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Safe water and healthy water services in a changing environment

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Key messages

The present report summarises existing knowledge of climate change impacts on water services and health; the nature and effectiveness of the policy response; and the coverage and gaps in existing assessments of these themes.

The key messages arising from the analysis are as follows:

Climate change, water and health

- *Millennium Development Goal 7 (MDG7) is to halve the proportion of the global population without sustainable access to safe drinking water and basic sanitation by 2015. A WHO assessment in 2010 finds that access to improved water sources, sanitation and wastewater treatment has increased over the past two decades. However, in many countries in eastern European region the progress is slow. More than 50 % of the rural population in ten countries has no access to improved water, giving rise to important health inequalities.*
- *It is important to understand how climate change and extreme events will affect the achievement of MDG7. Drinking water supplies and sanitation systems will have to be made resilient to climate change and drinking water and sanitation must be fully incorporated in integrated water resource management.*
- *Climate change is projected to cause major changes in yearly and seasonal precipitation and water flow, flooding and coastal erosion risks, water quality, and the distribution of species and ecosystems.*
- *Climate change will impact all areas of water services — the quality and availability of water sources, infrastructure, and the type of treatment needed to meet quality standards. We will also see more frequent and severe droughts, flooding and weather events.*
- *Countries of eastern Europe, the Caucasus and central Asia face the greatest threats to safe water. The infrastructure in many towns and rural areas is in poor condition and water provision is erratic and of unsatisfactory quality.*
- *Heavy rainfall events may also lead to flooding, especially in urban areas, and this can have serious impacts on the performance and efficiency of water supply and wastewater treatment systems, which may potentially lead to health risks. Waterborne diseases arise predominantly from contamination of water supplies after heavy rainfall and flooding.*
- *Low river flows and increased temperatures during droughts reduce dilution of wastewater effluent, and drinking water quality could be compromised, increasing the need for extra treatment of both effluent and water supplies.*

Water management policies and extreme events

- *Water management policies at the European and EU level are being made increasingly adaptable to climate change, which should help safeguard public health and ecosystem services in the future.*
- *There are numerous guidelines for the design of water and human health policies across Europe (e.g. WHO guidelines for drinking water quality, Protocol on Water and Health, and draft guidance on water supply and sanitation in extreme weather). Recently such guidance has focused on how policies design and implementation might be affected by and adapted to climate change events.*
- *The WHO Vision 2030 study assesses how and where climate change will affect drinking water and sanitation in the medium term, and what can be done to maximise the resilience of drinking water and sanitation systems.*
- *Several existing EU policies address water management issues (the Urban Wastewater Treatment Directive, the Water Framework Directive, Floods Directive and the EU Water Scarcity and Droughts Strategy) and others deal more directly with potential water-related impacts on human health (e.g. the Drinking Water Directive, and Bathing Water Directive).*
- *There is a clear recognition that climate change creates a need for coherent, sustainable, cross-sectoral policy and regulation; sharing of available tools; facilitating mechanisms for partnerships and financing; and readiness to optimise across sectors during implementation.*
- *The water utility sector faces a unique set of challenges. A primary challenge will be enhancing its capacity to cope with climate change impacts and other*

human pressures on water systems, while fostering greater resiliency to extreme hydrologic events.
- *With more frequent higher-intensity storms projected, utilities face the need to update infrastructure design practices. This necessitates investments — not necessarily only in larger structures but also smarter (using better process control technologies) or local measures on stormwater runoff.*

The assessment knowledge base

- *At international, national and local levels, much information is produced for assessments of the state of water and related health impacts. Overall, both the current international and national water and health assessments have limited focus on extreme events and their effects on water services.*
- *In national assessments and programmes, countries appear to be aware of the adverse consequences of climate change on water and health. However, sometimes assessments appear to be based on 'expert knowledge', largely qualitative in scope, and not going further than identifying likely scenarios. The evidence-base is lacking to make reliable estimates of the health effects of climate change resulting from impacts on water resources.*
- *Much effort is now focused on the impact of climate change on water and the environment, including health-related impacts. Many international and European organisations have mapped out future climate change impacts on water-related issues, identifying vulnerable groups and vulnerable sub-regions.*
- *The vast majority of the assessments of drought and water scarcity have focused on the impact of water scarcity, water use by sectors and strategies for meeting demand. Very little consideration has been given to the health effects or consequences of future extreme events.*
- *The health effects of flooding do not feature significantly in national assessments. The main focus is identifying regions most at risk of flooding and preparing plans for responding and mitigating the main consequences.*
- *Sufficient public health competences exist to cope with the health effects of climate change. However, no (comprehensive) assessment has been undertaken to predict the severity or extent of future health risks related climate change's impact on water services.*
- *Irrespective of an assessment of the disease burden, actions being taken on the wider scale to respond to both water scarcity and drought and flooding will help to reduce the health effects associated with climate change and water.*

1 Introduction

The present report addresses the topic of safe water and healthy water services in a changing environment. It is the product of cooperation between the European Environment Agency (EEA) and the Italian Ministry of the Environment, Land and Sea (MATTM) in preparation for the Fifth Ministerial Environment and Health Conference in Parma in March 2010.

This report focuses on climate change's effects on water and ecosystems services, particularly under extreme weather conditions such as flooding and drought. It covers the European Region of the World Health Organization (WHO) ([1]) and is based on a review of existing assessments and other literature conducted by the Water Research Centre, UK, (WRC) during the period November 2009–February 2010.

The paper was also prepared as a contribution to the 'European Environment Assessment of Assessments' process prior to the 2011 Astana Environment Ministers Conference, which aims to support the development of a regular process for assessing the pan-European environment in an effective, streamlined and sustainable manner.

Safe and healthy water and the threat of climate change

United Nations Millennium Development Goal 7 calls on countries to 'Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation'. Within the context of this report, safe water is defined as water of sufficiently high quality that it can be consumed or used without risk of immediate or long-term harm. The focus in on human health rather than environmental health issues.

Climate variability and change increasingly threaten the supply of safe water via manmade infrastructure, as well as water-related ecosystem services (in this report together defined as 'water services').

More intense extreme events are already being observed, including heavy rainfall and flooding, and low flow and drought conditions. These will test water utilities' infrastructure ([2]) to the limit, risking the failure of water treatment plants, drinking water contamination and even the breakdown of supplies. It will also affect some of the water services, such as adequate water resources, that we take for granted today, meaning the loss of these 'free' goods.

As experience shows, most recently on the island of Madeira in February 2010, the direct human, environmental and economic consequences of extreme events are potentially very significant. Managing environmental and health threats also requires knowledge of the medium- to long-term recovery of ecosystems, and resilient water supplies and sanitation from utilities. EU countries have invested significantly in infrastructure to manage these threats but climate change induced variations in the water cycle are impairing their efforts.

For policymakers and utilities, a number of questions stand out:

- To what extent can existing policy and planning measures be effective tools to reduce risks arising from climate change?

([1]) The European Region of WHO comprises: Central Asia (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan); European Neighbourhood Policy (ENP) East (Armenia, Azerbaijan, Belarus, Georgia, Moldova, Ukraine); EU-27 (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom); Iceland, Israel, Monaco, Norway, the Russian Federation, San Marino, Switzerland, Turkey, Western Balkans (Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia, Slovenia, the former Yugoslav Republic of Macedonia). See http://www.euro.who.int/AboutWHO/About/MH.

([2]) For abstraction, water treatment, mains water supply, sewerage, wastewater treatment and effluent discharge.

- What technical and institutional barriers stand in the way of improving risk management in a changing environment?
- What practices are already being used to tackle and cope with the issues at local, national, EU and international levels?
- Do we have the information to answer these questions and if not what type of assessments are required to analyse the issue further and keep the problem under regular review?
- What could be the role of improving synergies with relevant responsible stakeholders such as utilities managers and technology researchers?

This report aims to bring these questions to the attention of policymakers and other relevant stakeholders to help develop a way forward which can assure supply of safe water and healthy functions of water services under a changing climate.

Report structure

The report is structured as follows.

Chapter 2 sets the scene, giving a summary of current understanding of how climate change and water cycle variations affect safe water and healthy water services.

Chapter 3 overviews and analyses the policy landscape to clarify whether current policies can meet the needs arising from climate change and identify gaps and challenges. It also addresses the role of utilities in making effective adaptation strategies and analyses existing practices to help identify opportunities for better decision-making and collaboration.

Chapter 4 contains an overview of available assessments and information on the safe water and health aspects of climate change. This summary aims to support policy development and implementation, as well as helping identify knowledge gaps to be filled in the future.

2 Climate change, water and health

Key messages

- *Millennium Development Goal 7 (MDG7) is to halve the proportion of the global population without sustainable access to safe drinking water and basic sanitation by 2015. A WHO assessment in 2010 finds that access to improved water sources, sanitation and wastewater treatment has increased over the past two decades. However, in many countries in eastern European region the progress is slow. More than 50 % of the rural population in ten countries has no access to improved water, giving rise to important health inequalities.*
- *It is important to understand how climate change and extreme events will affect the achievement of MDG7. Drinking water supplies and sanitation systems will have to be made resilient to climate change and drinking water and sanitation must be fully incorporated in integrated water resource management.*
- *Climate change is projected to cause major changes in yearly and seasonal precipitation and water flow, flooding and coastal erosion risks, water quality, and the distribution of species and ecosystems.*
- *Climate change will impact all areas of water services — the quality and availability of water sources, infrastructure, and the type of treatment needed to meet quality standards. We will also see more frequent and severe droughts, flooding and weather events.*
- *Countries of eastern Europe, the Caucasus and central Asia face the greatest threats to safe water. The infrastructure in many towns and rural areas is in poor condition and water provision is erratic and of unsatisfactory quality.*
- *Heavy rainfall events may also lead to flooding, especially in urban areas, and this can have serious impacts on the performance and efficiency of water supply and wastewater treatment systems, which may potentially lead to health risks. Waterborne diseases arise predominantly from contamination of water supplies after heavy rainfall and flooding.*
- *Low river flows and increased temperatures during droughts reduce dilution of wastewater effluent, and drinking water quality could be compromised, increasing the need for extra treatment of both effluent and water supplies.*

2.1 Climate change

In Europe as a whole, precipitation extremes such as heavy rain events have become more intense in the past 50 years and are projected to become more frequent and severe (EEA/JRC/WHO, 2008).

Observed data show that droughts and water shortages are longer and more severe in drought-prone regions such as southern and eastern Europe, due to decreased rainfall and enhanced evaporation. This trend is likely to continue in the future (Figure 2.1).

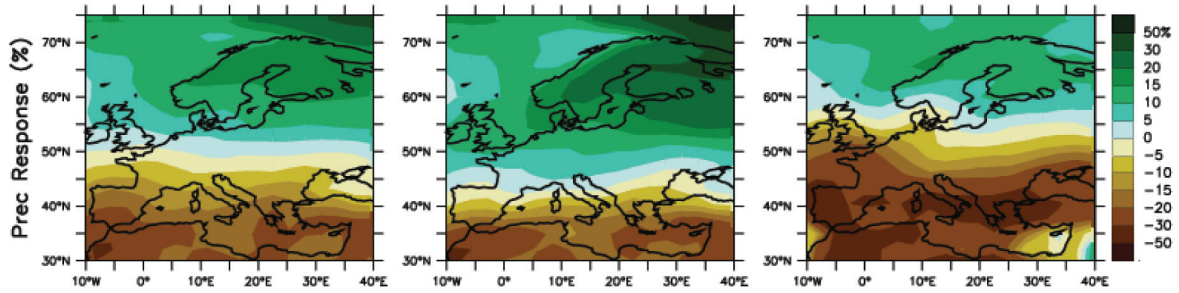
Climate change is projected to cause major changes in yearly and seasonal precipitation and water flow, flooding and coastal erosion risks, water quality, and the distribution of species and ecosystems. Models indicate that southern Europe, the Caucasus and central Asia will generally show a significant drying trend and northern Europe will become wetter (EEA, 2007; EEA/JRC/WHO, 2008).

In its 2008 report, the Intergovernmental Panel on Climate Change voiced serious concerns regarding water services in a changing climate:

> *Current water management practices may not be robust enough to cope with the impacts of climate change on water supply reliability, flood risk, health, agriculture, energy and aquatic ecosystems. In many locations, water management cannot satisfactorily cope even with current climate variability, so that large flood and drought damages occur. As a first step, improved incorporation of information about current climate variability into water-related management would assist adaptation to longer-term climate change impacts. Climatic and non-climatic factors, such as growth of population and damage potential, would exacerbate problems in the future* (IPCC, 2008).

Climate change will impact all areas of water services — the quality and availability of water sources, infrastructure, and the type of treatment needed to meet quality standards. We will also see

Figure 2.1 Percentage changes (averaged over 21 models) in annual (left), winter (middle) and summer (right) mean precipitation between 1980–1999 (observed) and 2080–2099 (predicted)



Source: EEA, 2008.

more frequent and severe droughts, flooding and weather events.

In some areas, current practices are unable to manage effects of hydrologic variability in a satisfactory fashion (EC, 2009; UNECE, 2009a). Unsustainable management has already created water shortages in many regions. The balance between water demand and availability has reached a critical level in many areas, such as the central Asian countries, as a result of over-abstraction and prolonged periods of low rainfall or drought.

Box 2.1 Effects of climate change on water quality in the Netherlands

While the possible effect of climate change on rainfall patterns in the Netherlands is reasonably well understood, there is much greater uncertainty regarding the impacts of this change on river water quality. However, experiences in the long period of drought in summer 2003 provide some indications. Flows in the rivers Rhine and Meuse were substantially lower than during the same period in 2002. The Meuse had particularly low flows as it is fed solely by rainwater, while the Rhine is also fed by snowmelt. Water quality in the Meuse deteriorated to almost stagnant conditions, with high temperatures, low dissolved oxygen and high chloride concentrations. The Rhine also showed significantly increased chloride concentrations, exceeding the drinking water standard for 17 days. Climate change may lead to an increase in the frequency, length and intensity of such low flow periods, and may therefore seriously affect water quality.

Source: Senhorst and Zwolsman, 2005.

Low river flows and increased temperatures during droughts reduce dilution of wastewater effluent, and drinking water quality could be compromised, increasing the need for extra treatment of both effluent and water supplies. Water treatment could also be affected.

Heavy rainfall events can exceed treatment plant capacity or lead to other infrastructure failures, resulting in increased emissions of pollutants to receiving waters, with severe short-term environmental pollution and health risks. Flood events may also cause contamination of reservoirs or other drinking water sources and of treatment works, which may lead to increased incidence of waterborne diseases.

2.2 Water and health

Safe water is a top priority environment and health issue within Europe. The WHO report 'Health and Environment in Europe: Progress Assessment' concluded:

> *[I]n many countries in the East of the Region the progress are slow: more than 50% of rural population of 10 countries has no access to improved water, giving rise to important health inequalities. Data on drinking-water related disease outbreaks indicate that unsafe water remains a burden to public health throughout the European Region, including the most economically developed countries* (WHO, 2010a).

Several outbreaks of drinking-water-related diseases have been reported in recent years. The burden of waterborne diseases is difficult to approximate, however, and is most likely underestimated (ENHIS,

Box 2.2 Outbreaks of waterborne diseases in Albania

Since 1988, Albania has lacked sufficient resources to sustain high standards of drinking water and sanitation. Frequent outbreaks of waterborne diseases have occurred and it is thought that high background rates of enteric diseases are also related to water quality. Water-related diseases seen in Albania in recent years include hepatitis A outbreaks in 2002 and 2006 totalling around 550 cases, 180 cases of gastroenteritis in 2007, typhoid fever, dysentery and poliomyelitis.

Source: EEHC, 2008.

2007; ECDC, 2009; EFSA, 2010). Generally, the risks of an outbreak are greater where the standard of water and sanitary services is low and a clear East-West divide is apparent in the geographic distribution of the incidence of waterborne diseases.

Intermittent drinking water supplies can reduce water quality, resulting in health issues. In regions where climate change may exacerbate water scarcity, problems with intermittent drinking water supplies may worsen.

Climate change will significantly increase the health risks by directly or indirectly affecting drinking water supply or wastewater treatment. Climate change will have a significant impact on the quality and quantity of water that is available for treatment to produce drinking water.

A considerable amount of water is lost from piped networks during distribution, often due to poor construction work, lack of maintenance and repair or illegal tapping. This is particularly pronounced in many of the countries of eastern Europe, the Caucasus and central Asia, which face much greater threats to providing safe water (OECD, 2007). With the exception of the wealthier countries and larger cities in these regions, the infrastructure in many towns and rural areas is in poor condition and water provision is erratic and of unsatisfactory quality. Unless the situation changes with higher priority given to proper construction and maintenance of water supply infrastructure, these countries may face increased vulnerability to the effects of climate change.

Extreme events such as flooding, drought, windstorms and periods of exceptionally high and low temperatures may lead directly to a multitude of adverse effects on human health, such as death, injuries and post-traumatic mental disorders. These events may also lead to an increase in diarrhoeal diseases, vector-borne diseases, respiratory infections, and skin and eye infections.

Floods can potentially increase the transmission of several water-borne and vector-borne diseases (WHO, 2010d). The risk of infectious diseases depends on a number of factors, including the impact of the disaster on water and sanitation systems, the availability of shelter and the scale of population displacement, the functionality of the public health infrastructure and access to healthcare services, and the nature of response after the disaster (Ivers and Ryan, 2006). Also, the pre-existing burden of infectious diseases in a population plays a role. There is increasing evidence of the impact that climate-related disasters have on mental health. For example, flooded communities experience a higher incidence of depression (Reacher et al., 2004). In Scotland, social, 'intangible' impacts, such as emotional losses, living in temporary accommodation and dealing with insurers, were more severe than the material losses, particularly among the elderly (Werritty et al., 2007).

Reduction in river flows may lead to increased stagnation, which, combined with rising temperatures, can create more suitable conditions for disease vectors such as mosquitoes to breed. Such advantageous conditions may favour the spread of vector-borne diseases new to the European region, such as Chikungunya fever. The first outbreak of this disease transmitted by the tiger mosquito was reported in Italy in 2007 (ECDC, 2009). On the other hand, drought conditions or severe floods may restrict the distribution of some vector-borne diseases, for example, Lyme disease (borreliosis), which is transmitted by ticks (Semenza and Menne, 2009).

The typical impacts of flood and drought extreme events are summarised in Table 2.1. Examples of the impacts listed in Table 2.1 are presented in the case studies below.

Water resources

In many locations, water use by agriculture, public water supply and tourism poses a threat to Europe's water resources and demand often exceeds availability (EEA, 2009). The combination of over-abstraction and periods of low rainfall result in low flow rivers, lowered groundwater levels and the drying up of wetlands. This in turn has detrimental

Table 2.1 Overview of types of impacts from flood or drought extreme events

Impact on \ Impact from	Flood	Drought
Water resources	Chemical and pathogenic contamination	Lack of resource Algae blooms in reservoirs
Drinking water	Pathogenic contamination	Lack of supply Need for more advanced treatment/ desalination
Bathing water	Pathogenic contamination	Eutrophication Toxic algae
Aquatic ecosystems	Combined sewer overflow Sediment resuspension	Low dilution High temperature
Water supply and sanitation infrastructure	Erosion/land slides Flooding of installations	Sediment accumulation

impacts on freshwater ecosystems, worsens water quality and permits saltwater to intrude in aquifers.

Many countries already face increasing demands on their water resources to meet ever greater requirements for domestic, industrial and agricultural use. Countries with abundant water resources will be well placed to cope with fluctuating availability caused by reduced rainfall. Even in these countries, however, extreme conditions may create demand that is difficult to satisfy.

Balancing the needs of all water users during a drought can be difficult and agencies must decide how water can be used most effectively to satisfy critical needs and minimise environmental impacts. Consumers must be motivated and educated to use water efficiently and share the limited amounts available. A drought management plan should aid the decision-making process and help minimise wastage.

Box 2.3 Drought in Cyprus

By 2008, Cyprus had suffered a fourth consecutive year of low rainfall and the drought situation reached a critical level in the summer. To ease the water crisis, 30 tankers delivered water from Greece. In addition, the Cypriot Government was forced to implement emergency measures, including cutting domestic supply by 30 %. Households were supplied with water three times a week for around 12 hours.

Source: EEA, 2009.

Due to changing conditions, water sources may be more contaminated and in dry periods there may be less dilution of pollutant discharges. Higher temperatures may also increase eutrophication and the potential for algal blooms associated with toxin-producing cyanobacteria. Once algae get into drinking water supplies they can cause gastroenteritis in humans and may also lead to a bad odour or taste in chlorinated waters.

Scarcity of regular water resources will encourage the use of alternative sources to supply drinking water, industrial processes and irrigation. Alternative sources include desalination, rainwater harvesting and reclaimed (or recycled) water. Treated wastewater can be used to top up depleted aquifers (Vigneswaran and Sundaravadivel, 2004; EEA, 2009).

If these alternative sources are to be used in emergency situations resulting from extreme events, public health must not be compromised. The sources must be properly quality assured before use in order not to introduce a new health risk.

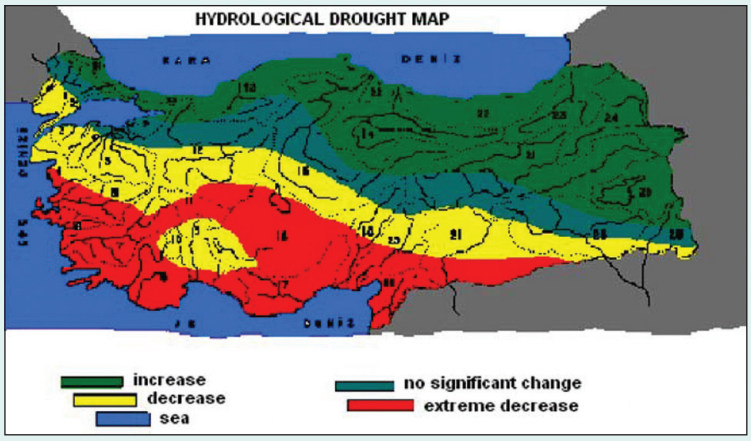
In cases of poor infrastructure, drought may lead to the use of water sources containing harmful contaminants, such as from old private wells, previously considered unsuitable and not equipped with treatment systems. Periods of drought may also lead to the breakdown of sanitation measures if insufficient water is available for personal and household hygiene and cooking. This leads to the

Box 2.4 Drought management plan for Ankara, Turkey

Significant decreases in annual rainfall have been seen in Turkey since the 1970s, with the most recent droughts in 2006 and 2007. Vulnerability to drought is influenced by a number of factors, including population growth, urbanisation and water use trends. Turkey's population has grown by around 2 % annually since 1927, with the largest growth in urban areas.

The city of Ankara is growing rapidly, but, due to its location, water resources are insufficient to meet demand. Accordingly, a drought management plan has been developed, setting out actions to be undertaken when water reserves hit certain 'trigger levels'. These include varying levels of restriction on the use of sprinklers, residential pools and hoses for car washing and halting operation of public fountains.

Figure 2.2 Hydrological drought map of Turkey



Source: WMO, 2009.

potential for increased mortality from infectious diseases and malnutrition.

Drinking water

Severe flood events can damage or inundate water treatment facilities and contaminate the distribution system, leading to severe water quality problems. An example is cryptosporidium, a parasite that can cause gastroenteritis in humans and is frequently found in water supplies following severe flooding. Oocysts, a spore form of the parasite, are very difficult remove efficiently from water supplies through filtration and coagulation. Those remaining are very resistant to water treatment and only a few are needed to cause infection.

Flooding events can also lead to other infectious diseases, via contamination of drinking water. These include hepatitis, cholera, typhoid, leptospirosis and dysentery. For example, heavy rainfall events have been linked to leptospirosis outbreaks in the Czech Republic in 1997 and 2002 (Zitek and Benes, 2005). Some episodes were also reported from Sweden, Finland, and the United Kingdom. In general, however, flooding in Europe has rarely been associated with an increased risk of waterborne disease outbreaks (Semenza and Menne, 2009).

Increased rainfall and higher temperatures may also cause problems with colour and odour of water supplies (Water UK, 2008).

Some developed countries have installed multiple barrier water treatment capable of responding to existing and emerging threats. Such infrastructure costs 20–30 % more than traditional equipment and is also very energy intensive.

The biggest issue in severe drought conditions is supplying sufficient good quality water to all users. Water companies in countries such as Spain and the United Kingdom have used drought controls such as the banning hosepipe and sprinkler use or the filling of swimming pools in order to ensure that sufficient supplies are available for essential services.

Efficient use of water will become increasingly important in the context of climate change but

Box 2.5 Floods in England 2007

In June 2007, extreme rainfall over the Midlands and northern England led to large-scale urban flooding, affecting more than 55 000 properties. The Environment Agency of England and Wales estimates that one-third of these were flooded by rivers and two-thirds from other sources,

predominantly surface water run-off overloading drainage systems. Combined damage from the June and July floods is estimated to be around GBP 3 billion.

Figure 2.3 Floods in Tewkesbury, 2007

Flooding of a wastewater treatment works in Gloucestershire left 140 000 of the 160 000 homes it serves without piped water. Water supplies were restored to all properties within 10 days but were not safe to drink until 15 days after the flood. Since this event, 1000 m of semi-permanent flood barrier to a height of 13.5 m AOD (Above Ordnance Datum) has been installed to protect against future flooding (Environment Agency, 2010a).

achieving it will be a major challenge for most countries and water suppliers. In England and Wales water companies have to prepare drought plans. These plans should be updated every three years and should include a range of actions to manage the situation and ensure public water supplies under future climate conditions (Environment Agency, 2010b).

Bathing water

Climate change is likely to cause a decline in the microbiological quality of bathing waters and a subsequent increase in their impact on human health. Climate change will lead to warmer summers with more intense rainfall and increased chances of flooding. This increases runoff, risk of eutrophication and algal growth rates, and decreases mixing of waters. Higher ambient temperatures are also likely to increase use of bathing waters with consequent higher potential for exposure to bacterial pollution or toxic algae. Direct skin contact with toxin producing cyanobacteria can cause allergic reactions, skin and eye irritation (UNESCO/IHP, 2005).

Climate change can create more favourable conditions for a number of pathogens, increasing their survival and therefore the risk

Figure 2.4 Algal Blooms in the Netherlands in 2005 and 2006

Source: Roijackers and Lürling, 2007.

of several infections, for example: Legionnaire's disease (*Legionella pneumophila),* leptospirosis (*Leptospira icterohaemorrhagiae*), cryptosporidiosis (*Cryptosporidium parvum*), giardiasis (*Giardia duodenalis)* and hepatitis A.

Rainfall-induced runoff has also been identified as the cause of faecal contamination in areas such as Hampstead Heath in London. This was a particular problem in 2006 when one bathing pond failed to meet bathing water standards because large amounts of dog faeces had been washed off the surrounding land (Haycock Associates, 2009).

Box 2.6 Algal blooms in the Baltic Sea

Unusually high temperatures in the Baltic Sea in recent years (e.g. 2006) have caused significantly increased growth rates of a range of bacteria and led to the formation of larger than usual algal blooms. For a number of species, this increase correlates with water temperatures above 15 or 16 °C, and cyanobacteria growth rates have increased faster than other algae (Roijackers and Lürling, 2007). Algal blooms have led to serious infections in bathers with open wounds (Semenza and Menne, 2009).

This indicates that warmer temperatures due to climate change will increase cyanobacterial growth rates and algal bloom occurrence and duration in this area, leading to a higher risk of infection in bathers.

Higher temperatures in the Netherlands in 2003 led to increased thermal stability and stratification in temperate lakes, and the same would be expected with climate change. The lack of movement in surface waters aids the development of blooms, and can lead to severe oxygen depletion and increased decomposition in deeper waters. This anoxia will provide ideal circumstances for some groups of pathogens (Roijackers and Lürling, 2007).

Aquatic ecosystems

Extreme rainfall events can result in stormwater discharges from combined sewer and surface water overflows, fluvial erosion leading to mobilisation of stored chemicals, and run-off of agricultural fertilisers and pesticides, animal wastes and manure. The predicted increased frequency and intensity of storms due to climate change will exacerbate these impacts.

If contaminated land, hazardous waste sites or sites used for storing pesticides or other potentially hazardous materials are flooded, contaminants can reach water courses and cause significant damage. Studies of the flooding of the River Elbe in 2002 illustrated the risks arising from several sources, including formerly contaminated river sediments in still water zones and bioaccumulated polychlorinated substances in biota (Stachel et al., 2004).

Heavy rainfall can also lead to weakening or failure of earth or mine tailings dams, as shown in the case study below.

Box 2.7 The Baia Mare accident, Romania

On 30 January 2000, in the town of Baia Mare, Romania, a mine tailings dam burst releasing over 100 000 cubic metres of cyanide and heavy metal contaminated water into the Sasar, Lapus, Somes and Tisza rivers. After two weeks, the contaminated water reached the Danube and then continued on, eventually reaching the Black Sea. The contamination caused substantial fish kills in the affected rivers, and also disrupted drinking water supplies.

The cause of the failure is thought to have been an overflow of the ponding liquid, caused by snowmelt and heavy rain. Heavy climate-change-related rainfall could cause similar failures in the future if sufficient precautions are not taken.

Source: WISE Uranium Project, 2001; UNECE, 2010b.

Low flows and subsequent intense rainfall events may also lead to fish kills, such as the one detailed below. Increased temperatures can also put cold water fish at risk. Some aquatic organisms may alter their spatial distribution, moving to find the most suitable water quality and temperature, while other species may become extinct. Farmed fish and shellfish may also be affected by changes in water level, temperature, oxygen levels and increased levels of harmful algae (Cheney and Dewey, 2005).

Box 2.8 Fish kills in Southport, United Kingdom

In July 2009, heavy rainfall led to untreated sewage from a storm water overflow being discharged into the Three Polls Waterway. Combined with already low dissolved oxygen levels due to recent hot weather, this caused a major fish kill. It is estimated that between 15 000 and 20 000 fish died. The Environment Agency of England and Wales used pumps to move and dilute the effluent and introduced hydrogen peroxide to increase oxygen levels.

Source: Environment Agency, 2009.

Severe drought can degrade or destroy wetland ecosystems through changes in water availability, higher temperatures and increased evaporation rates, causing a deterioration in wildlife habitats (WMO/UNEP/IUCN 2009). Changing temperatures may also cause many plants and animals to migrate polewards, and species which cannot move as easily may be lost.

Water supply and sanitation infrastructure

Heavy rainfall events can exceed network capacities in combined sewer and surface water networks. Existing sewerage systems were designed to withstand certain rainfall intensities and return periods. Consequently, increasing rainfall intensities and return periods in some regions due to climatic changes will result in more frequent urban flooding and increased damage unless adaptation measures are taken.

Flood events may put a large number of water and wastewater treatment works and pumping stations at risk of flooding in many places on the network. This may lead to the failure of operation and the loss of public water supplies, and can also have significant impacts on drinking water quality.

Assets on the coast (such as pipe networks, water and wastewater treatment works and pumping stations) will also be at increased risk of coastal flooding and storm damage, and may be lost altogether through coastal erosion and sea level rise.

Reduced flushing by stormwater and — to some degree — reduced water use under drought conditions means that the self-cleaning capacity of sewers will be reduced. In catchments with minimal slopes, this may induce sediment deposits, in worst cases leading to blockages.

3 Current water management policies and extreme events

Key messages

- *Water management policies at the European and EU level are being made increasingly adaptable to climate change, which should help safeguard public health and ecosystem services in the future.*
- *There are numerous guidelines for the design of water and human health policies across Europe (e.g. WHO guidelines for drinking water quality, Protocol on Water and Health and draft guidance on water supply and sanitation in extreme weather). Recently such guidance has focused on how policies design and implementation might be affected by and adapted to climate change events.*
- *The WHO Vision 2030 study assesses how and where climate change will affect drinking water and sanitation in the medium term, and what can be done to maximise the resilience of drinking water and sanitation systems.*
- *Several existing EU policies address water management issues (the Urban Wastewater Treatment Directive, the Water Framework Directive, Floods Directive and the EU Water Scarcity and Droughts Strategy) and others deal more directly with potential water-related impacts on human health (e.g. the Drinking Water Directive, and Bathing Waters Directives).*
- *There is a clear recognition that climate change creates a need for coherent, sustainable, cross-sectoral policy and regulation; sharing of available tools; facilitating mechanisms for partnerships and financing; and readiness to optimise across sectors during implementation.*
- *The water utility sector faces a unique set of challenges. A primary challenge will be enhancing its capacity to cope with climate change impacts and other human pressures on water systems, while fostering greater resiliency to extreme hydrologic events.*
- *With more frequent higher-intensity storms projected, utilities faced the need to update infrastructure design practices. This necessitates investments — not necessarily only in larger structures but also smarter (using better process control technologies) or local measures on stormwater runoff.*

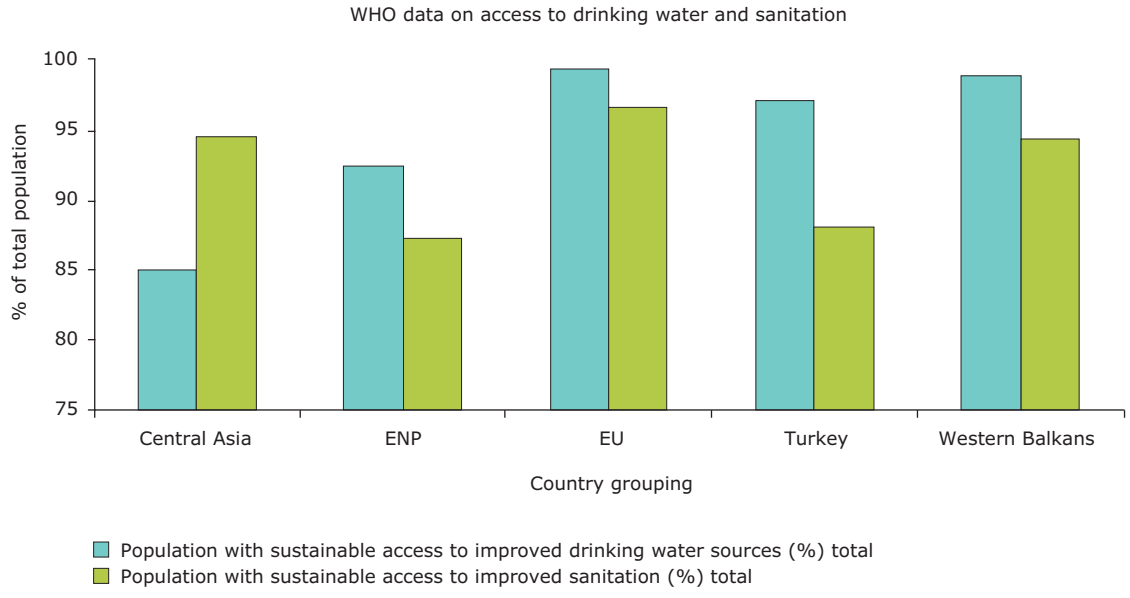
The present chapter assesses the ability of existing policy and legislation to protect human health and ecosystem services in the context of environmental change and extreme events. There are numerous guidelines for the design of water and human health policies across Europe. Recently such guidance has focused on how policies design and implementation might be affected by and adapted to climate change.

3.1 European level

The WHO guidelines for drinking water quality are the basis for international and national standards, and drinking water quality regulations. The guidelines contain advice for establishing incident response plans. During emergency situations, guideline values (for short-term exposure) for some, but not all, substances, are increased. The guidelines also recommend Water Safety Plans (WSPs) to ensure safe drinking water through good water supply practice. They apply to all types and sizes of water supply systems. Because the WSP approach is flexible and adaptable to national situations, Plans are suited to deal with changes in water quantity and quality resulting from climate change and extreme weather events.

The Vision 2030 study (WHO/DFID, 2009) assesses how and where climate change will affect drinking water and sanitation in the medium term, and what can be done to maximise the resilience of drinking water and sanitation systems. The focus is on low- and middle -income countries, where climate change risks are greatest and access to water supply and sanitation services is relatively limited. The study is seen as a contribution to achieving Millennium Development Goal 7 (MDG7) on halving of the proportion of the global population without sustainable access to safe drinking water and basic sanitation by 2015. One conclusion of the study was that there is an urgent need for drinking water and sanitation to be fully incorporated into integrated water resources management.

Figure 3.1 WHO data for 2006 on sustainable access to drinking water and sanitation (WHO, 2010b)



Note: The grouped data are simple averages of the country percentages: there has been no weighting according to the population of each country.

Central Asia: Kazakhstan; Kyrgyzstan; Tajikistan; Uzbekistan.

ENP: Armenia; Azerbaijan; Georgia; Republic of Moldova; Ukraine.

EU: Belgium; Bulgaria; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Luxembourg; Malta; the Netherlands; Poland; Portugal; Romania; Slovakia; Spain; Sweden; the United Kingdom.

Western Balkans: Albania; Croatia; Serbia; the former Yugoslav Republic of Macedonia.

In 2005, almost 16 % of the population (140 million people) in the WHO European Region lacked a household connection to a drinking water supply, 10 % (85 million people) lacked basic sanitation and 5 % (41 million people) lacked access to a safe drinking water supply (WHO Europe, 2005). Inequities in the region are greatest for sanitation. The lack of progress towards MDG7 is most pronounced in rural areas (Figure 3.1).

The Protocol on Water and Health to the 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes targets access to drinking water and sanitation for all. It also advises that Parties should take preventative action to avoid water quality incidents and that full contingency plans should be developed to aid response to water-related disease incidents, especially those caused by extreme weather events. The Protocol came into force on 4 August 2005 and as of September 2009 there were 36 signatories and 24 ratifications. Of the countries covered in the current report, two-thirds have signed and around half have ratified the Protocol. None of the Central Asian countries have signed or ratified the Protocol and not all EU Member States have signed or ratified the Protocol.

In 2007 the Parties to the Protocol on Water and Health established a Task Force on Extreme Weather Events to develop guidance on water supply and sanitation in extreme weather. The guidance is expected to be submitted to the Parties at their second meeting in Autumn 2010 (UNECE, 2009b). This guidance document sets out adaptation strategies for extreme events including vulnerabilities and impacts of extreme weather, risk assessment and management, and warning and communication systems. In addition guidance on water and climate adaptation is jointly being developed with the Task Force on Water and Climate. European Union

Several existing EU policies address water management issues (the Water Framework Directive, Floods Directive and the EU Water Scarcity and Droughts Strategy) and others deal more directly with potential water-related impacts on human

health (e.g. the Drinking Water Directive, Bathing Waters Directives and EU Food Hygiene Regulations (in terms of shellfish flesh)). These policies apply to the 27 EU Members States but are also relevant to EU candidate and potential candidate countries. Through the EU Neighbourhood policy, these policies are also relevant for Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine, because although there is no general obligation to accept Community laws and policies, harmonisation with the relevant laws and policies may be required in order to participate in and reap the full benefits of Community programmes.

One of the aims of the Water Framework Directive (WFD) is to mitigate the negative effects of floods and droughts. Climate change may affect the occurrence and severity of floods and droughts but is not explicitly addressed in the Directive. However, the cyclical nature of River Basin Management Plans (RBMP) makes them well suited to managing climate change impacts adaptively.

The Commission has recently published a guidance document, entitled 'River basin management in a changing climate' (EU, 2009). It is aimed at those responsible for river basin management, including flood and drought risk management, for delivery of the second and third RBMP cycles (from 2015 until 2027). This planning process will require a combined approach that balances efforts to enhance monitoring and understanding of climate-driven impacts, with implementation of 'no regret' actions to improve resilience and ensuring that long life-time investments are climate resilient.

The Floods Directive (2007/60/EC), which came into force in 2007, also provides a framework for adaptation to climate change. It establishes a legal framework for assessing and managing flood risks across Member States, aiming to reduce adverse consequences of floods to human health, the environment, cultural heritage and economic activity. Climate change is explicitly included in the Floods Directive, and Member States are clearly expected to take into account the likely impacts of climate change on the occurrence of floods. Although all types of flood might be considered, the Directive indicates that flooding from sewers may be excluded. Importantly, it requires States to map probabilities of floods and assess resulting risks.

The implementation of the Floods Directive and the WFD must be coordinated from 2015, when the second cycle of RBMPs commences. This will therefore provide an opportunity to deliver cost-effective and sustainable catchment-based approaches that realise multiple benefits for flood risk management, water scarcity and drought management and river basin management.

The European Commission adopted an official Communication regarding water scarcity and droughts on 18 July 2007 (EC, 2007b), which aims to further adaptation measures to address increasing impacts of water scarcity and droughts in coming decades. Recommendations include drafting Drought Management Plans and establishing a European Drought Observatory. The Commission also introduced the possibility of using European funds for countries suffering prolonged droughts. The EC's Adaption to Climate Change White Paper (COM/2009/147) was issued in April 2009 and sets out a framework to reduce the EU's vulnerability to climate change impacts.

Also relevant is the European Commission's communication on an approach on the prevention of natural and man-made disasters (COM (2009) 82 final). Issued in February 2009, it sets out the framework for the steps in the risk management cycle: prevention, preparedness, response and recovery.

The objective of the EU Drinking Water Directive (98/83/EC) (DWD), which entered into force in 1998, is to protect the health of the consumers in the European Union and to make sure the water is wholesome and clean. Member States may exempt water supplies serving less than 50 persons or providing less than 10 m^3 of drinking water per day on average. The Commission is currently revising the DWD to ensure consistency with other EU policy such as the WFD. The Water Safety Plan approach, as proposed by WHO in the 2004 guidelines for drinking water quality, is being integrated. As a result, drinking water quality surveillance would shift from focusing only on the quality at the tap towards quality control from abstraction to delivery. The revision should also address drinking water quality for small supplies, which at present create large health risks for significant parts of the EU population.

Drinking Water Protected Areas (DWPAs) were introduced under Article 7 of WFD. These are defined as all bodies of water used for the abstraction of water intended for human consumption providing more than 10 m^3 a day on average or serving more than 50 persons, and those bodies of water intended for such future use. Each DWPA must meet the requirements of the DWD. This includes a general requirement to ensure that water is free from contamination that

could constitute a danger to human health, and a requirement to comply with formal DWD standards at the point of delivery to consumers (i.e. the tap).

The revised Bathing Water Directive 2006/7/EC entered into force on 24 March 2006 and Member States will have to publish their first classification of bathing waters under the new Directive in 2015. In determining compliance with bathing water standards, the Directive allows States to take account of 'short-term pollution' (not expected to affect bathing water quality for more than 72 hours) and 'abnormal situations' (events impacting bathing water quality on average not more than once every 4 years). Normal sampling can be suspended during abnormal situations. Bathing waters may temporarily be classified as 'poor' as a result of short term pollution and abnormal events and still remain in compliance with the Directive as long as the public are advised and informed of the potential health impacts of bathing in affected waters using signs and media such as the internet. Bathing may also be prohibited.

There is no explicit mention of quality deterioration under extreme circumstances in the Nitrates Directive (91/676/EC) though action programmes for Nitrate Vulnerable Zones should consider climatic conditions and rainfall when applying rules on the limitation of fertiliser use on land.

3.2 National actions

More intensive rainfall or prolonged rainfall events are likely to increase discharges from stormwater overflows either from combined sewage and surface drainage systems or just from surface water run-off. Combined sewers are responsive to rainfall: the heavier the rain the greater the flow the sewer has to carry. The overloading arising from prolonged heavy rain if not relieved from combined sewer overflows (CSOs) could lead to storm sewage flooding homes, roads and open spaces. Such discharges are often highly polluting in terms of organic matter and microbiological contaminants and hence have to be subject to the regulatory processes within countries as they are not regulated directly via the Urban Waste Water Treatment Directive (UWWTD) and only indirectly via the Water Framework Directive (WFD).

In the United Kingdom, for example, specific standards for intermittent discharges are used to regulate and consent CSO discharges. These are based on permitted (standard) concentrations of dissolved oxygen and ammonium in the receiving waters in relation to defined periods of exposure to pollutants in the discharge, and the frequency of discharge events (return period). The capacities of the sewerage system and storm tanks are then designed to meet the standards. In terms of regulating chemical substances at the EU level, maximum allowable concentrations (MAC) environment quality standards (EQS) have been set to help safeguard aquatic ecosystems from the effects of intermittent and short events such as storms (COM 2010). The MAC EQSs are used in conjunction with annual average EQSs which are for protection against long-term acute exposure to chemicals.

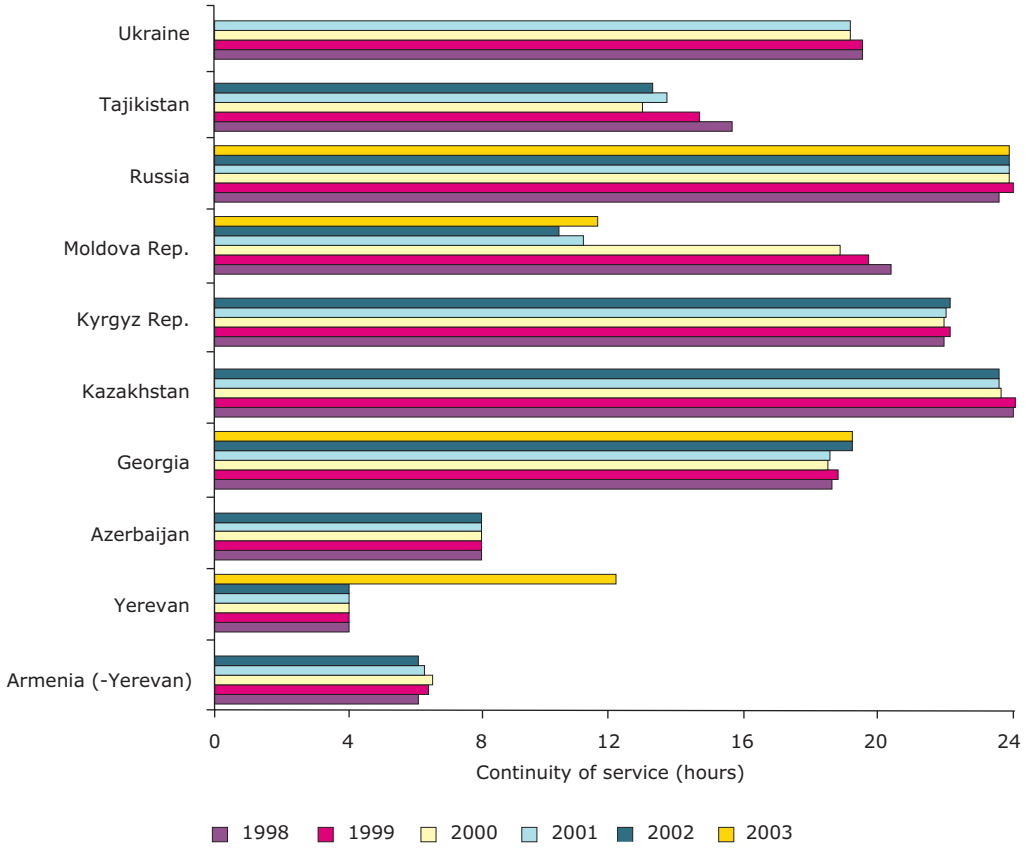
Box 3.1 Combined sewage overflows in England and Wales

In the early 1990s it was estimated that there around 25 000 CSOs in England and Wales and that some 8 000 were causing pollution problems (Clifforde et al., 2006). The cost of improving these CSOs was estimated at some GBP 3 billion. The Urban Waste Water Treatment Directive (91/271/EC amended by 98/15/EC) requires action to limit pollution from storm overflows and to improve unsatisfactory intermittent wet weather discharges from CSO and storm tanks at wastewater treatment plants. However, the criteria for effluents from urban wastewater treatment plants do not apply under unusual situations, such as heavy rain. By the end of 2008 more than 6 000 overflows posing the highest risk had been improved, rebuilt or removed altogether (Water UK, 2009).

National Water Policy Dialogues were launched in the Kyrgyz Republic in 2008 and in Tajikistan and Turkmenistan in 2009 under the EU Water Initiative. They are used to develop 'Policy packages', which guide policy reforms towards sustainable development and water supply and sanitation infrastructure development, including environmental conservation, prevention of water pollution, strengthening of regulatory services and institutional frameworks (EC external relations. 2009).

The UNECE Environmental Strategy for the countries of Eastern Europe, Caucasus and Central Asia was adopted in 2003 and aims towards convergence with EU policy. The strategy includes all countries in the ENP East and Central Asian groupings in this report. Countries of eastern Europe, the Caucasus and Central Asia face the greatest threats to safe water. The infrastructure in many towns and rural areas is in poor condition and water provision is erratic and of unsatisfactory quality. Progress on water supply rates is shown

Figure 3.2 Continuity of water supply (hrs/day) in countries of eastern Europe, Caucasus and central Asia



Source: EEA, 2007b.

in Figure 3.2. Many countries have improved the institutional and legislative framework for the water sector and some have developed legislation to guide tariff setting but progress in pricing is uneven.

Box 3.2 Promoting metering in Armenia

Metering of water sources contributes to water company finances and consequently helps improve supply coverage. Armenia has developed an incentive framework for households that encourages them to request meters and cover the installation costs. The National Assembly passed a law in 2002 that offered to write off a portion of past arrears for households that installed a water meter within six months.

This has had a significant positive effect on the bill collection rate, enhancing the financial standing of the water companies and increasing transparency in the water sector.

Source: EAP Task Force/EUWI, 2007.

3.3 Potential institutional barriers at national level

There is a clear recognition that climate change creates a need for coherent, sustainable, cross-sectoral policy and regulation; sharing of available tools; facilitating mechanisms for partnerships and financing; and readiness to optimise across sectors during implementation.

At national governmental level, several ministries normally share responsibility for handling water and health issues, including the ministries of environment, agriculture, industry, and health. This division of responsibilities, which is also apparent at the EU level, evidently calls for cooperation across sectors to manage and balance conflicting interests.

As an example, the Water Framework Directive (WFD) specifically includes River Basin Management Plans with Programme of Measures working across sectors with the aim of integrated approaches for cost-effective solutions

3.4 Roles of utilities

An International Water Association (IWA) paper summarising practical responses and actions for the water industry to manage climate change reports that:

The water utility sector has a unique set of challenges ahead. A primary challenge for the water sector will be to enhance its capacity to cope with the impacts of climate change and these other human pressures on water systems while fostering greater resiliency to extreme hydrologic events. The impact of climate change on drinking water resources and services is of increasing concern to a growing number of utilities worldwide. Driven by shareholder expectations, regulatory constraints, customers with their own set of growing expectations, and governments with responsibilities to deliver on both water quantity and quality objectives, these concerns present a future of increased risk across the climate, social and economic areas. (IWA, 2009).

Whereas regulatory bodies at the European, national, regional or local levels are responsible for setting standards and checking compliance, water utilities are responsible for delivering safe water — as drinking water for consumers and as treated effluents for discharges to the environment. Consequently, each utility has to take very site-specific measures to adapt to projected increases in extreme events, relating to both water supply security and quality.

Several professional associations, representing various joint interests of the 'water industry' or the 'water sector' have been established to promote research and development, practical implementation and knowledge sharing. They include both national associations, those at the European level, such as EUREAU ([3]), and those at the international level, such as IWA.

These frameworks make available numerous technical documents and facilitate events (conferences, workshops, exhibitions) and professional networking to promote efficient planning and operations for the utilities (Parkinson and Mark, 2005; AWWA and IWA, 2010).

It is the role of utilities to install the appropriate technologies to provide safe water and limit overflows and urban floods from sewerage and stormwater collection systems. A wide range of technologies already exist and are continuously under further development. However, the implementation depends on drivers as well as abilities.

Management of extreme events by utilities involves both risk and hazard management and there is always a risk that the capacity of infrastructure may be exceeded. Design practices are therefore typically based on certain accepted return periods (frequencies) of exceedance, e.g. based on corresponding storm intensities and durations.

With more frequent higher-intensity storms projected, utilities faced the need to update infrastructure design practices. This necessitates investments — not necessarily only in larger structures but also smarter (using better process control technologies) or local measures on storm water runoff.

Concerning operator ownership, over 70 % of the total population in EU and EFTA countries are served by a public or a public-private operator for drinking water services, the figure being 80 % in the case of wastewater services. In France, the Czech Republic, and the United Kingdom, more than 50 % of the population is served by a private or mixed (public-private) operator both for drinking water and wastewater services (EUREAU, 2009).

Regardless of whether ownership is private or public, utilities need to balance financial priorities against environmental and social responsibilities. For example, utilities may face a choice between making extra investments in infrastructure or allowing environmental services or society at large to bear the costs that arise when infrastructure proves inadequate during extreme events. In this context, it is important to note that regulating the prices that utilities can charge consumers is likely to influence investment decisions, potentially affecting the balance between a utility's financial and environmental goals.

([3]) EUREAU is the European federation of national associations of drinking water suppliers and waste water services.

4 An overview of the assessment knowledge base

Key messages

- *At international, national and local levels, much information is produced for assessments of the state of water and related health impacts. Overall, both the current international and national water and health assessments have limited focus on extreme events and their effects on water services.*
- *In national assessments and programmes, countries appear to be aware of the adverse consequences of climate change on water and health. However, sometimes assessments appear to be based on 'expert knowledge', largely qualitative in scope and not going further than identifying likely scenarios. The evidence-base is lacking to make reliable estimates of the health effects of climate change resulting from impacts on water resources.*
- *Much effort is now focused on the impact of climate change on water and the environment, including health-related impacts. Many international and European organisations have mapped out future climate change impacts on water-related issues, identifying vulnerable groups and vulnerable sub-regions.*
- *The vast majority of the assessments of drought and water scarcity have focused on the impact of water scarcity, water use by sectors and strategies for meeting demand. Very little consideration has been given to the health effects or consequences of future extreme events.*
- *The health effects of flooding do not feature significantly in national assessments. The main focus is identifying regions most at risk of flooding and preparing plans for responding and mitigating the main consequences.*
- *Sufficient public health competences exist to cope with the health effects of climate change. However, no (comprehensive) assessment has been undertaken to predict the severity or extent of future health risks related climate change's impact on water services.*
- *Irrespective of an assessment of the disease burden, actions being taken on the wider scale to respond to both water scarcity and drought and flooding will help to reduce the health effects associated with climate change and water.*

4.1 'Assessment of Assessments'

At international, national and local levels, much information is produced for assessments of the state of water and related health impacts. This chapter reviews the knowledge on safe water and health aspects of climate change and extreme events as described in the previous sections. The review is not exhaustive and does not include a complete overview of European water assessments. The illustrative approach taken, covering selected examples of assessments from European, national and local/specific levels, is an input into a more in-depth and comprehensive 'Assessments of Assessments' which is needed on this topic (see Box 4.1).

4.2 Assessments of water and health

The information and assessments on water produced by European countries at regional and local levels has markedly increased over the last 15–20 years. Similarly much information has been produced on health and water, and in recent years on climate change impacts. Information on water and health is often scattered across many institutions and gathered in non-standardised formats.

Most countries have water and health topic websites describing the state of water, and environment and health impacts. In addition, countries generally report every one to four years on the state of water and several countries have established Internet-based services that provide public access to monitoring results and water assessments.

The quantity of regional and local information and assessments on water produced in Europe has increased markedly over the last 15–20 years. Similarly much information has been produced on health and water, and, in recent years, on climate change impacts. In general, however, existing international and national water and health assessments have only a limited focus on extreme events and their effects on water services.

Box 4.1 Role of an 'Assessment of Assessments' in supporting sound policy

Europe's Environment Assessment of Assessments

Assessments are formal efforts to assemble selected knowledge with a view to making it publicly available in a useful form for decision-making

Background

The Europe's Environment Assessment of Assessments (EEAoA) is inspired by the marine environment 'Assessment of Assessments' (AoA) published at the end of 2009 (AOA, 2009). The marine AoA was undertaken as part of the start-up phase establishing a regular process for global reporting and assessment of the state of the marine environment.

Concept and approach

Following the AoA approach and in preparation for the Astana environment ministers conference to be held in the autumn of 2011, the EEAoA will provide a critical review of existing environmental assessments that are of relevance to the region, specifically those at the national, sub-regional and pan-European levels.

The aim is to identify gaps, overlaps and emerging issues, as well as good practice in preparing effective environmental assessment. From this, proposals will be prepared on how to build a framework for continuous pan-European assessments to keep the European environment under constant review. This is foreseen to include the gradual development of a shared environmental information system (SEIS) in the region and a possible extension of Eionet.

Like the marine AoA and other integrated assessment activities, the EEAoA will evaluate assessments against three major criteria: scientific credibility; policy relevance and usefulness; and legitimacy. The process will seek to maximise these properties in a future regular process of assessment.

The Protocol on Water and Health to the 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes includes legally binding targets ([4]) on the prevention of waterborne diseases (UNECE/WHO Europe, 1999). The WHO Regional Office for Europe is assisting Member States to reduce ill health from water-related diseases by:

- supporting implementation of the Protocol on Water and Health;
- carrying out capacity-building activities at regional, sub-regional and country levels by developing, revising and updating manuals and guidelines (WHO Europe, 2010).

During the last ten years there has been more focus on assessing water and health in Europe. The first European assessment was published in 2002 as a joint EEA/WHO report (EEA/WHO, 2002).

WHO Europe has investigated the region's progress after the 2004 Fourth Ministerial Conference on Environment and Health, where ensuring access to safe and affordable water and adequate sanitation was recognised as a regional priority. The findings are published in four fact sheets that will contribute to discussions at the Fifth Ministerial Conference on Environment and Health (WHO Europe, 2010). The factsheets cover the following issues:

- outbreaks of waterborne diseases;
- public water supply and access to improved water sources;
- access to improved sanitation and wastewater treatment;
- bathing water quality.

The WHO 2010 report, 'Health and Environment in Europe: progress assessment' (WHO, 2010a), concluded:

> *The analysis of the data on the water-related risks to health concluded that population access to improved water sources, sanitation and wastewater treatment has increased, over the past two decades, in most, but not all, countries. However many countries in the East of the Region the progress are slow: more than 50% of rural population of 10 countries has no access to improved water, giving rise to important health inequalities. Data on drinking-water related disease outbreaks indicate that unsafe water remains a burden to public health throughout the European Region, including the most economically developed countries. Harmonized waterborne diseases and outbreak surveillance systems are still missing*

([4]) Although legally binding, the Protocol is non-confrontational and non-judicial

in majority of the countries in the Region, as are systems for monitoring bathing water related health risks.

The European Environment and Health Information System (ENHIS) identifies gastrointestinal diseases as a key health effect linked to the provision of proper water and sanitation services (ENHIS, 2010).

WHO Guidelines for Drinking Water Quality promote a systematic approach towards ensuring microbial safety and require the development of a management strategy based on the concept of (drinking) Water Safety Plans (WSP). When implemented, a WSP provides the basis for ensuring that harmful chemicals and pathogens present a negligible risk to public health.

The current European Union Drinking Water Directive (Council Directive 98/83 EC) requires that drinking water must be wholesome and sets standards for quality at the tap. These standards are generally based on those in the WHO Guidelines. The Directive is currently undergoing revision and it is likely that a new regime for safeguarding water quality will be adopted which incorporates a risk-based approach to operating and managing drinking water supply systems compatible with the WHO Water Safety Plan framework.

The Third Ministerial Conference on Environment and Health in 1999 called for the development of national environmental health action plans (NEHAPs) to address environmental health. So far, more than 40 countries in the European region have developed a NEHAP. As general guidance, most NEHAPs address the following subject areas in terms of policy and planning (WHO, 2010c): environmental health management; environmental health hazards and media including drinking water and bathing water; and economic sectors.

In 2004, the Fourth Ministerial Conference on Environment and Health adopted the Children's Environment and Health Action Plan for Europe (CEHAPE), including a regional priority goal to ensure access to safe and affordable water and adequate sanitation (focusing on children). In the process leading up to the Fifth Ministerial Conference on Environment and Health, most countries have provided information on progress made in implementing this Regional Priority Goal I. These national overviews are for some countries supported by separate documents assessing their activities for providing safe waters.

4.3 Assessments of climate change and water and health

Much effort is now focused on the impact of climate change on water and the environment, including health-related impacts. Many international and European organisations have mapped out future climate change impacts on water services to populations, identifying vulnerable groups and vulnerable sub-regions (e.g. EEA-JRC-WHO 2008; IPCC. 2008).

The IPCC Fourth Assessment (IPCC, 2007) and its 2008 technical report on climate change and water together provide a comprehensive assessment of future climate change impacts on water (IPCC, 2008). In 2008 the European Environment Agency, the European Commission's Joint Research Centre and WHO provided an overview of climate change impacts in Europe including impacts on water quantity and quality and some of water-dependent sectors (EEA/JRC/WHO, 2008). On 25 November 2009, the final report of the PESETA project was published. This JRC research project integrates a set of high-resolution climate change projections and physical models into an economic modelling framework to quantify the impacts of climate change in vulnerable areas in Europe, including impacts river floods and human health (JRC, 2009).

Both Parties to the UNECE Water Convention and the European Community have in recent years focused on providing more information and guidance on assessing climate change impacts on water and adaptation to future conditions. In November 2009, at its fifth session, the Meeting of the Parties to the Water Convention adopted the guidance on water and adaptation to climate change and in the same month the water directors of EU Member States issued a guidance document on adaptation to climate change in water management (CEC, 2009). Draft guidance on water supply and sanitation in extreme weather events is current being prepared (UNECE/WHO Europe 2009)

Improved understanding of climate change impacts on water services in Europe has identified the need for research to quantify better the links between weather patterns and transmission of infectious waterborne diseases. The programme 'Climate Change and Adaptation Strategies for Human health' in Europe (cCASHh) assessed the major guidelines for health risk assessment, and climate change impact, vulnerability and adaptation assessment (Füssel and Klein, 2004).

A workshop organised by the European Centre for Disease Prevention and Control identified the risks that climate change would pose for infectious disease and public health and assessed the capacity for response (ECDC, 2007). A range of potential scenarios were examined to determine the effects on the transmission of water, food and vector-borne diseases, but the workshop was not able to judge the severity of the risk.

At national level, a number of countries have made detailed assessments of the likely impacts of climate change. These reports have tended to identify the risks posed by climate change but have not determined the scale of the problem or identified adaptation measures (WHO Europe, 2008a).

Parties to the Convention on Climate Change (UNFCCC) must submit national reports on implementation of the Convention to the Conference of the Parties (UNFCCC, 2010). These communications contain a chapter with assessment of vulnerability, climate change impacts and adaptation measures. A review of the national communication reports found that most of them had description of climate change effects on water resources but did not contain detailed assessments of the likely health impacts of climate change and only limited information of the consequences for water services under extreme events.

4.4 Assessments of water scarcity and drought

The vast majority of the assessments of drought and water scarcity have focused on the impact of water scarcity, water use by sectors and strategies for meeting demand. Very little consideration has been given to the health effects or consequences of future extreme events.

The European Commission carried out an assessment of water scarcity and drought in 2006 and early 2007 (EC, 2010). The assessment identified the principle sectoral water users; the extent of water scarcity and drought; and possible gaps in implementation of existing EU policy instruments. Based on the assessment, on 18 July 2007 the Commission adopted a Communication addressing the challenge of water scarcity and droughts in the EU (EC, 2007). The assessment also noted significant data gaps and uncertainty in estimating water availability, and water abstraction.

In March 2009, EEA published the report 'Water resources across Europe — confronting water scarcity and drought' (EEA, 2009). The report provides a comprehensive overview of water availability, water abstraction and water scarcity in Europe and addresses possibilities for and progress towards fostering demand-side management of water resources. It also discusses sustainable supply-side measures. Water scarcity and drought issues were substantially covered in the 2008 joint EEA/JRC/WHO report on climate change impacts in Europe.

Plan Bleu ([5]) and the EU Water Initiative working group on Mediterranean water scarcity and drought (MED-EUWI) ([6]) have produced several assessments on water scarcity and drought issues in Mediterranean region. These include the water chapters in the Plan Bleu 2005 and 2009 State of the Environment Reports and the MED-EUWI 2008 Mediterranean Water Scarcity and Drought report (MED-EUWI, 2008).

At national level, most countries have produced national overviews of water resources and demand for water. These include annual hydrological/water resource assessments, state of water assessments, and water chapters in national state of the environment reports. During recent years, several countries have produced assessments of drought events, including England and Wales (WaterWatch, 2006) and Portugal (INAG, 2005). Others have developed national homepages on droughts, such as France ([7]) and Spain ([8]). Often more detailed assessments are produced in the context of water strategies or plans (e.g. Spain and Portugal Hydrological Plans).

Both the UNECE and OECD national environmental performance or country reviews (UNECE, 2010a; OECD, 2010) generally have chapters on water scarcity and drought. The United Nations Food and Agriculture Organization (FAO) 'Aquastats' also provide country profiles and factsheets on water resources and water use (FAO, 2010).

([5]) See http://www.planbleu.org/indexUK.html
([6]) See http://www.emwis.net/topics/WaterScarcity
([7]) http://www.ecologie.gouv.fr/-Secheresse-.html
([8]) http://www.mma.es/portal/secciones/acm/aguas_continent_zonas_asoc/ons/sequia_espagna/index.htm

For the United Nations Commission on Sustainable Development meetings, countries have produced documents on freshwater (for the twelfth and thirteenth sessions in 2004–2005) and drought (for the sixteenth and seventeenth sessions in 2008–2009) (UNCSD, 2010).

4.5 Assessments of floods

The adverse human health consequences of flooding are complex, far-reaching and difficult to attribute to the flood event itself (Few et al., 2005). Health aspects do not feature significantly in European and national assessments of floods, which focus primarily on identifying regions most at risk and preparing plans for responding and mitigating the main consequences.

Both the Parties to the UNECE Water Convention and European Community have in recent years focused on flood risk assessments. At the fifth session of the Meeting of the Parties to the Water Convention in November 2009 a report was published on transboundary flood risk management with experiences from the UNECE region (UNECE, 2009a).

The EU Floods Directive (2007/60/EC), which entered in force in 2007, establishes a legal framework for the assessment and management of flood risks across EU Member States, aiming to reduce adverse consequences of floods to human health, the environment, cultural heritage and economic activity. Climate change is explicitly included in the Floods Directive, and EU Member States are clearly expected to take into account the likely impacts of climate change on the occurrence of floods. Flood hazard and flood risk maps must be created showing areas most likely to flood and those with the most consequences.

On a European scale several assessments provide an overview of the frequency of and vulnerability to floods. The WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) has an Emergency Events Database EM-DAT including an overview of major flood events (EM-DAT 2010) and Dartmouth Flood Observatory also provides information on major flood events (Dartmouth Flood Observatory, 2010). Baredo (2007) provided an overview of major flood disasters in Europe in the period 1950–2005 and Kundzewicz et al. (2005) analysed the relationship between flood frequency and climate change. There are several studies on how future changes in the intensity and frequency of extreme precipitation events are likely to cause an increase in flood hazard across much of Europe (e.g. EEA/JRC/WHO, 2008; Dankers and Feyen, 2008).

Flood forecasting is seen as being very important and the European Flood Alert System is a research project that attempts to provide sufficient warning to allow implementation of local flood response plans (JRC, 2010). Further research is being conducted to develop integrated flood risk analysis and management methodologies that provide a consistent approach across Europe

At national level, a number of assessments have been published that detail national responses to flooding. For example, in a national assessment of flood risk (Environment Agency, 2009b) the England and Wales Environment Agency estimated there are around 5.2 million properties at risk of some form of flooding in England. The expected annual damages are estimated at more than £1 billion and it is likely that climate change and development pressures will increase flood risk in the future. In 2009, the United Kingdom government committed to increase spending on flood risk and coastal management. Around two-thirds of the budget is spent on building and maintaining flood defences, but these are not the only methods used to prevent flooding. Local authorities in the United Kingdom must consult the Environment Agency on planning applications to avoid building in high risk areas such as flood plains, and flood warning systems have been extended with the creation of the National Flood Forecasting Centre. Catchment Flood Management Plans (CFMPs) have been developed covering the main catchments in England.

In Serbia, an indicator-based review (Serbian Environmental Protection Agency, 2007) concluded that the frequency of flooding has increased in recent years, despite decreases in annual average precipitation. Severe floods occurred in 2005 and 2006. These events have damaged agriculture and natural ecosystems. New laws on environmental protection are harmonised with EU legislation. However, no details are given on the health impacts of floods or on what mitigation/adaptation is taking place.

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