bases for evaluation (*see Box 6*).

Guidelines that are comprehensive can present both advantages and disadvantages. Inclusion of various substances and estimation of cut-off values for each substance can result in a very high acceptance values, because limits are clearly defined. However, users may feel discouraged to use an instrument that seems too complicated.

For example, the Australian drinking water guidelines 2011 are very comprehensive and the deduction of each cut-off value is explained. However, the document has more than 1300 pages, so might be considered too complex and onerous to use effectively.

Challenges remain in regulating the presence of nitrogen in the water environment. For example, the US EPA initiated a strategy to develop region-specific numeric water quality criteria for nutrients to provide better protection to aquatic ecosystems from eutrophication. This effort exemplifies the complexity in establishing water quality standards to meet ecological goals in water quality management (*see full case 'United States water quality criteria for nitrogen' in Part II*).

Key findings and recommendations

1. Classification of water bodies by what they are used for (e.g. protected area, recreational use, etc.) before treatment and effluent discharge control can improve efficiency because this allows selection of relevant parameters for testing water quality.

2. When selecting parameters and designing indicators, these should be relevant to specific water use. This is especially relevant when comparing with other water quality instruments.

3. Comprehensive water quality guidelines can have very many parameters, leading to users being discouraged from implementation. Appropriate tools and a framework can support implementation of complicated guidelines, thus improving acceptance (e.g. Water Safety Planning).

4. New approaches to water toxicity evaluation, through bioassays or the "health-related indicator value", such as those developed by Germany, should be included in the guideline criteria, when appropriate.

Chapter 4: Implementation of Water Quality Guidelines

Download Chapter 4 from the Database

This chapter provides an overview of challenges and opportunities in the enforcement and application of the selected guidelines and general recommendations on their implementation. The main issues are enforceability, flexibility, transparency, cross-sector coordination and transboundary conflicts.

Enforceability

Voluntary-based instruments and excessive delegation of duties may affect enforceability, depending on the financial and technical capacity of local authorities. Other issues that may affect the effective implementation of these instruments are inadequate division of powers, lack of sufficient mandate for control and monitoring, and lack of clear penalties for non-compliance. In the case of the Canadian Guidelines for Water Quality, there are no provisions for the division of duties and responsibilities among administrative bodies. In the Jordanian Water Strategy, the Project Management Unit (PMU) under the Ministry of Health has the function of 'enforcement' of water quality parameters but the actual powers to enforce compliance are not defined in the rules of operation. Another example is the Kenyan Water Quality Regulation, which does not set enforcement or penalties for non-compliance.

Transboundary conflicts

Cross-boundary policy and legal instruments often have enforceability issues which emerge from insufficient mechanisms to adequately cope with conflicts. For example, the Canadian Guidelines for Recreational Water Quality only become legally enforceable if the individual provinces and territories adopt them into provincial or territorial legislation. Consequently, this has the potential to lead to conflict over water quality control between neighbouring provinces and territories. Lax standards in one province or territory can directly affect the effectiveness of standards set by neighbouring provinces in the same watershed. Therefore collaboration between provinces is necessary to effectively implement recreational water quality standards. An example of an effective mechanism to enhance collaboration between governments is the International Joint Commission for the US/Canada Great Lakes *(in Part II see case 'Three examples of law and policy instruments…')*.

Transparency

Transparency and participation concerns are also issues that need to be considered, including lack of public access to information on enforcement and compliance, lack of provisions for active community participation, and lack of focus on growing populations placing stress on water resources.

The EU Water Framework Directive expressly encourages community participation (Article 14) but this tends to be consultation rather than active participation. Furthermore, the effectiveness of this provision requires Member States to develop sufficient mechanisms to actually incorporate public participation into decision making, which can vary between countries (European Commission, 2003; Palaniappan, et al., 2010).

In Jordan, quality standards are established through technical norms set at central government level (Ministry of Water and Irrigation, PMU). However, information related to enforcement and compliance is not publicly accessible, resulting in concerns over transparency.

Cross-sector coordination

The lack of integration between competent authorities often causes competition between different uses, such as between industrial production of food and environmental protection. This can lead to regulatory gaps, for example to appropriately deal with agricultural and even urban non-point source pollution.

For example, China faces serious water quality and availability issues, in part owing to rapid urbanisation, population growth and climate change. Six national technical standards on wastewater reuse were established between 2002 and 2005. These standards allowed for the development of an effective reclaimed water system nationwide, and improvement of the reliability and performance of municipal wastewater treatment processes (Yi, et al., 2011). To better manage the water needs of different water users, these guidelines need to be complemented with capacity development, integrated water resources management and adequate infrastructure financing *(see more in Part II).*

In Brazil, there is promotion of conservation and improvement of surface and groundwater quality to support multiple uses; however, this also presents some enforcement gaps and challenges. The different effluent standards across industries, as well as coordination with authorities from other sectors are some of the main challenges. Lack of coordination also entails compatibility issues between implementing tools such as sanitation plans and water quality goals *(see Box 7 below).*

Box 7 Brazil CONAMA water quality resolutions

The National Environmental Council (CONAMA) Resolutions are the framework for the environmental public policies in Brazil. These resolutions comprise a group of water quality regulations that have been implemented in Brazil since 1986 and complemented by successive instruments over subsequent years to address use-related requirements and pollution control of surface and groundwater resources.

These instruments address recreational (primary and secondary contact) and aquatic ecosystem uses, among others such as water supply sources for drinking, aquaculture, livestock watering, shellfish farming and irrigation. The CONAMA Resolutions were developed to promote the conservation and improvement of surface and groundwater quality to support multiple uses:

- The resolution that controls water use for recreational bathing (CONAMA Res. 294, issued in 2000) was supported by a local epidemiological study and has standards based on faecal coliforms, E. coli and Enterococcus, as well as recommendations for pathogenic monitoring and studies in sand quality. It also defines sampling procedures and the procedures to limit access to such areas.
- CONAMA Resolution 357, issued in 2005, establishes ambient water quality standards according to different uses, using a classification system. Fresh water, brackish water and saline water are classified in a set of categories relating uses and their respective quality requirements. *Figure 4* shows the five freshwater classes according to these water uses (ANA, 2012). Each category has specific physical and chemical parameters such as pH, dissolved oxygen, turbidity, temperature and several other general requirements, followed by a list of concentration limits for inorganic and organic chemicals, cyanobacteria, chlorophyll-a and faecal indicators. Water quality goals are established for water bodies according to this classification system and effluent discharges have to respect these goals.
- CONAMA Resolution 396, issued in 2008, also establishes the classification of groundwater bodies and threshold values for water quality indicators to define beneficial uses and to provide input for zoning of protection areas. It strongly depends on monitoring and management instruments to link land use zoning and groundwater protection. The challenge in fully applying this regulation is a need for reference (background) values for the different parts of the aquifer.
- CONAMA Resolution 430, issued in 2011, complements Resolution 357 and establishes standards for industry and wastewater treatment plant effluents released into water bodies. These resolutions are

Box 7 Brazil CONAMA water quality resolutions (continued)

approved at the federal level but the state environmental agencies are also responsible for enforcement and respective penalties. The Resolution determines that, despite the standards established for effluents, discharges into surface waters may not change the quality of the receiving body. An innovative approach in these Resolutions is the establishment of chronic and acute toxicity criteria for ecosystems.

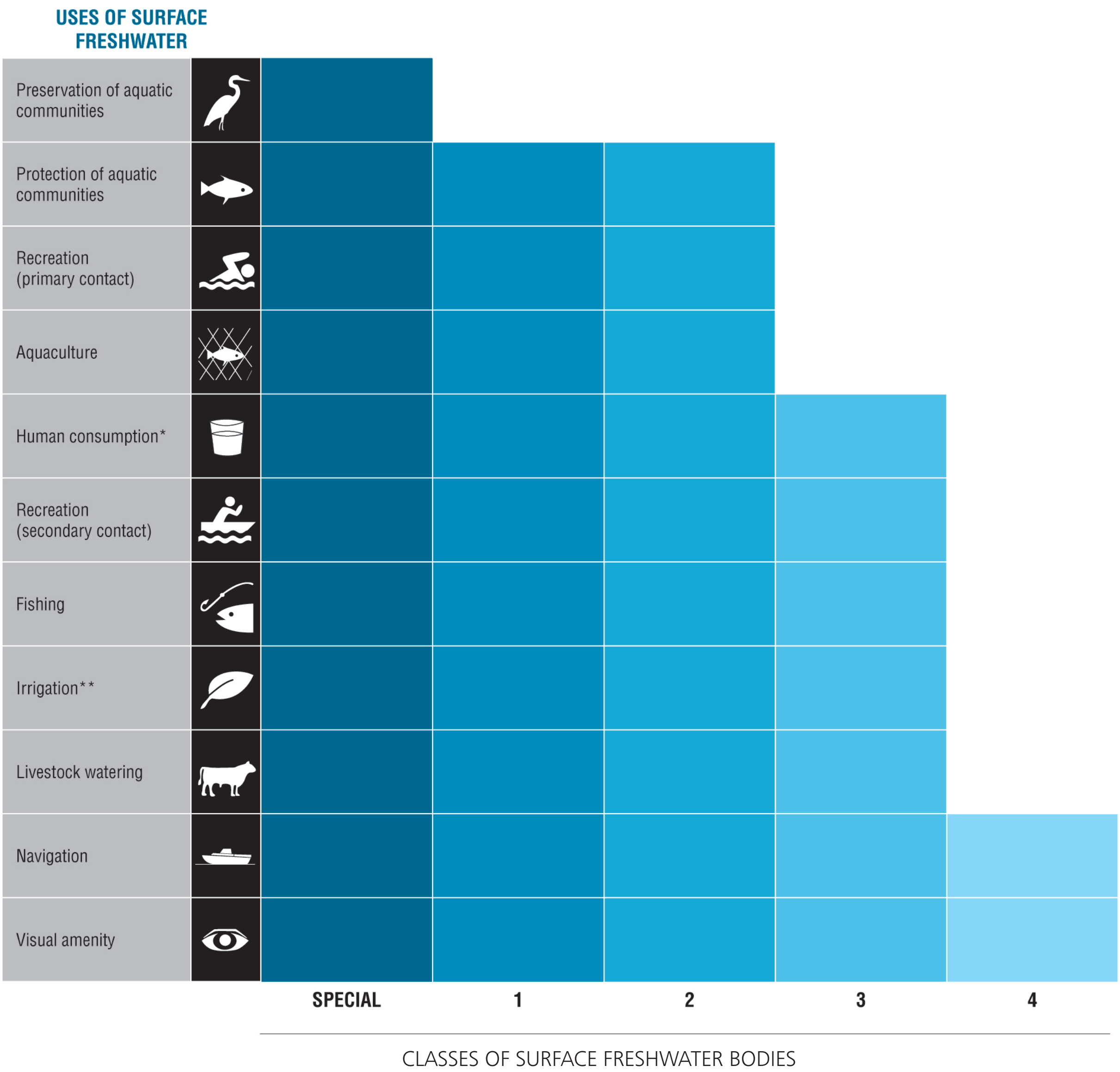

Figure 4 Classes of Surface Freshwater Bodies According to Their Uses (ANA, 2012).

Note. Surface freshwater in the "special" class must be maintained in pristine condition. In classes 1 to 4 an increasing level of pollution is permitted, resulting that only less stringent water uses (e.g. Navigation and landscape amenity) are possible in class 4.

Flexibility

Water quality regulations can promote or hinder innovation of technology, processes and infrastructure for more efficient use of water resources. For example, regulations can include provisions to allow alternative sanitation measures, promote water efficient technologies in industry or encourage water-saving irrigation technologies and processes.

The lack of such provisions has been seen as a problem of rigidity in cases such as the German Drinking Water Ordinance 2001 and the Russian requirements for drinking water quality. Further consideration of actual water uses and scientific analysis within the text of these regulations, could improve flexibility to enable innovation.

A unified regulatory framework with coherent implementation measures at different geographical scales is crucial for innovation. Rapidly evolving technology solutions and infrastructure need regulators that are prepared to respond in a timely manner.

When implementation requirements and procedures are not coordinated there is a risk of duplication of efforts across geographies as well as associated costs. The distribution of capacity building and financial resources can become the cause of inequality between places with

Box 8 Australian Guidelines for Water Recycling 2006

The Australian Guidelines for Water Recycling (AGWR 2006) promote a risk management framework based on the Australian Drinking Water Guidelines (ADWG 2004) and the WHO Guidelines for Drinking Water Quality (WHO, 2011). A National Recycled Water Regulators Forum supports uniform application of the guidelines.

One of the 12 components of this risk management framework is the validation of water treatment technologies before a particular recycling scheme is made operational.

Specific water quality requirements are established separately for the different parts of the country and generally according to use. Validation aims to determine how well a technology can improve the quality of the source water to meet the respective water quality requirement.

Validation is the 'substantiation of a technology's (or process') ability to effectively control hazards'; which in practice translates into the confirmation by the authority that a particular treatment technology 'meets the performance target allocated to that technology'. The validation process is undertaken through scientific testing in laboratories or in-situ, and validation methods differ for different technologies (Australian Water Recycling Centre of Excellence, 2015).

Although the guidelines described the concept, they did not establish a consistent approach for validation of treatment technologies across the country. As a result, stakeholders described the scheme as complex, slow and costly, hindering innovative and equal development.

For stakeholders (Aither, 2012; Muston & Halliwell, 2011), the absence of a unified regulatory system has resulted in the following:

- Similar technologies validated in one territory will need to be validated again in others where the operation takes place. This means that regulators will have to replicate the process and the costs associated with validation in each jurisdiction.
- Since the validation process is not unified, there will be differences in requirements and protocols as well as in the approach that each regulator will undertake. This not only creates uncertainty among stakeholders but also increases the workload of regulators in guiding proponents, thereby slowing down the process and making it hard to keep up with evolving technology.

This example demonstrates a gap in knowledge, and the Australian Water Recycling Centre of Excellence has led the development of a national validation framework which is nearing completion. Development of the framework has involved input from the National Recycled Water Regulators Forum, process manufacturers and recycled water providers. The framework and its associated protocols aim to reduce duplication across jurisdictions, providing greater certainty for manufacturers, and reduce implementation costs.

similar activities, technologies and regulations. The case of regulating the use of recycled water in Australia illustrates this point in *Box 8.*

The lack of flexibility or adaptability in water quality laws and policies is a factor that can intensify emerging issues, such as climate change and increasing rates of population, which can in turn lessen their effectiveness. Extreme climatic events, such as droughts and floods, are more frequent, severe and widespread, which can result in destabilisation of ecosystems, also impacting human livelihoods and supporting infrastructure. Flooding, in addition to its direct impacts on infrastructure, can lead to the contamination of water sources by wastewater and solid waste. Similarly, droughts can reduce water quality because lower water flows reduce the dilution of pollutants and increase contamination of the remaining water sources (Wilk & Wittgren, 2009).

Adaptability

Effective regulation of water quality is a complex and dynamic task. It is an exercise in which decision makers synthesise considerations of human health and economic affordability. Higher standards aim for better quality of water – which makes people healthier – but they also require higher investments. Therefore, determination of adequate standards – i.e. those that effectively meet their objectives – will necessarily differ between developed and developing economies.

To find the right balance between these two factors (i.e. consideration of human health and economic affordability), decision makers can choose to adapt standards or their enforceability. Reducing protection levels down to achievable objectives can facilitate regulations to be enforced. However, this option will also prevent the modernisation of regulations when more resources are available for improving water quality. Using non-binding instruments can be an option to introduce high levels of protection and progressive implementation of the norms without affecting their reliability.

For example, the Chinese National Standard for Drinking Water Quality (GB 5749-2006) came into effect in 2007, increasing the existing protection levels substantially. The new standard was prepared with reference to the WHO Guidelines for Drinking-water Quality (WHO, 2008) and the EU Drinking Water Directive (The Council of the European Union, 1998). Compared with its predecessor, the new regulation increased the levels of protection substantially: from only a 35 parameter index with the old standard issued in 1985, to an index with 106 parameters including micro-contamination, similar to those proposed by the WHO.

However, only the biggest cities have been able to reach this standard, with many smaller cities first needing maintenance and updating of their water treatment systems and distribution networks. The biggest challenge for local governments has been the financing of investments in infrastructure. Especially in western regions, with current water prices –which account for 1.5% of the family income – local government cannot afford upgrades to existing treatment facilities.

Key findings and recommendations

1. Incorporation of provisions that address the impacts of climate change or the occurrence of extreme events will contribute to a more resilient framework for water quality.
2. Balancing the powers and duties of implementing authorities should give special consideration to factors such as financial and technical burdens.
3. There needs to be adequate division of powers among agencies, with a sufficient mandate for controlling and monitoring, and clear penalties for non-compliance.
4. Transparency and public participation facilitates acceptability and compliance, enabling better implementation. Regulatory authorities are encouraged to ensure public access to enforcement and compliance information, active community participation and consideration of the impacts of emerging issues such as population growth.
5. Water quality instruments should allow adaptability of regulations to include new technologies, processes and infrastructure, and to enable and promote innovation for more efficient water resource use.
6. Water quality issues need to be incorporated into transboundary management plans and conflict mitigation measures.
7. Policies from different sectors, including water quality management (e.g. environment, sanitation, industry, agriculture), ideally need to be harmonised or at least recognise water quality controls for different uses.

Criteria for Assessment

The criteria for assessment are one of the key outputs of this Compendium but also a tool for its continuous development and update. The criteria highlight key information that the reader should look into when using the Compendium as a reference. They also suggest areas where more information is needed and can be improved in the Compendium.

The criteria were developed in the process of answering the following question: what makes a particular law or policy a good instrument to regulate water quality? The response is a list of aspects to be considered in the drafting, content, management and implementation of the various water quality instruments.

Good instruments are those that meet their objectives efficiently. The following criteria are thus suggested to determine whether an instrument is effective or not, answering the following questions:

1. Are the objectives sufficiently clear so that they can be monitored through a set of indicators? For example, a reduction in the concentration of one or more particular water quality parameters, the frequency of incidence of non-compliance, etc.
2. Are there monitoring and evaluation schedules? This includes a description of monitoring and evaluation practices, with specification of numbers of samples, frequencies of sampling, sources of samples, and parameters tested.
3. Is there laboratory analytical capacity and quality control, ensured by having analyses conducted by an accredited laboratory (e.g. the South African National Accreditation System; in Brazil, the National Institute of Metrology, Quality and Technology)?
4. Is there a baseline against which future situations can be assessed should be established (i.e. benchmarking)? Have the parameters that have been included in the baseline assessment been identified and aligned with the pre-established monitoring and evaluation schedule?
5. Is there access to information about the facilities that have permits to discharge pollutants? For example, this could be through a water pollution database.
6. Is there a regulatory framework that enables public acceptance of the respective water quality requirements? Effective water quality guidelines are a progressive work that has to be improved and adapted according to regional differences and emerging needs.

Bibliography

Aither, 2012. National Validation Framework for Water Treatment Technologies—Business Case, Brisbane: Australian Water Recycling Centre of Excellence.

ANA, 2012. Table 2 - Classes of Surface Freshwater Bodies According to Their Uses. In: Surface Freshwater Quality in Brazil - Outlook 2012. Brasilia, DF: Agência Nacional de Águas (ANA), 2012.

Ashbolt, N. J., Grabow, W. O. & Snozzi, M., 2001. Chapter 13: Indicators of microbial water quality. In: L. Fewtrell & J. Bartram, eds. Water quality: Guidelines, standards and health - Assessment of risk and risk management for water-related infectious disease. s.l.:WHO by IWA Publishing.

Australian Water Recycling Centre of Excellence, 2015. Road Map for a National Validation Framework. [Online] Available at: *http://www.australianwaterrecycling.com.au/projects/road-map-for-a-national-validation-framework* [Accessed 30 March 2015].

BASF, 2015. Genotoxicity [Online] Available at: *http://www.alternative-methods.basf.com/group/corporate/alternatives/en/microsites/alternatives/methods-in-use/genotocity* [Accessed 30 March 2015].

Braune, E. & Adams, S., 2014. Groundwater governance: A global framework for action (2011-2014) - Regional diagnosis for the Sub-Saharan Africa Region, s.l.: University of the Western Cape; Water Research Commission.

Department of Water and Forestry, 2006. Guideline for Determining Resources Water Quality Objectives (RWQOs), Allocatable Water Quality and the Stress of the Water Resource. 2. ed. Pretoria: Department of Water and Forestry.

European Commission, 2003. Public Participation in relation to the Water Framework Directive. Luxembourg: Office for Official Publications of the European Communities.

European Commission, 2012. Report from the Commission to the European Parliament and the Council on the Implementation of the Water Framework Directive (2000/60/EC) River Basin Management Plans, s.l.: European Commission.

European Commission, 2015a. Legislation. [Online] Available at: *http://ec.europa.eu/legislation/index_en.htm* [Accessed 11 March 2015].

European Commission, 2015b. Environment. Groundwater in the Water Framework Directive. [Online] Available at: *http://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm* [Accessed 11 March 2015].

European Commission, 2015c. Environment. Introduction to the new EU Water Framework Directive. [Online] Available at: *http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm* [Accessed 11 March 2015].

European Commission, 2015d. Implementing the EU Water Framework Directive & the Floods Directive. [Online] Available at: *http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm* [Accessed 23 June 2015].

Grummt, T. et al., 2013. Tox-Box: securing drops of life - an enhanced health-related approach for risk assessment of drinking water in Germany. Environmental Sciences Europe, Volume 25.

Helmer, R. & Hespanhol, I. eds., 1997. Water Pollution Control - A Guide to the Use of Water Quality Management Principles. London: E & FN Spon on behalf of WHO/UNEP/WSSCC.

IWA, 2015. The Lisbon Charter: Guiding the Public Policy and Regulation of Drinking Water Supply, Sanitation and Wastewater Management Services. s.l.:International Water Association.

Jin, G., Englande, A. J., Bradford, H. & Jeng, H., 2004. Comparison of E. coli, Enterococci, and Fecal Coliform as Indicators for Brackish Water Quality Assessment. Water Environment Research, 76(3), pp. 245-255.

Muston, M. & Halliwell, D., 2011. NatVal Road Map Report - The road map to a national validation, Adelaide: Water Quality Research Australia Limited.

OECD, 2001a. Water Use. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=2915* [Accessed 30 March 2015].

OECD, 2001b. Glossary of Statistical Terms. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=78* [Accessed 30 March 2015].

OECD, 2001c. Recreational land and associated surface water. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=2257* [Accessed 30 March 2015].

OECD, 2001d. Glossary of Statistical Terms. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=1271* [Accessed 30 March 2015].

OECD, 2001e. Glossary of Statistical Terms. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=678* [Accessed 30 March 2015].

OECD, 2001f. Glossary of Statistical Terms. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=1271* [Accessed 30 March 2015].

OECD, 2001g. Non-Point source of pollution. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=1820* [Accessed 30 March 2015].

OECD, 2007. Brackish water. [Online] Available at: *http://stats.oecd.org/glossary/detail.asp?ID=7337* [Accessed 30 March 2015].

OECD, 2012. OECD Environmental Outlook to 2050, s.l.: OECD Publishing.

OECD, 2014a. Green Growth Indicators 2014, OECD Green Growth Studies, Paris: OECD Publishing.

OECD, 2014b. Green Growth Indicators. Paris: OECD Publishing.

Palaniappan, M. et al., 2010. Clearing the Waters, A focus on water quality solutions. Nairobi: United Nations Environment Programme.

Patole, M., 2009. How the national water laws of Brazil address groundwater abstraction and pollution control?. [Online] Available at: *http://www.academia.edu/6784195/How_the_national_water_laws_of_Brazil_address_groundwater_abstraction_and_pollution_control* [Accessed 30 June 2015].

Planbureau voor de Leefomgeving, 2015. Het Compendium voor de Leefomgeving. [Online] Available at: *http://www.compendiumvoordeleefomgeving.nl/* [Accessed 11 March 2015].

Recycled Water in Australia, 2015. What is recyled water?. [Online] Available at: *http://www.recycledwater.com.au/index.php?id=46* [Accessed 30th June 2015].

The Council of the European Union, 1998. Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. s.l.:Official Journal.

U.S. Environmental Protection Agency, 1998. Guidelines for Neurotoxicity Risk Assessment. Washington, DC.: s.n.

UN Water, 2014. Thematic Priority Area: Water Quality. [Online] Available at: *http://www.unwater.org/activities/thematic-priority-areas/water-quality/en/* [Accessed 23 June 2015].

UNDP, 2006. Human Development Report 2006, New York: UNDP.

US EPA, 2004. Water Quality Standards for Coastal and Great Lakes Recreation Waters. Washington, DC: s.n.

US EPA, 2012. Recreational Water Criteria. s.l.:Health and Ecological Criteria Division, Office of Science and Technology, United States (U.S.) Environmental Protection Agency (EPA).

Van het Koninkrijk der Nederlanden, 2009. Staatsblad. [Online] Available at: *https://zoek.officielebekendmakingen.nl/stb-2010-15.html* [Accessed 23 June 2015].

WHO, 2005. Water Safety Plans: Managing drinking-water quality from catchment to consumer. Geneva: World Health Organization 2005.

WHO, 2006. Guidelines for the safe use of wastewater, excreta and greywater. Geneva: World Health Organization.

WHO, 2008. Guidelines for Drinking-water Quality - incorporating 1st and 2nd addenda. 3 ed. Geneva: World Health Organization.

Wilk, J. & Wittgren, H. eds., 2009. Adapting Water Management to Climate Change. s.l.:2009, Swedish Water House (SWH).

WWAP, 2012. The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk, Paris: UNESCO.

Yi, L., Jiao, W. & Chen, X. a. C. W., 2011. An overview of reclaimed water reuse in China. Journal of Environmental Sciences, 23(10), pp. 1585-1593.

Part II: Case studies

Case studies showcase best practices and different methodological approaches to regulate water quality requirements for different uses. They illustrate the different themes and topics included in the Compendium in order to identify the characteristics that make an instrument efficient, innovative and practical, considering different uses and geographical scales.

Structure and content

The structure of the case studies follows a template (*see below*). Cases are divided into sections, each one containing a list of guiding questions. Guiding questions have been drafted to orient the content of the sections so that it aligns with the Compendium chapters. Each case study reflects local or specific situations and focuses on selected topic areas.

Unlike the rest of the Compendium, the information conveyed in each case study is provided by an identified author. This allows room for opinions and analysis of instruments and practices through the author's perspective. The cases do not provide official information on regulatory instruments, nor have they been endorsed by the countries unless otherwise stated.

The case studies are a first step in a broader dialogue on water quality. It is the very purpose of this Compendium to encourage officials, practitioners and decision makers in general to join this dialogue by adding information and new perspectives to the current analysis, or even by contradicting the opinions provided in them.

Download the Template

Case Study Summaries

In this section, case studies referred to in Part I are summarised. To access the full text of each case study, please click the hyperlink 'read full case'.

Canada's Water Quality Guidelines

The federal Guidelines for Canadian Drinking Water Quality serve as a competent guide to drinking water quality governance in Canada. However, there are a number of recommendations for effective implementation. These include the uniform enforcement of provincial standards across the country, proper accreditation and operational planning, and the identification of risk management priorities. Solving Canada's water resource problems requires the accommodation of various competing interests, innovations and leadership to address emerging complexity and policy coordination at all political and administrative levels. *Read full case*

China Reclaimed Water Reuse Regulations

China faces serious water quality and availability challenges due to rapid urbanization, population growth and climate change. Six national technical standards on wastewater reuse were established between 2002 and 2005 which allowed for the development of an effective reclaimed water system nationwide, resulting in the improvement of the reliability and performance of municipal wastewater treatment processes (Yi et al., 2011). To maintain and continue water quality improvement there needs to be capacity development, integrated water resources management and the development of financing instruments. *Read full case*

Portugal's Drinking Water Quality Regulatory Model

Twenty years ago the Portuguese legal framework for drinking water quality could only guarantee 50% of safe water, with the remaining supply being beyond authorities' control or in violation of national standards. Between the years 1993 and 2004, the coverage of safe water for drinking increased to 84%. However, this was still far from excellent drinking water quality as defined by international standards (99% of safe water coverage). To pursue this goal, a new regulatory model for drinking water quality was established based on the European Drinking Water Directive 98/83/CE. Ten years after its implementation, safe water coverage in Portugal has reached 98% and new tools –like water safety plans– are being implemented to achieve 99% coverage. *Read full case*

South African Green Drop Certification for Excellence in Wastewater Treatment Plant Operation

Municipalities in South Africa face many challenges in providing effective water services to consumers, especially with regard to the management of wastewater treatment plants (WWTPs). Any WWTP not operating properly discharges effluent which damages the receiving water resource. The Green Drop certification programme was designed to serve as a stimulus for change; a catalyst to establish motivation and leadership in the water sector regarding the management of wastewater services. The aim of the Green Drop programme is to create a paradigm shift by which wastewater operations, management and regulation is approached. It promotes incentive-based regulation; establishing excellence as the benchmark for wastewater services. The criteria focus on the effective management of wastewater services instead of the continuation of end-point monitoring and subsequent reactive operations. *Read full case*

The eMalahleni Water Reclamation Plant in South Africa

Mining is always a challenge, especially in water stressed regions. Safety and environmental problems caused by rising underground mine water in eMalahleni were addressed by mining operators implementing a water reclamation system. Currently, the plant purifies 30 Ml/d to potable quality and covers almost 20% of the total potable water demand. eMalahleni is an example of how wise water management can provide a common solution by addressing interests of both the mining industry and the local community. *Read full case*

The Flemish Decree on Integrated Water Policy

Belgium has a complicated government structure and Flanders in particular is characterized by poor surface and ground water quality, excessive water use and increasing flooding risks. The Decree on Integrated Water Policy attempts to tackle these problems in an integrated way and is, despite remaining struggles, a good example of how to attain truly integrated water management from international to local scales. This decree covers the requirements of multiple uses of water resources through the involvement of diverse actors and stakeholders during several steps of the development and implementation process. Although several targets related to European directives are not yet met, the implementation of the Decree has resulted in progress in the improvement of water quality and flood management. *Read full case*

The European Water Framework Directive in the Netherlands

The Water Framework Directive (WFD) is the current European legislation aiming at long-term sustainable water management based on a high level of protection of the aquatic environment. It addresses both the chemical and ecological status of surface water through a variety of parameters. According to the precautionary principle, the overall indicator is aggregated with the 'one out/all out' method. This means that specific improvements to improve water quality do not always have a positive effect on the final indicator. Consequently, this could also generate worse results for member states which have comprehensive monitoring which includes more parameters. Therefore, besides the final indicator of the ecological quality, it is advisable that the most important underlying indicators are also shown. The following case study illustrates the advantages and disadvantages in the implementation of this Directive to assess water quality using The Netherlands as example. *Read full case*

Three examples of law and policy instruments addressing water quality issues caused by climate change

Why should climate change be considered when regulating water quality? Climate change affects all elements of the water cycle, but examples of instruments regulating water quality are still quite scarce. The cases summarised in this text demonstrate some of the rare examples of law and policy instruments addressing water quality issues caused by climate change in a transboundary context. *Read full case*

United States water quality criteria for nitrogen

Water quality degradation caused by over-enrichment due to nitrogen is a widespread and pressing environmental issue. While quantitative water quality standards have been established for nitrogen compounds in drinking water, challenges remain in regulating the presence of nitrogen in the ambient water environment. In the United States, the USEPA initiated a strategy to develop region-specific numeric water quality criteria for nutrients to provide better protection to aquatic ecosystems from eutrophication. This U.S. effort exemplifies the complexity in establishing water quality standards to meet ecological goals in water quality management. *Read full case.*

Glossary of Terms

The glossary is ordered alphabetically and provides definitions of terms found in the Compendium. The chosen definitions correspond to authoritative sources where available. Where information was contradictory or inconclusive, a descriptive definition has been provided. The glossary will continuously be improved by users. Users are invited to suggest new terms or refine those included.

Agricultural water use: Agricultural water use includes water abstracted from surface and groundwater, and return flows (withdrawals) from irrigation for some countries, but excludes precipitation directly onto agricultural land (OECD, 2001b).

Application gaps and weaknesses: The gaps and weaknesses that appear during the application of law and policy instruments.

Brackish water: Water where the salinity is appreciable but not at a constant high level. The salinity may be subject to considerable variation due to the influx of fresh or sea waters (OECD, 2007).

Complementary instrument: Other guidelines that need to be considered during implementation.

Drip irrigation: A water-saving technique of surface irrigation through pipes made of plastic. The process delivers the water drop-by-drop to plants through tiny holes, and prevents waterlogging of soils (OECD, 2001e).

Freshwater Ecosystems: The abiotic (physical and chemical) and biotic components, habitats and ecological processes contained within water bodies and their fringing vegetation, but excluding marine and estuarine systems.

Faecal indicator: A group of organisms that indicates the presence of faecal contamination, such as the bacterial group thermotolerant coliforms or E. coli. Hence, indicators only imply that pathogens may be present (Ashbolt, et al., 2001).

Freshwater: Any water source excluding sea and brackish waters.

Genotoxicity: The potency of a compound to interact with the genetic constitution of a cell (BASF, 2015).

Health-Related Indicator Value (HRIV): Concept developed for evaluating substances, for which only limited data are available. Genotoxicity is considered the worst possible effect. When no data on genotoxicity are available, the substance in question is assumed to be genotoxic. Therefore, an HRIV of 0.1 µg/l is set for this chemical. Once it is proved that a chemical is not genotoxic, an HIRV above 0.1 µg/l can be set (Grummt, et al., 2013).

Hydropower: Electricity generation using the power of falling water (OECD, 2001d).

Irrigation: The artificial application of water to land to assist in the growing of crops and pastures. It is performed by spraying water under pressure (spray irrigation) or by pumping water onto the land (flood irrigation) (OECD, 2001f).

Law(s): Content wise, a rule or set of rules, enforceable by the courts, regulating the government of a state, the relationship between the organs of government and the subjects of the state, and the relationship or conduct of subjects towards each other. Formally, they are rules of conduct of binding force and are effected, prescribed, recognised and enforced by the state. They are also a 'legislative act' as the legislature has the sole power to create, amend and repeal laws. Laws may be referred in different systems and countries as 'acts', 'bills', 'statutes' or 'codes'.

Neurotoxicity: An adverse change in the structure or function of the central and/or peripheral nervous system after exposure to a chemical, physical or biological agent (US EPA, 1998).

Non-point source of pollution: Pollution sources that are diffused and without a single point of origin or not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by storm water run- off. The commonly used categories for non-point sources are agriculture, forestry, urban areas, mining, construction, dams and channels, land disposal and saltwater intrusion (OECD, 2001g).

Parameters and indicators: A parameter or a value derived from parameters that describe the state of the environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the responses steering that system. An indicator has gone through a selection and/or aggregation process to enable it to steer action.

Policy(s): A plan of action adopted or pursued by an individual, government, party, business, etc. It includes all executive instruments without legal status, such as the general principles a government follows in its management of public affairs. This term can also be referred to as 'guidelines', 'strategies', 'plans' or 'programmes'.

Recreational land and associated surface water: Land that is used as privately owned amenity land, parklands and pleasure grounds and publicly owned parks and recreational areas, together with associated surface water (OECD, 2001c).

Recycled water: This is a generic term for used water that is recovered and supplied again for beneficial uses. Water can be recycled from rainwater, stormwater, greywater and treated effluent. When these alternative sources are treated as required, the water is suitable for a range of purposes (Recycled Water in Australia, 2015). For example, drainage water may be used several times as is the case in Egypt.

Reused water: Treated wastewater, greywater or storm water runoff, recovered to a quality suitable for beneficial use.

Regulations: All rules that emanate from the executive branch. Laws can delegate the power to make rules to the executive branch with the same legal force. This allows the technical, scientific and other expertise available to the executive branch to be incorporated more easily. This term can also be referred as 'decree', 'ordinance', 'circular' or 'by-law'.

Water quality criterion: Numerical concentration or narrative statement recommended to support and maintain a designated water use. This includes providing basic scientific information about the effects of water pollutants on a specific water use (Helmer & Hespanhol, 1997).

Water quality objective (synonyms: water quality goal or target): A numerical concentration or narrative statement that has been established to support and to protect the designated uses of water at a specific site, river basin or part(s) thereof. This takes into consideration a water quality criterion and a critical assessment of national priorities (Helmer & Hespanhol, 1997). A water quality objective is therefore a management decision and not a scientific statement. Objectives can be stated in policy documents, but they can also be established in laws or regulations, especially to be attained at a future specified date.

Water quality standard: An objective that is recognised as mandatory. Normally these would be established in a law or probably, a regulation. However, it is possible to establish binding standards in a policy document, which is then enforced through some other means. The term is used in this Compendium more broadly, to designate a general water quality rule that can be binding for users (when established by law or regulation) or non-binding (as when established by policy – for instance in guidelines – in which case their purpose is aspirational.

Wastewater: Liquid waste discharged from homes, commercial premises and similar sources to individual disposal systems or to municipal sewer pipes, and which contains mainly human excreta and used water. When produced mainly by household and commercial activities, it is called domestic or municipal wastewater or domestic sewage. In this context, domestic sewage does not contain industrial effluents at levels that could pose threats to the functioning of the sewerage system, treatment plant, public health or the environment (WHO, 2006).

Water Use: Use of water by agriculture, industry, energy production and households, including in-stream uses such as fishing, recreation, transportation and waste disposal (OECD, 2001a).

Annexes

Annex I: Methodology

The initial study and proposed methodology, which consisted of a desk study focusing on the collection and analysis of laws and policies regulating water quality, was enriched by a constant and overarching process of drafting, review, consolidation and consultation with water quality experts from developing and developed countries, policy makers and practitioners. This was followed by a verification process with country and regulatory bodies' representatives to ensure accuracy in primary sources and the relevance of the criteria for assessment.

The section on Overview of Working Groups explains in detail the involvement of water quality experts and country representatives, which was on a voluntary basis, (*see section below that outlines the involvement of working group members in various subgroups)*. Individual contributions varied according to the field of expertise and availability of information.

The Compendium is predominantly written in a descriptive style supplemented by opinion analysis from the experts and practitioners. The laws and policies in this document are duly referenced and online sources – such as institutional websites – are included whenever possible. Secondary sources and opinions are also referenced to allow the inclusion of different points of view.

The development of the Compendium can be summarised into the following phases: (1) inception, (2) selection of instruments and (3) draft and review. However, the various instruments included and analysed evolved with the process of input and feedback from the contributors.

Inception Phase

The geographical scope, content, structure and criteria for analysis were determined on the basis of Compendium aims and objectives. To facilitate its use as reference tool, the Compendium was divided into four areas for analysis, each one organised as a separate chapter; namely (1) scope,

(2) management frameworks, (3) parameters and thresholds, and (4) implementation.

Each regulatory instrument was described and analysed under each chapter and included in a database as an independent item. Reference to complementary instruments or referred regulations is also included where appropriate. However, given their broad diversity, not all the topics covered in each chapter were applicable to each of the instruments included in the Compendium (for example, not all instruments provide parameters).

During this phase the proposed scope and structure of the Compendium was presented in various fora for feedback. These consultations were held in conjunction with discussions on the portfolio of water quality projects being coordinated by UNEP. The first presentation was held at the World Water Week in August 2013 in Stockholm, Sweden, followed by the IWA Development Congress in Nairobi, Kenya, in October 2013; this phase also included bilateral consultations, mostly with the WHO and the IWA Task Force on Water Quality.

Selection of instruments

The initial selection of 80 or more instruments was reviewed within the project team and through consultation with selected experts from the IWA Water Quality Task Force. The Compendium Working groups were also formed and consulted in this first instance at the first coordination meeting held via teleconference on 13 May 2014. During the inception phase, experts also contributed references of primary and secondary sources, and technical analysis.

The outputs of the inception phase and the first consultations were compiled and consolidated to be the basis for the drafting and review process. The selection of instruments was then extracted from this initial list taking into account the following:

1. Type or nature of the document - Documents that were not of legal or policy nature, or did not provide a clear set of recommendations or guidance, were removed, for example environmental status reports and enforcement decrees. These documents were still included in the overall Compendium as complementary instruments wherever appropriate.
2. Region - In addition to global instruments, documents were shortlisted aiming for an equal representation of all regions, namely West Asia, Africa, Europe, North America, Asia and the Pacific, and Latin America and the Caribbean (these are based on UNEP's defined regions).
3. Document accessibility - The availability of official supporting information or reliable translation was essential.
4. Regulated water use - The selection aimed to address a variety of economic sectors and water uses including industrial, domestic, agricultural, mining, recreational, environmental and power generation.
5. Current status of implementation - The selection of instruments preferred those implemented for a longer time and currently in force. This criterion aimed to collect lessons learned to determine what instruments are effective, practical and better promote the wise use of water resources.
6. Work group expertise - An additional criterion was to take into account the expertise of working group members, including the availability of case studies and implementation experiences associated with particular instruments.

For each regulatory instrument (guidelines and standards, laws and policies) information was compiled following the chapter structure and the guiding questions of the criteria for analysis *(see Table 1)*. Where available, complementary materials, related regulatory instruments and case studies were also included (*see Part II Case studies).* Collection and analysis used templates that were also used to receive inputs and feedback from the working groups *(see Annex II: Input forms).*

Drafting and Review

The information gathered was consolidated in a database organised into the chapter structure. Additionally, a narrative was drafted to accompany each chapter in the database and facilitate its navigation.

The narrative chapters were drafted to explain the methodology and scope of each chapter, highlighting key findings and referencing case studies where possible to illustrate the topics covered.

The draft database chapters and accompanying narrative were shared with the working groups for inputs and review. The members provided technical input and feedback over successive drafts, adding sources and case studies where possible.

Development of the 'Criteria for Assessment' was proposed and initiated in the drafting and review phase. This stemmed from discussions which asked: What makes a particular law or policy a good instrument to regulate water quality? The response is a list of aspects to be considered in the drafting, content, management and implementation of the various water quality instruments.

The criteria for assessment are one of the key outputs and a tool for the Compendium's continuous development and update. They highlight the type of key information that the user should look into when using the Compendium as a reference.

Key findings and outcomes from the process of developing the Compendium were discussed at World Water Week in August 2014 in Stockholm and the IWA World Water Congress 2014 in Lisbon. A final draft was made available to country and regulatory body representatives to verify the accuracy and up-to-date character of the primary sources included.

Overview of Working Groups

The Compendium has been developed with the active technical input and feedback from renowned experts from developing and developed countries, as well as policy makers and practitioners. Three groups were created for such purpose.

The first group – within the IWA member network – was the IWA Task Force on Water Quality, which specifically provided initial technical advice and suggestions on water quality guidelines, the criteria used to analyse the selected water quality guidelines, and the methodological approaches in terms of process and content.

In addition, two working groups were created to support the Compendium by inviting high-level experts and decision makers in the field of water quality from different sectors and from developed and developing countries. The groups resulted from a response to various calls for contributions within the IWA network, personal invitations to decision makers and practitioners with significant experience in water quality issues, and suggestions from UNEP.

The first working group (Working Group 1 Development) was set up to provide technical input into the Compendium, giving advice on the final criteria to gather and analyse standards and guidelines; suggestions for the selection of innovative guidelines and standards to be included in the Compendium; as well as guidance to the content of the necessary reports and assessments to be included. This working group was composed of 25 members from all regions and economic sectors, including government authorities, regulators, service providers, industry representatives and academicians.

The second working group (Working Group 2 Review) was set-up to review the documents produced in collaboration with Working Group 1 and to provide technical input and feedback on the application of the Compendium at national and regional levels. This will give relevant officials improved access to information on water quality requirements for different water uses, which in turn will promote efficient water use. This working group was composed of 27 members from all regions and equivalent representation from different sectors.

After the establishment of the working groups, a first coordination meeting was held via teleconference on May 13th, 2014. The meeting was convened to introduce the members of each working group, set-up their work plans, review the preliminary outputs of the Compendium drafting team and collect further feedback. This meeting included discussion of: the scope and purpose of the Compendium and how it can be used as a reference tool to select and design future instruments; the management framework (methods or approaches) that is used to apply these instruments; the implementation of laws and policy instruments for water quality and the identification of their gaps and weaknesses; and, finally, suggestions of case studies to illustrate good practices and opportunities.

Because of the large number of participants in both working groups, four subgroups were created following the structure of the Compendium: namely subgroups to define the scope of the Compendium guidelines and standards, management frameworks used to apply guidelines and standards, the parameters and thresholds to be considered, and the implementation of guidelines and standards *(see Table 2 below).*

Table 2- Subgroups

Scope	Management	Parameters and	Implementation
Mihaela Vasilescu	Jeffrey A Thornton	Hua Xie	Nilce Ortiz
Nilce Ortiz	John Whitler	Nilce Ortiz	Jeffrey A Thornton
Boris David	Bala Vigneswaran	Jeffrey A Thornton	John Whitler
Maria Inês Z. Sato	Jo Burgess	Alexander Eckhardt	Bala Vigneswaran
Selmin Burak	Baton Begolli	Maria Inês Zanoli Sato	Florin Iliescu
Chris Dickens	Marcelo Costa	Chris Dickens	Sarah Hendry
Monica Porto	Luis Simas	Monica Porto	Xujun Liu
Bala Vigneswaran	Peter van Puijenbroek	Deborah Chapman	Baton Begolli
Sarah Hendry	Peter Goethals	Bala Vigneswaran	Marcelo Costa
		Peter Goethals	

Annex II: Input forms

This Annex provides details of the input request submitted to each subgroup within Working Group 1. These input requests were gathered using online tools (email and google forms). The objective of these calls for inputs was to facilitate collection of information and target specific feedback from working group members according to their expertise and experience. For each theme, contributors were asked to focus on the following questions.

Chapter 1: Scope of the Guidelines or Standards [Access Online form]

1. What policy or regulatory instruments are innovative, practical and promote the wise use of water resources? Should we set different analysis criteria for developed and developing countries?
2. What is needed for them to be implemented? What type of enabling regulatory framework is usually in place? What capacity is required for implementation?
3. What characteristics would 'the best guideline/regulatory instrument' have for water quality management for different uses (e.g. guidelines, regulations, laws, etc.)?
4. What case studies can you recommend or provide?

Chapter 2: Management framework used to apply the guidelines or standards [Access Online form]

1. What are the main outcomes guidelines/regulatory instruments are working towards? What uses are usually included?
2. How are the public and private sectors involved in applying the guidelines? What are the advantages and disadvantages of their involvement?
3. Which public or private entities are subject of the guidelines/regulatory instruments? What challenges do they face?
4. What methods or approaches are commonly used to apply the guidelines and what are their advantages and disadvantages (for example, incorporation into National Standards and/or implementing best practices such as Water Safety Plans)?
5. Which other instruments should be considered when applying water quality guidelines for each use?
6. What case studies can you recommend or provide?

Chapter 3: Parameters, Indicators and Thresholds adopted for Different Uses [Access Online form]

1. How are the different parameters and indicators to be assessed and incorporated (with reference to different uses) into the database?
2. What types of parameters and indicators are usually covered or should be covered by the guidelines/regulatory instruments for water quality for each use?
3. What types of water sources are usually considered or should be considered by guidelines/regulatory instruments for each use?
4. What parameters and indicators are appropriate to be considered in each use? And what are the common challenges around their use?
5. What case studies can you recommend or provide?

Chapter 4: Implementation of Water Quality Guidelines [Access Online form]

1. What are the common gaps and weaknesses in the application of guidelines/regulatory instruments for water quality for different uses?
2. What measures are/should be taken to enforce them?
3. What are some emerging issues that have arisen through the implementation process?
4. What are some of the challenges and opportunities around their implementation?
5. What case studies can you recommend or provide?

Annex III: List of selected regulatory instruments

	DATE	NAME	STATUS	COUNTRY
GLOBAL	2011	World Health Organization Drinking Water Quality 2011	In use	All
	2006	World Health Organization Safe Use of Wastewater 2006	In use	All
AFRICA	2006	Kenya Water Quality Regulations 2006	In use	Kenya
	2002	Morocco Water Quality Standards for Irrigation 2002	In use	Morocco
	1996	South Africa Aquatic Ecosystems 1996	In use	South Africa
	1996	South Africa Domestic Use 1996	In use	South Africa
ASIA-PACIFIC	2011	Australia Drinking Water Guidelines 2011	In use	Australia
	2006	Australia Water Recycling Guidelines 2006	In use	Australia
	2013	China FAO Control Water Pollution from Agriculture 2013	In use	China
	2006	China Standards for Drinking Water Quality 2006	In use	China
	2005	Japan Water Reuse Guidelines 2005	In use	Japan
	1997	Korea Water Quality and Ecosystem Conservation Act 1997	In use	Korea
	2001	Russia Requirements for Drinking Water Quality 2001	In use	Russia
	1991	Russia Quality Standards for Feed Water and Steam 1991	In use	Russia
EUROPE	1999	Belarus Requirements for Drinking Water Quality 1999	In use	Belarus
	2006	EU Bathing Water Directive 2006	In use	European Union
	1998	EU Drinking Water Directive 1998	In use	European Union
	2006	EU Shellfish Water Directive 2006	Repealed	European Union
	1991	EU Urban Waste-water Treatment Directive 1991	In use	European Union
	2000	EU Water Framework Directive 2000	In use	European Union
	2006	EU Groundwater Directive 2006	In use	European Union
	2008	EU Environmental quality standards for surface water 2008	In use	European Union
	2011	France Misting Systems Guidelines 2011	In use	France
	2007	France Water Safety Regulation 2007	In use	France
	2013	France Cooling Tower Regulation 2013	In use	France
	2006	France Harvested Rainwater for Domestic Use Regulation 2006	In use	France
	2014	France Irrigation with Reclaimed Water Regulation 2014	In use	France
	2001	Germany Potable Water Ordinance 2001	In use	Germany
	2012	Kosovo Drinking Water Quality Instruction 2012	In use	Kosovo
	2014	Moldova Water Supply and Sanitation Strategy 2014-2018	In use	Moldova
	2002	Romania Drinking Water Quality Law 2002	In use	Romania
	2007	Spain Reclaimed Water Use Decree 2007	In use	Spain
	2004	Turkey Regulation on water pollution control 2004	In use	Turkey

LATIN AMERICA AND THE CARIBBEAN	1983	Caribbean Protocol on Land Activities 1983	In use	*
	2000	Brazil Conama Resolution 274, Recreational Water Quality 2000	In use	Brazil
	2005	Conama Resolution 357, Surface Water Quality Guidelines 2005	In use	Brazil
	2008	Conama Resolution 396, Growndwater Quality Guidelines 2008	In use	Brazil
	2011	Brazil Conama Resolution 430, Effluent Quality Regulations	In use	Brazil
	2011	Brazil Ordinance No 2914, Drinking Water Quality 2011	In use	Brazil
NORTH AMERICA	2012	Canada the Metal Mining Effluent Regulations 2012	In use	Canada
	2012	Canada Recreational Water Quality 2012	In use	Canada
	1996	Canada Drinking Water Quality 1996 (2012)	In use	Canada
	1997	Texas Use of Reclaimed Water 1997	In use	United States
	2004	US EPA Guidelines for Water Reuse 2004	Repealed	United States
	2012	US EPA Guidelines for Water Reuse 2012	In use	United States
*	2009	Jordan Water Strategy 2009	In use	Jordan

* WESTERN ASIA

* Barbados, Colombia, Cuba, Costa Rica, Dominica, Dominican Republic, France, Jamaica, United Mexican States, Netherlands, Panama, St. Lucia, Trinidad and Tobago, UK, USA, Venezuela

Annex IV: Complementary sources

In September 2010 UN-Water established a Thematic Priority Area (TPA) on Water Quality to enhance inter-agency collaboration and support UN Member States in addressing global water quality challenges. The aim was also to monitor and report on the state of water quality, identify emerging issues and propose relevant responses (UN Water, 2014). Under the umbrella of UN-Water TPA on Water Quality, a series of initiatives were started to fulfil the aforementioned goals and to contribute to achieving the current development targets in the global agenda.

The International Water Quality Guidelines for Ecosystems (IWQGES)

The freshwater phase of ecosystems is an excellent proxy to characterise the ecological health of an upstream catchment or even an entire river basin. However, this potential is not yet utilised adequately.

Although international water quality guidelines already exist for other uses, similar regulatory mechanisms are needed for freshwater ecosystems. These would facilitate the integration of an ecosystem-based management approach in water resources management and allocation.

Further to the mandate from UN-Water, the UNEP Governing Council adopted decision GC 27/3 in February 2013, to "develop International Water Quality Guidelines for Ecosystems that may be voluntarily used to support the development of national standards, policies and frameworks taking into account existing information while integrating, as appropriate, all relevant aspects of water management". In implementing this decision, UNEP is working closely with the United Nations University – Institute for Environment and Human Security (UNU-EHS). A Drafting Group has been established for the drafting process, comprising international members of the scientific community.

The IWQGES focus on water quality conditions that sustain healthy freshwater ecosystems and their functions. They will additionally draw linkages between provisioned ecosystem services and respective human uses. The IWQGES are intended to be global in scope and relevance, with a strong focus on assisting developing countries.

Their objective is to define regionally relevant principles and thresholds, to advise how to establish standards to guide and support the formulation of locally relevant policies, and protection and rehabilitation towards improving freshwater ecosystem health.

These Guidelines are intended to be science-based recommendations, hence providing, among others, a set of non-prescriptive physical, chemical and biological characterisations of certain categories of freshwater ecosystems. The development of the IWQGES benefits from the Compendium and the other complementary activities described below to develop a roadmap, as follows:

A roadmap with scientifically based policy and technical recommendations to assist transnational, national and regional authorities in establishing appropriate regulatory mechanisms to improve the sustainable management of their water resources and protect freshwater ecosystems.

The World Water Quality Assessment (WWQA)

The WWQA is an initiative of UN-Water led by UNEP with the Global Environment Monitoring System for Water (GEMS/Water).[1] The assessment is two-fold: first, it identifies current and future problem areas of freshwater quality in surface waters, especially in developing countries; second, it evaluates policy options for addressing water pollution.

The WWQA will use the DPSIR conceptual framework to describe and analyse the global freshwater water quality with its connections between "drivers", "pressures", "state", impacts" and "responses". The analysis will be performed at global, regional and local levels.

Assessment goals

- Review the state of water quality in rivers and lakes/reservoirs, especially in developing countries, with particular emphasis on public health issues and the status of the freshwater fishery.
- Identify areas under serious threat by water pollution, now and over the coming decades.
- Identify policy options that can be replicated and scaled up to protect or restore water quality.
- Raise awareness of the importance of water quality degradation for local and national sustainable development.
- Increase the capacity of developing countries to protect or restore the quality of their surface waters, supporting identification and shaping of policy options.

3 The initial scientific partners for the assessment are as follows:

The UN-Water Group led by the United Nations Environment Programme.

The UNEP Global Environment Monitoring System for Water (GEMS/Water).

The Helmholtz Centre for Environmental Research-UFZ, Germany.

The Center for Environmental Systems Research-CESR, Germany.

Wastewater Monitoring and Assessment

UNEP is implementing a comprehensive Wastewater Monitoring and Assessment, which will establish significant wastewater targets and indicators that can also feed into the development of the IWQGES. The project will strengthen the normative wastewater assessment and monitoring baseline. Furthermore, a resource book of technologies for wastewater management will be established and an economic and sustainability rationale for wastewater management provided. The project will be directly undertaken by UNEP in its Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).