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Water Security in Europe, in the Danube Basin and in Hungary

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Abstract

The past years have seen a growing interest in water security. This paper presents the "working definition" of water security proposed by UN-Water to provide a common framework for collaboration in water management and security across the UN and also Europe.

The main objective of this paper is to provide an outlook on the challenges of water security in Hungary. Hungary is a member of the EU, whose the total area belongs to the Danube Basin. The major water security challenges to be addressed are similar on various levels, such as the EU, the Danube Basin and Hungary. This is why these issues are discussed together on various levels. In addition, the paper also discusses the GWP's "Water Secure World Vision" and the OECD's "Water Security for Better Lives" initiatives with special regard to Europe and Hungary.

The paper offers an overview of the current status and future challenges of European waters, the security of drinking water, outdoor bathing water and ecosystem, flood and drought risk management, critical infrastructure protection, the climate adaptation and sustainable development in Europe and Hungary.

The paper underlines the important role that cooperation plays in addressing water security challenges, including various levels and scales. ICPDR's activity sets a good example for cooperation across the Danube Basin for handling shared challenges of water security.

Water Safety Plans are improved risk management tools designed to ensure the safety of drinking water through the use of a comprehensive risk assessment approach that encompasses all steps in water supply from catchment of the source to the consumer. As a case study, an overview of the status of the water safety planning in Hungary is presented. Finally, the paper also describes the important role of the application of integrated water resources management in addressing water security challenges.

Keywords: water security, drinking water security, water-secure world, integrated water management, river basin management, water scarcity, drought, flood risk management, environmental security, sustainable development goals

Introduction

This paper is aimed at providing an overview of the concept of, and the need for, strengthening water security, as well as the global actions proposed and launched with the aim of achieving an acceptable level of water security. It reviews trends in water security in Hungary during the past decades, what is to be expected during the coming years and decades and what will have to be done in the future to achieve improvements in water security that can be regarded as reasonable and expected by the society.

Water and nutrition security – a global review

Why is it necessary to deal with water security? Water security, crises, conflicts and the like, are being discussed and written about more and more these days. The question is, whether all this is for good reason. To answer this question we will present a simplified overview of the relevant global trends (Somlyódy, 2011), although this study is devoted primarily to matters of relevance to the Danube basin, as well as domestic issues. Existing global trends are making impacts of smaller – regional and local – scales are even more remarkable.

The fundamental question regarding water management is whether the available resources are sufficient for meeting the existing and future demand. The total quantity of water *(Q)* available on Earth is *constant* and very large: about 1400 million km³ (Papp–Kümmel, 1992) – to be compared to the approx. 2 km³ volume of Lake Balaton. Of the total of 1400 million km³ however, only 35 million km³, that is, 2.5%, is freshwater of which, however, only a certain part is available for human societies. Extraction is limited to the dynamic resources that are renewed year after year in the relatively quick water cycle. If that limit is exceeded, the resources undergo a variety of unsustainable changes: the groundwater table sinks, the amount of water stored by lakes decreases and rivers may fail to reach seas. The end result of the process is *waters disappearing.* The most famous/infamous examples include the Aral Sea and Lake Chad, the Colorado River (Postel, 1992) and a multitude of subsurface waters in China, India, Saudi Arabia or the USA.

The renewable resources are a result of a hydrological cycle, an immense distilling process driven by solar energy. The amount of water vapour (steam) making its way into the atmosphere is somewhat more than 400 km³/year (Papp–Kümmel, 1992). However, much of this falls back into the oceans in the form of precipitation. Consequently, the actually

available *renewable* quantity is a result of overland flow, amounting to a mere Q* = 40 000 km³/year.

At a global level, household water consumption equals 10%, while industry uses 20%, with agriculture, the largest water consumer using 70% of the total amount of water used by mankind (UN-Water, 2009). The estimated total per capita water demand is about 600–700 m³/person/year. Checking the indicator from the aspect of demand for food the average per capita water demand appears – according to literature – to be approx. 1000 m³/person/year (WPJ, 2009/2010). The scale of demand for water is clearly illustrated by the high rates of water demand of the key elements of the food basket. The following quantities of water is used for the production of 1 kg of some of the key food products: rice (3000 l), wheat (1500 l), soya (1800 l), chicken (4000 l), beef (16 000 l) and milk (200 l) (Chapagain–Hoekstra, 2004; UN-Water, 2009). Thus it is important to note – and this is our first conclusion – that *the key issue associated with the "water problem" is not household water supply but food security, which itself requires many times as much water.* One prerequisite for food security is water security.

The recognition of the vast quantities of water "built into" various products, directly or indirectly, leads to the concept (similarly to the ecological footprint) of *water footprint (I*).* Water footprint is the volume of water used for the production of a unit quantity of product or in the provision of a unit quantity of a service. The water footprint of a country is calculated on the basis of all of its products and services. The global average water footprint is estimated at present to be about 1240 m³/person/year (UN-Water, 2009). This ratio is highest in the US (2480 m³/person/year, indicating an inconceivable degree of wastefulness), some 700 m³/person/year in China, while in Hungary it is somewhat below the global average. The rounded ratio of 1000 m³/person/year has an additional meaning in practice: this is considered to be the so-called stress threshold below which water management starts to be very difficult *owing to the physical scarcity of the resources*. Water scarcity is sometimes also characterized in terms of the degree to which the resources are utilized (demand/quantity of the available resources: *D/Q*), with 40% being considered as a critical threshold (see below).

Accordingly, the global demand, with 7.5 billion people on the globe, is about 7500 km³/year, to be compared with the Q* = 40,000 km³/year, or the per capita Q* = 5500 m³/person/year to be compared with the I = 1000 m³/person/year ratio. These figures are not very far from each other. The trend is not conducive to optimism either: at the beginning of the 20th century the specific water resource was as great as 27,000 m³/person/year, which (calculating with a total global population of 8.5 billion[1]) may drop to approx. 4700 m³/person/year by year 2035. *Accordingly, rather than the total available resources, the per capita ratio is decreasing as a consequence of the population increase, and at an alarming rate.* The situation is made all the worse by the fact that attempts made at curbing the increase of demand have not been successful so far: the per capita demand has been increasing at twice the rate of the population increase during the past one hundred years.

A variety of marked reducing factors have been appearing on the resources' side. First, some 20% of the renewable resources are to be found in remote areas and are hardly accessible at all – see for example the huge resources of the Amazon River. Secondly, half of the remaining resources – depending on the sizes of watercourses – come with floods and

[1] www.cia.gov/library

monsoons (Mckinney–Schoch, 1996), quickly passing downriver, only a small proportion of which can be utilized by building reservoirs (which are not without their own specific problems). Thirdly, at least 30% of the resources are rendered useless as a consequence of ecological water demand and a variety of pollutions, unless costly water treatment practices are applied. In this way, the renewable, accessible and available quantity *(Q**)* and the demand are as follows: Q** = 2000 m³/person/year and D = 1000 m³/person/year. The $Q^{**} \geq D$ relationship is a crucial prerequisite for sustainability.

The result of the analysis of scale is disconcerting: at a global level the total amount of resources actually available for use is only twice the amount of the total demand. In other words: the degree of utilization is about 50% (with emphasis being laid on scale and trend), which is an extremely high ratio.

Regional variability

Were the available resources of and the demand for water evenly distributed, there would be no reason for being concerned. This, however, is not the case. Water management is characterized by a high degree of variability in space (and time as well), a phenomenon based primarily – besides factors such as population and the level of social and economic development – on the territorial variability of climatic conditions, in terms of evaporation, precipitation, snowfall, snowmelt, floods, dry spells etc. The renewable resources are ultimately determined by precipitation and evaporation, in the context of the water cycle. Precipitation replenishes the aquifers and provides surface run-off and groundwater flows. Evaporation on the other hand (together with transpiration from land vegetation) reduces the water resources available for human use. Both precipitation and evaporation vary heavily from place to place. Egypt, for instance, hardly ever sees rain falling. Runoff maps (UN-Water, 2009) show a conspicuous patch comprising Northern China, South-East Asia, the Middle East and North Africa, along with California and Australia, where the annual runoff is, in many places, only about 10 mm/year. Accordingly, these regions are primarily the areas where water scarcity should be expected to be faced. This is borne out by actual statistics, as these are the areas where the thirty most water-stressed countries of the world (such as Kuwait, the United Arab Emirates, Qatar, Libya, Algeria, Tunisia and Cyprus) are to be found.[2] In the Arab world about 5% of the word population has access to a mere 1% of the resources, with Canada at the other extreme, with only 0.2% of the global population and 20% of the global water resources.

Our question now is: how many people are affected today and how many will be in the future? In the absence of sufficient data we have no reliable answer but what information we have is sufficient for the outlining of existing trends. Kulshreshtha (1993) found that in view of the water resources available in various countries some 4–5% of the total population were living in areas affected by water scarcity. This percentage rate may increase by 2015 to 40–50%, depending on scenario, primarily in the developing world, essentially as a result of population increase and climatic effects. Population growth is expected to account for 70–80% of future water scarcity, while the remaining 20–30% is attributed to climate change.

[2] See: www.nationmaster.com/graph.

Unfavourable changes are also expected to take place in demand for water, as more and more water will be used for irrigation in response to rising temperatures. The structure of demand may change through urbanization, migration and the expansion of the global middle class where enabled by economic growth. Trends indicated by data from other sources are quite disconcerting. According to UN-Water (2009) *water stress* is and will be growing nearly all over the planet. According to the CIA database[3] the number of those affected will, by 2035, very likely rise to 1 billion, if only through population growth. The specific resources of critical countries (see above) may drop by 20–30% between 2010 and 2035.

According to the GWP/OECD Task Force on Water Security and Sustainable Growth some 3.9 billion people are expected to be facing severe water stress in 2050 as a consequence of a chronic global water scarcity. The bleak outlook makes efforts at strengthening water security crucially important even in areas other than those referred to above (Sadoff et al., 2015). The likely impacts of climate change are difficult to forecast but it is concluded from the task force report that climate change may drive under-nourishment up by 25% by 2080, unless steps are taken to enhance water security.

Another conclusion is that water scarcity caused primarily by population growth, the disappearing of waters and other problems are affecting a significant proportion of the global population, primarily in the developing world. The trends are definitely negative. Problems are likely to grow worse and interact with other issues in the future (Somlyódy, 2008). Some of the most relevant issues include urbanization, lack of safe and reliable water supply and sanitation, pollution and contamination, coming in surprising forms (including micro and nano pollution), water quality issues, weather extremes and phenomena driven by climate change (floods, droughts), and, finally, potential conflicts on international waters (half of the global population live in such so-called shared river basins).

Combining the above two conclusions: population growth and the trend of development are gradually eroding water and nutrition security. This then may lead to the outburst of crises, hinder growth and development in ways not foreseeable and, ultimately, trigger major sustainability disorders. Accordingly, the management of water security is, in this aspect, one of the most crucial issues to be dealt with in the future.

Other important aspects of water security

Without preventive actions the most severe forms of damage resulting from the materialization of risks relating to water may be caused by inadequate levels and standards of water supply and sanitation. The WHO's estimate of the average amount of such damage is about USD 260 billion a year. Gastrointestinal diseases caused by drinking water of inadequate quality lead to the premature death of 1.4 million people in 2010 (Sadoff et al., 2015). Inadequate drinking water and sanitation will continue to be the biggest threat facing people.

A total of 665,000 people died between 1991 and 2000 all over the world in more than 2500 natural disasters, some 90% of which were related to water (UN-Water, 2013). A global risk analysis carried out by the GWP–OECD task force (Sadoff et al., 2015) shows that the total amount of economic damage caused by coastal and river floods is about USD 120

[3] www.cia.gov/library

billion a year today. The risk of damage by coastal floods and the risk of damage by river floods is expected to quadruple and double by 2030, respectively. The average amount of damage that may be caused by river floods all over the world increased from an estimated USD 7 billion in the 1980s to USD 24 billion by 2001–2011. The risk of floods will continue to grow due to population growth and the increase in the value of economic assets threatened, as well as owing to the likely effects of climate change (Sadoff et al., 2015). These estimates highlight the importance of focusing efforts on the situation of, and the possibilities of increasing, water security.

According to a more recent estimate of the OECD Environmental Outlook project (OECD, 2013a) amount of water used globally will increase by 55% by year 2050 and some 40% of the world's population will live in water stressed areas. Things will be made even worse by the deterioration of the quality of water resources. The world's population is expected to increase to about 9 billion by 2050. This will entail an increase in the demand for water, food and energy, along with the impacts jeopardising the state of the environment. These processes will weaken water security, which bound to be further eroded by climate change up to 2050, depending on what regulatory measures and actions may be taken in the meantime.

The future vision of water management differs remarkably between developing and economically developed countries. This difference is analyzed in detail by an OECD report (OECD, 2013a). The conclusions concerning the differences between OECD and non-OECD countries apply to the situation of Europe, including Hungary. According to most recent estimates the annual demand for water in OECD countries is expected to decrease (from the estimated 1000 km^3 in 2000 to 900 km^3 in 2050). Of the non-OECD countries the annual demand for water in the BRIICS countries (Brazil, Russia, India, Indonesia, China and South-Africa) is expected to grow from 1900 km^3 in 2000 to 3200 km^3 in 2050. In other non-OECD countries the rates of growth will be different from the above: the annual demand may increase from the 700 km^3 in 2000 to 1300 km^3 in 2050.

Another major difference between countries is that nutrient loads from point and non-point sources will grow significantly faster in non-OECD countries than in the OECD countries. Non-point pollution, seasonal and local water scarcity and floods will, however, pose major challenges in OECD countries as well in the future. The infrastructure required for acceptable water security is far less well developed and resources are also far less abundant in developing (non-OECD) countries, than in developed countries. There is a need for infrastructure development in the majority of the OECD countries as well (including reconstruction of ageing infrastructure elements) but their priorities are different from those of developing countries.

A total of 276 major international river basins have been identified across the world, taking up nearly half of the Earth's landmass. The areas of 148 countries cover one or more cross-border river basins. There are 39 countries with more than 90% of their respective territories to be found in one or more cross-border river basins. There are 21 countries having the whole of their respective territories in one or more cross-border river basins. Hungary is an example of the last category, with the whole of its territory in the Danube River Basin. In countries sharing river basins water security is usually largely affected by the hydrological situation that has come about and the activities being carried out in the

other countries sharing the same river basin. In response to this recognition the UN-Water (2013) introduced the concept of *cross-border water security*.

On the whole, the global water situation is more than disconcerting and the prevailing trends are unfavourable. This conclusion is even more apt in view of regional variability and its indicators. It is therefore necessary to carry out an analysis of water security and to integrate it in decision making processes at different levels.

Why does water security need to be analyzed in Europe, in the Danube River Basin and in Hungary together? The past two decades have produced a significant number of positive results in domestic water management: Hungary's preparations for EU membership, then its actual membership and cooperation with countries sharing the Danube River Basin may be viewed as the most important changes. This trend is highly likely to continue in the coming decades as well. The member states of the European Union must provide for the protection of human life, health and the state of the aquatic environment on the basis of a set of harmonized principles, in accordance with the Water Framework Directive and the related body of water protection legislation. Hungary is situated in the Danube River Basin. Many of the factors affecting water security can only be influenced in the whole of the Danube River Basin, by joint action on the part of countries sharing the river basin. This is why work on increasing cross-border water security (UN-Water, 2013) is so important for us.

The world will have to tackle major water management challenges during the coming decades (Somlyódy, 2011; Sadoff et al., 2015). Such major challenges include the diminishing of specific water resources, disappearing waters, physical and economic water scarcity, urbanization, climate change, drinking water supply and sanitation, water pollution, conflicts in and over shared river basins etc., along with the fact that these issues often appear in mutual interaction, aggravating the situation in existing crisis zones or creating new ones.

Water is an essential element of human life, welfare, economic development and good status of flora and fauna that are dependent on water. The great water management challenges facing the world cannot be tackled and sustainable development goals cannot be accomplished without satisfying water-related needs to a degree of security that is acceptable to society. Society expects its reasonable and justified demand for water to be satisfied to a high level of security. Complete security however, does not exist; a social consensus should be reached in regard to an accepted level of water security. The term "water security" is construed in a variety of ways. The resulting misunderstandings may be avoided by defining – as part of a given study or research – what is to be understood as water security for the given purposes. This is what we do in this paper when we apply the definition adopted by UN-Water (2013) (see below).

One question that may arise is what new is there in discussing the "water issue" from the perspective of security. The most important factors may include the innovation that lies emphasis on uncertainties and risks relating to the possibility of satisfying needs for water and on impacts of the risks concerned, along with our seeking, with the involvement of society in general, to identify a level of security that is acceptable to society and that is feasible from an economic and environmental aspect. Neither Europe as a whole, nor Hungary alone, can afford to refrain from participating in water management, climate change adaptation, sustainability and other major programmes that are currently under way at a global level (Shah, 2016). At the same time, it would be amiss to refuse to take into account the differences that are to be found between and among continents, countries and regions.

For this reason, global water security programmes and their relations with European strategies will also be noted in this paper.

Water management satisfying the needs of society, the economy and the environment in an acceptable way is no longer possible without the adoption of an integrated approach encompassing an entire river basin. Applying such an approach plays a fundamental role in creating water security, something that has certain special characteristics in Europe. This paper is closed by a summary of the key issues relating to its subject, including conclusions drawn from our own research.

A working definition of water security, efforts made towards realising the vision of a "water-secure world"

The importance of enhancing water security has been emphasized, interpretations of the concept of water security have been worked out, global water security programmes have been recommended and proposals for the implementation of such recommendations have been made at a variety of important international and global forums. Mention should be made, for example of OECD's volume of studies, entitled *Water Security for Better Lives* (OECD, 2013a; 2013b), Water Security & the Global Water Agenda (UN-Water, 2013), as well as UN-Water activities aimed at redefining the Sustainable development goals (Shah, 2016). Hungary is actively participating in the latter (GWP Magyarország, 2016). One of the recently completed documents, recommended by GWP – setting out, among other things, some of the key elements of the initiatives made so far – entitled *Strategy a water-secure world* (GWP, 2014), worked out the vision of what is referred to as a "water-secure world." The most recent, scientifically-founded document discussing the relationship between water security and sustainable growth, is a report produced by the GWP-OECD Task Force on Water Security and Sustainable Growth (Sadoff et al., 2015). In the following sections we review activities undertaken at a global scale towards water security.

The concept and key issues of water security

Water security is interpreted in many ways and a wide variety of technical and scientific publications have come up with proposals for a definition of the concept. Definitions in broader and narrower senses have equally been put forward. In its narrowest sense water management is restricted to drinking water security, while the broadest proposed interpretation encompasses the security of the satisfaction of nearly all needs relating to water management. The UNO has, for instance, been dealing frequently and extensively with water security as one of the key prerequisites for global peace (Cosgrove, 2003). The currently most widely accepted working definition was elaborated by UN-Water, the body coordinating the activities of the UN organizations and institutions dealing with matters and issues of water management (UN-Water, 2013: 1.):

Water security means "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne

pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."

This paper construes the concept of water security in accordance with the above definition. Shared interpretation of the concept is indispensable for effective international dialogue and action. UN-Water (2013) highlighted five key policy-type issues pertaining to water security:

- water security and human rights,
- the role of water security in social and economic development,
- water, food and energy security,
- climate change and water security,
- the role of ecosystems in creating water security.

UN-Water proposed that the use of three water policy instruments be assessed with the aim of creating water security:

- answering water security challenges,
- capacity building towards creating water security,
- development of water administration to promote water security.

This is the most recent and most important document on tackling water security challenges at a global scale at present. It discusses key issues of relevance to creating acceptable water security, together with the possible instruments for dealing with those issues. Europe, and Hungary alike, must by all means facilitate the creation of water security all over the world. At the same time, there is a need for analyses as to how the UN-Water's conclusions should be understood in Europe and in Hungary. Priorities that befit our own circumstances need to be established, together with key areas of a regional and country relevance.

Strategy for a water-secure world (2014–2020), proposed by the GWP

After thorough preparations the GWP formulated three strategic objectives (GWP, 2014). Making efforts towards accomplishing them may help countries in improving their water governance and water management and in the realization of the vision of a world of water security.

Goal 1: altering the policies and the practice of water management,
Goal 2: creating and spreading a knowledge base,
Goal 3: strengthening cooperation.

The most important activities to be carried out towards realising the vision of a world of water security must, according to the strategy, belong to the following six key areas:

- climate change adaptation and water security,
- international (cross-border) water security,
- food and water security,
- energy and water security,
- urbanization and water security,
- ecological systems and water security.

Realization of the vision worked out by the GWP is in the very best interests of the countries of Europe as well. It is also a moral obligation for Europe to help developing countries in achieving their water security objectives, which are, for the most part, different from those of the European countries. Attaining water, food and other related security goals may be one of the key instruments for preventing migration processes of the type being witnessed today.

The role of water security in attaining the SDG6 sustainable development goal

In 2013 the UN Economic and Social Council adopted the *Post-2015 Development Agenda.* A total of 17 *Sustainable Development Goals – (SDG)* were worked out on the basis of the agenda. The sixth of the goals is referred to as the water management goal, *(SDG6* – Ensure availability and sustainable management of water and sanitation for all), and the rest of the goals also include some whose accomplishment requires integration with water management (e.g. SDG11.5 Water-related disasters).

SDG6 comprises 6 targets. The prerequisites for the attainment of each target include the creation of an acceptable level of water security: the prescribed water security, a satisfactory level of equitable sanitation, water quality meeting the requirements, water scarcity management of an acceptable level, integrated water management (including international cooperation in the shared river basins) and ensuring a good status of aquatic ecosystems (Shah, 2016; GWP Magyarország, 2016). Although the important role of water security in the accomplishment of the SDG6 targets is emphasized at a variety of forums, nonetheless, the enhancement of flood security is not included in the description of any of the SDG6 targets (GWP Magyarország, 2016). Nor is flood security included in a number of major documents on water security (e.g. GWP, 2012; 2014). At the same time, the main document setting out the working definition of the term water security and the one laying down the foundations for global actions – the UN-Water recommendation (2013) and the report of the GWP-OECD Task Force on Water Security and Sustainable Growth (Sadoff et al., 2015), deal with flood security as one of the key requisites for water security.

The GWP-OECD report looks at water security from the perspective of risks and describes it with four factors or indicators: water scarcity, floods, inadequate water supply and sanitation and deterioration of the state, and pollution, of ecosystems. The report points out that the first two of the above factors result primarily from hydrological variability, while the other two are caused by human activities, noting at the same time, that each of the four factors are closely connected with the others.

It was with the aim of promoting the accomplishment of SDG6 that the UN and the World Bank set up a High Level Panel on Water. The ten members of the panel are heads of state and prime ministers highly committed to the management of water-related challenges, including Hungary's President János Áder. This panel is expected to coordinate global actions towards enhancing water security. The fact that Hungary is represented by its President may facilitate Hungary's contribution to the accomplishment of the vision of a water-secure world.

Water security for better lives

The issue of water security were analyzed by OECD experts under the motto of "better policies for better lives" (OECD, 2013a; 2013b). They scrutinized the role of water security and the possibilities of achieving it primarily from the perspective of the economically more advanced OECD countries, but they also discussed water security challenges facing non-OECD countries.

An OECD report (2013a; 2013b) claims that the accomplishment of the water security objectives means that four types of risks are kept at adequate levels:

- the risk of water scarcity (including drought),
- the risk of inadequate water quality,
- the risk of too much water (including floods),
- the risk of irreversible changes in the hydraulic and biological functions of surface and groundwater bodies.

Of the four types of risks the first and third ones are readily compatible with the four areas of water security as highlighted in the report produced by the GWP-OECD Task Force on Water Security and Sustainable Growth (Sadoff et al., 2015). The other two however, are different in this aspect. This is why both approaches are worth studying in depth; it may help us in drawing important lessons for use in enhancing Hungary's national water security.

According to the report (OECD 2013a; 2013b) the four types of risks should be examined in an integrated way, as mitigating one risk may result in aggravating another (reducing the risk of water scarcity by irrigation may, for instance, increase the risk of deterioration of the status of water-dependent ecosystems). One of the most profound functions of water management is concerted management of such risks. Failing to carry out the latter, or to carry it out properly, may lead to extreme damage (droughts, floods, diseases etc.). Creating water security of a level acceptable to society is impeded in many cases by the lack of knowledge of the risks.

The report of the GWP-OECD task force (Sadoff et al., 2015) points out that the levels of water security are higher in more developed countries: most of these countries have better means for creating and maintaining water security at acceptable levels. The report also notes however, that water security poses major challenges for both developed and developing countries. It is also emphasized in the report that the creation of water security of an acceptable level is not a static goal; it changes dynamically, as a consequence of climate change, economic growth and the decrease of the quantity and deterioration of the status of the available water resources. The water security objective is also influenced by changes in social, cultural and aesthetic priorities and values.

Water security may only be achieved though collaboration involving experts of a variety of fields and disciplines relating to water management. The tasks of creating global water security are discussed from an engineering perspective in the report prepared by the Steering Group on Global Water Security of the Royal Academy of Engineering (Royal Academy of Engineering, 2010). The report contains a number of recommendations that are worth taking into consideration in national water security programmes. For example:

- In international trade negotiations account must be taken of products' water footprint (see above), and their virtual water content, to promote actions against increasing water stress.
- Optimally balanced national policies should be worked out, with a view to considerations of water, food and energy security.
- The water footprints of local production processes should be reduced in order to promote global water security.

Water security in Europe: tasks of creating a "water-secure Europe"

Many are of the opinion that the implementation of the regulations of the Water Framework Directive is in progress, therefore everything is all right in regard to the situation and future of water management in Europe. This is just a first impression. EEA's complex analyses however, show that there are still a number of problems that will take major efforts to resolve. To name but a few, there are the much-discussed floods and droughts that are (may be) profoundly affected by climate change, which may trigger unexpected occurrences and substantially change their territorial distribution and extent. In many places, primarily in Southern Europe, demand for water for use in irrigation is on the increase; this leads to sinking groundwater tables and an influx of salty seawater, often necessitating the introduction of membrane technology. The price of water rises unfavourably in many cases, together with the ratio of extraction, agricultural non-point pollution, P and N loads, the orthophosphate concentration of rivers, as well as the emission of certain heavy metals. Regional problems – Black Sea, Baltic Sea – demand continued and consistent efforts; the vision of a Europe of water safety will not be easy to realize.

The status of European waters in 2012

2012 was the Year of Water in Europe In the context of the campaigns and actions launched during the year the European Commission published what is called the *Blueprint to safeguard European waters*, hereinafter: *Blueprint)* (EC, 2012c). It contains a revision of the first river basin management plan prepared pursuant to the regulations laid down in the Water Framework Directive, the European water scarcity and drought policy, and water management related considerations of climate change adaptation and of vulnerability.

To supplement the Blueprint, and by way of background materials, the European Environmental Agency (EEA) has published six reports on the status of European waters:

- Towards efficient use of water resources in Europe
- European bathing water quality, annual report, 2015,
- Territorial cohesion and water management in Europe
- Water resources in Europe in the context of vulnerability
- European waters – assessment of status and pressures
- Report on the status of European coastal waters

In addition to the above, the EEA prepared three more reports:

- Adaptation of cities to climate change in Europe
- Environmental indicator report – 2012
- Climate change, impacts and vulnerability in Europe – 2012

The results of the nine report were summed up in a synthesising report (EEA 2012b), *providing an unprecedented, integrated overview of the status of European waters, making it one of the most important basic documents of European water security.* The immense (though, according to the authors, still insufficient) amount of information presented and referenced in the report shows that the status of European waters had improved less than expected. This may be partly a result of the "one bad – all bad" principle applied in the assessment of the status of waters. The underlying reason is that the status of a water body is rated on the basis of more than twenty factors, and if the status of the water body is not good in terms of even only one of them, the integrated status of the water body cannot be rated good. Consequently, although in many cases a variety of massive and costly actions have been taken to improve the status of waters, resulting in significant improvements in terms of various specific factors and probably in water security as well, these improvements are not reflected by the reports on the changes in the statuses of waters. One of the key messages of the EEA report (2012b) was that such a European water policy is required that would ensure effective utilisation of water resources (satisfying the water management related needs of society and the economy, acceptable security of water supply) and the protection of aquatic ecosystems (the water security of ecosystems) as well.

The implementation of the provision of the Water Framework Directive may perhaps be the world's largest environmental programme. As a unique achievement of the European Union the *first river basin management plans have been prepared on the basis of harmonized principles* for the entire area of the EU and the European countries that have jointed the programme. In the plans the member states worked out action programmes required for improving the statuses of 13,000 underground and 125,000 surface water bodies to a "good" level and for keeping up their good statuses. The implementation of the planned actions is envisaged to create in the EU member states the drinking water, outdoor bathing water and aquatic ecosystem security of the levels they have jointly determined, by the end of year 2027 at the latest.

The first river basin management plans showed that the ecological statuses of more than 50% of the European surface waters were rated worse than the at least "good" status prescribed as a minimum requirement in the Water Framework Directive (EEA, 2012a; 2012b). However, only 10% of the surface waters whose chemical statuses were known, belonged to categories worse than "good". The statuses groundwaters were found to be better than those of surface waters; the statuses of more than 90% of groundwaters were good in terms of both quantity and quality. *The statuses (or potentials) of more than 51,000 water bodies (56% of the identified water bodies) or 630,000 km of watercourses (64% of the total length of all watercourses) were worse than good.*

The EEA synthesis report found that European countries will reach water quality levels required for reaching the good ecological status within 10-15 years once the provisions of the directive on municipal waste water treatment are fully complied with. It is not likely however, that the nitrogen content of surface waters, originating from non-point sources,

will meet the requirements of the good ecological status within 10-15 years, if the prevailing trend continues unchanged. For this reason, additional actions had to be planned in the second river basin management plan for reducing non-point source stresses. *The picture of the situation, the trends and the conclusions disclosed in the EEA synthesis report and the attached part-reports show that there is still quite a lot to do towards creating water security at acceptable levels.* The necessary statutory guidelines, methodologies and plans are available for this.

Protection and security of outdoor bathing waters in Europe

Primarily as a consequence of the development of sewage networks and the improvement of the effectiveness of wastewater treatment plants today the *quality of outdoor bathing waters is better in most places in the EU than 30 years ago* (EEA, 2016b). By 2015 the quality of water at 96% of the monitored bathing sites was up to the prescribed minimum requirements. Some 83% of the bathing sites had excellent water quality. Accordingly *water security at the outdoor bathing sites is adequate at present.* This level is likely to be kept up during the coming decades as well, owing to the increasing weight of tourism in the respective national economies and the interest representing capabilities of the representatives of tourism. This is made all the more likely by the fact that a number of non-EU countries also undertook to observe the strict guidelines of the European Union. The improving trend is indicated by the fact that the phosphorus pollution of watercourses dropped by 54 %, while that of lakes decreased by 31% between 1990 and 2010 (EEA, 2012b).

Drinking water security in Europe

Particular emphasis is laid in the European Union on achieving drinking water security. The Water Framework Directive provides that all waters that are used – or are planned to be used in the long term – for human consumption, must be regarded as protected areas. These waters are protected primarily by the provisions of the Water Framework Directive, the nitrates directive and the municipal waste water directive, along with a number of other EU directives (including the EIA directive, the SEA directive, the directive on public participation) (EU CIS, 2007) and national legislation. The EU member states *have identified more than 78,000 drinking water protection areas* where the status of water resources is protected by particularly strict regulations. In fifteen EU member states groundwaters are the main source of drinking water supply, while in nine member states most drinking water comes from surface waters. The ratio of groundwaters varies between 16% (Ireland) and 100% (Austria, Denmark and Lithuania).

Ecosystem security in Europe – Natura 2000 areas

The EU bird protection directive provides for the preservation of 193 wild birds species and sub-species, while the habitat protection directive secures the protection of 1250 species,

sub-species and 233 habitat types. Some 18% of the total area of the European Union is covered by Natura 2000 sites, making up the world's largest network of nature conservation areas, managed under a harmonized system of regulations. The EU 2020 biodiversity strategy plays a key role in creating ecosystem security. According to the report on the implementation of the provisions of the bird protection directive some 54% of all protected birds are safe in Europe (EEA, 2015). According to the habitat protection directive some 23% of the biogeographic habitats are in adequate statuses, but the statuses of more than half of them are below this level. The statuses of 26% of the habitats below adequate are improving, while the statuses of 22% of the same category are deteriorating.

The security of aquatic ecosystems is considered as one of the key factors of water security by the most important documents on water security, such as the report prepared by the GWP-OECD Task Force on Water Security and Sustainable Growth (Sadoff et al., 2015). The enhancement of the security of aquatic ecosystems is facilitated by the European Commission through its "good practice" guides, prepared with the participation of member states' experts (e.g. EC, 2009; 2012a).

Water and food security – the water footprint of food waste

According to the summary report on the FAO's investigations about a third of the total amount of food produced globally is wasted each year (Hoekstra-Mekkonen, 2012; FAO, 2013). The amount of food wasted could feed as many as 2 billion people. The "blue" water footprint of the production of an amount of food equalling the total amount wasted each year (that is, the quantity of surface and groundwater used in producing it) is approx. 250 km^3/year. This amount of water is, according to the FAO (2013), more or less equal to the quantity of water carried by the Volga River in an average year, or three times the amount of water in Lake Geneva. To provide a domestic example: this twice the amount of water flowing down in the Danube River at Budapest in a year. It would take 1.4 billion hectares, or about 30% of the total land used all over the world for agricultural production, to produce the amount of food that is wasted globally each year. FAO estimates that the cost of producing the amount of food wasted each year is approx. USD 750 billion.

Europe's food wastage makes up – according to the FAO report – some 16% of the global wastage, the production of which takes an amount of water equalling 7% of the global blue water footprint (19 km^3). According to the report (FAO, 2013), the reason why a smaller amount of water would be required for making up for the loss in Europe because composition of the food wastage differs from that of other regions of the world. It would take about 100 million hectares of land to produce the total quantity of food products wasted year after year; half of it arable lands, the other half used for purposes other than agricultural production. The average blue water footprint of food wastage is 38 m^3/person/year globally (this is how much water would be required for producing food equalling the per capita wastage on an average). The average blue water footprint of the food wastage is 26 m^3/person/year in Europe, it is the highest (92 m^3/person/year), in North Africa and in West and Central Asia, and the smallest (13 m^3/person/year) in the Sub-Saharan Africa.

The amount of food wasted in Hungary in year 2010 was 175 kg/person. The wastage was lowest in Romania (76 kg/person) and it was highest in the Netherlands (541 kg/person).

It is clear from the above data that *reducing food wastage all over the world – including Hungary – may be an important means for reducing the amount of water used, and thus for the enhancement of water and food security, as well as, indirectly of energy security.*

The quantitative status of waters

The EEA's integrated synthesis report on the status of waters (EEA, 2012b) discusses not only the quantitative status of water that is necessary from an ecological perspective, but also its quantitative status from the aspect of water uses and water damage, including risks of floods, droughts and water scarcity as well. The statement in the report, that the assessment of the quantitative status of waters cannot, in general, be based solely on monitoring performed and databases created on the basis of the WFD and other EU directives that have to do with the protection of waters, is a self-evident proposition which is, however, not always taken into account in practice. Assessment is influenced by water uses, water damage response actions, the water carrying and drainage capabilities required for the management of water resources, the water resources that are available for utilization, water yields, water depths, hydromorphological features and other factors.

In view of the quantitative status of waters it seems likely that no water scarcity and resulting food shortages – of a severity leading to famine – need to be expected to develop in Europe during the coming decades. Restrictions due to water scarcity and unusual extreme situations may, however, occur increasingly frequently.

Flood security – is it important to enhance it in Europe?

The unprecedented database on the impacts and effects of floods in Europe since 1980 is an important product of the assessments prescribed by the EU flood directive *(Directive on the assessment and management of flood risks)* and of collaboration among European countries in water management, (EC, 2015a; 2015b; 2015c; EEA, 2016a). Based on information collected in order to enable the application of the flood directive, the relevant global databases and questionnaire based surveys the European Environmental Agency *(EEA)* has worked out a review of the floods that occurred during the period between 1980 and 2010, together with their social, economic and environmental effects. This was supplemented by the latest report on European floods (EEA, 2016a). These reports contain the latest data and information on Europe's flood security.

Floods in Europe

The latest report released by the European Environmental Agency (EEA, 2016a) reveals that – according to data supplied by 37 European countries – more than 3500 separate flood phenomena occurred in Europe between 1980 and 2010. There were 325 severe floods in watercourses after 1980, more than 200 of which occurred after 2000.

In year 2010 27 European countries were affected by a total of 321 floods (EEA, 2016a). In Poland, floods caused the deaths of more than 20 people, inundating 3400 km^2 of land, causing more than 2 billion euros worth of damage. Extremely severe floods raged in 2013 in Central Europe, in the Elbe and Danube River Basins. In many places the all-time record flood levels were recorded. The total flood-related cost along the entire length of the Danube River was estimated to equal 2.4 billion euros in 2014, including damage caused to property, other tangible losses caused by floods, as well as the cost of flood protection actions. In Austria the flood in 2013 was similar to the great flood of 2002. Nonetheless, the damage – thanks to the developments implemented after 2002 – was worth only 870 million euros in 2013, that is, over 2 billion euros less than the total damage of 3.2. billion euros estimated in 2002 (ICPDR, 2014a).

Year 2014 saw severe floods in South-Eastern and Central Europe (e.g. in the valley of the Sava River). The heaviest losses and damage were suffered in Serbia and in Bosnia and Herzegovina. More than 50 people were killed in Serbia alone, where about 32,000 people had to be evacuated with another 1.5 million residents being affected by occurrences associated with the floods.

The EEA reports draw attention to the fact that the methodologies underlying the flood reports are not harmonized, therefore a measure of prudence is needed in drawing conclusions from information on trends. Nonetheless, the EEA reports contain a number of important findings and conclusions, indicating that *enhancing flood security is one of the most important water management challenges facing Europe.* The reports deal primarily with the environmental effects of floods and flood protection actions. They also point out however, that *there is a need for integrated flood risk management practices, which necessitates the* combination *of economic, health and cultural considerations with environmental aspects.*

Shrinking floodplains in Europe

Nearly a total of 90% of floodplains along rivers have disappeared in Europe, or they are not functioning the way they used to (EEA, 2016a). This ecosystem loss is aggravated by the fact that only about 10% of all European floodplain woodlands have remained in place, mostly in the floodplains of the great Eastern European rivers. The losses of woodlands in the floodplains along the various segments of the Danube River ranges between 73% and 95%, but it is as low as 30% in the Danube Delta. With the tributaries also taken into account, the rate of the loss of floodplain woodlands equals 80% (EEA, 2016a).

Of the European countries the largest number of people live in areas threatened by floods in Italy (6.7 million people, or 11% of the total population of the country). *It is Hungary, however, where the highest percentage of the total population* live in floodplain areas. A key role is played in Europe in the efforts towards flood security by the EU directive on the assessment and management of flood risks, which entered into force in 2007 (2007/60/EC, *Floods Directive*. The completion of the tasks prescribed by the directive may create flood security of a level that is expected by the population across the whole of the area of the European Union.

The European Commission prepared a review of the preliminary flood risk assessment reports submitted by the member states in accordance with the provisions of the flood direc-

tive (EC, 2015b). 23 member states identified a total of 48,000 areas as *Areas of Potentially Significant Flood Risk (APSFR)* in the reports submitted to the EC. Most of the APSFRs (91%) are associated with river floods and only 0.3% are linked with groundwaters. *The largest number of the areas of potentially significant flood risks were reported by Croatia (2,976 areas), while the smallest number of such areas were reported by Hungary (2 areas).* The great difference above is also an indication of the fact that prudence must be exercised in using statistics of EU-level reports, because Hungary obviously regarded the flood protection system of the entire Tisza and Danube valley as a single area of potentially significant flood risks because risks can only be managed in an integrated system across the whole of the area concerned (thereby raising flood safety to an acceptable level). The "large number" reported by Croatia does not mean that flood risk management is a more significant issue in Croatia than it is in Hungary.

The recurrence time (and probability) of floods taken into account in the management of flood risks varies by member state: 5, 10, 2, 50, 100, 200 and 1000 years. Similarly to Hungary, most member states are applying "combined" methods (EC, 2015b), in that the recurrence time (the level of flood security to be attained) is determined subject to the number of people living as well as the economic and cultural values to be found in flood plains.

For example, the flood protection system of Amsterdam affords protection against floods occurring once every 10,000 years, the flood protection systems of London and Shanghai provide protection against floods occurring once every 1000 years, while that of New York only protects the city from being inundated by floods occurring once every 100 years. It was not until after Hurricane Sandy hit the region in 2013 that the idea of upgrading the flood protection system of New York City began to be dealt with (OECD, 2013a). The acceptable levels of water security are determined in a similar way in other areas of water security as well. For instance, the drinking water supply system of a city is recommended to be constructed in such a way that it can meet demand in terms of quantity in 95 of every 100 years, while the quality of the water should meet the requirements in 99 of every 100 years. Vulnerable horticultural plants needs for irrigation is recommended to be met in 9 of every 10 years, while that of less vulnerable field crops is recommended to be met in only 1 of every 2 years (OECD, 2013a).

Do we need to do anything in Europe to increase flood security? What are the scales of flood damage that should be expected in 2050 and in 2080? According to an EEA report (EEA, 2016a) *flood damage may increase in Europe to five times of today's levels by 2050 and to 17 times of the same by 2080.* Some 70–90% of the increase may be a result of social and economic development and growth (increase in the number of people living, and in the economic and cultural values to be found, in floodplains), while the remaining 10–30% may be caused by climate change. Despite the high degree of uncertainty of the estimates the above figures should be taken as a serious warning. They underscore the importance of enhancing flood security and of the implementation of the flood risk management plans, as well as the need for the same from an economic and cultural aspect.

Drought security – is water scarcity and drought management a crucial issue in Europe?

The management of water scarcity and droughts have been among the most serious challenges for centuries in certain parts of Europe, and the situation has, in this regard become even more challenging, primarily as a consequence of the climate change (Demuth, 2009; EEA, 2012b; 2012c; 2012d; Lavaysse, 2015).

Year 2003 brought severe droughts in Europe, affecting *more than 100 million people and a third of the total area of the European Union, entailing costs amounting to 8.7 billion euros in total.* It was in response to this that the European Commission began to work on a water scarcity and drought management policy for Europe (Euraqua, 2004). It was in order to tackle the challenge that the Commission submitted in 2007 its proposal comprising, as its key element, a set of "policy actions" (that is, structural and non-structural methods) recommended to be taken to reduce and prevent damage by water scarcity and drought [COM(2007) 414 finalized]. The status of the implementation of the proposed actions was assessed in "follow-up reports" in 2008, 2009 and 2010. The European water scarcity and drought policy was reviewed in 2012 (EC, 2012b).

At the time of the submission of the Commission's proposal in 2007 some 11% of the total population and 17% of the total area of the EU were affected by water scarcity. The situation has grown worse in the meantime. The extent of the aggravation of the situation may be concluded from the fact that the number of European river basins facing water scarcity in the summer or even during the whole of the year may – as modelled in the context of the ClimWatAdapt project – increase by up to 50% over the coming decades.

Much of Southern and Western Europe, indeed, even Northern Europe, was hit by droughts in 2011 as well as in 2012. *The drought in 2011 was called the most severe drought of the century*, as the total precipitation was a mere 40% of the usual amount. The available water resources decreased significantly in the spring of both of those years, in response to which limits were imposed on water use in much of the EU. The number of droughts and their effects increased dramatically in Europe during the past 30 years. The size of the areas and the number of people affected by droughts increased by nearly 20% between 1976 and 2006, and the damage caused by droughts amounted to a total of 100 billion euros. The number of countries affected by droughts increased in each decade. Droughts affected 15 countries between 1976 and 1980, 17 countries between 1981 and 1990, 24 between 1991 and 2000 and 28 between 2001 and 2011 (EEA, 2012b).

Droughts and water scarcity alike may cause economic losses in all of the key sectors using water, and they can cause negative and harmful economic impacts on biodiversity and the quality of waters. They can erode the statuses of wetlands, they can cause them to disappear, and they can lead to soil erosion, soil degradation and desertification. Some of the effects are limited to short periods and the circumstances quickly return to normal, some effects however, may become permanent.

It is with a degree of self-irony that a Communication from the European Commission (EC, 2012b) notes a large number of mutually related shortcomings in the policies in place for the management of water scarcity and droughts in Europe. The Communication criticizes the fact that the river basin management plans worked out on the basis of the Water Framework Directive contain insufficient data on current and future demand for water, the

available water resources, the actions taken to manage water scarcity and droughts as well as on the expected impacts of the actions on water scarcity and drought. These deficiencies cannot, however, be regarded as defects in the river basin management plans because the *Water Framework Directive and the river basin management plans are not aimed at satisfying the society's and the economy's water-related requirements or at planning actions to provide for their satisfaction.* Such actions must be planned in separate drought management plans – similar to flood risk management plans – which must, of course, be carefully coordinated with the provisions of the Water Framework Directive and the river basin management plans. The plans must be based on an integration of the relevant sector policies and strategies.

Assessment of the EU's water scarcity and drought policy

ACTeon reviewed the situation of the EU's water scarcity and drought policy by combining the LISFLOOD and the WaterGAP *(Water – Global Assessment and Prognosis)* models, as commissioned by the European Commission (ACTEON, 2012). According to the results and findings of the model analyses water scarcity (water stress) is affecting some 10%, and 23%, of the total area of Europe during the whole of the year, and in the summer months, respectively. According to ACTeon's results the Danube River Basin and the area of Hungary are not affected by water scarcity. In 2030, some 30 %, and 45%, of the area of Europe will be facing water shortages during the whole of the year, and in the summer months, respectively. According to the report, in the Danube River Basin it is only in Bulgaria and in Romania that water scarcity will have to be expected.

According to the analyses the number of river basins exposed to water stress throughout the year will increase from 26 to 47 by 2030 (the size of the water-stressed areas will increase from 460,000 km^2 to 1,290,000 km^2). As for seasonal water scarcity, the number of water-stressed river basins will grow from 43 to 63 (doubling the 990,000 km^2 area that is affected at present). *A number of countries in Northern Europe are already facing water scarcity and the trends in those countries are also unfavourable.* Accordingly, more than one countries in Northern Europe have to take preventive and/or adaptive actions to make sure that water scarcity and the resulting deterioration of water security do not cause disproportionately heavy damage.

The European Drought Centre *(EDC),* a virtual centre of organizations engaged in drought research and operational drought management, facilitates the joint utilization of the knowledge accumulated by European countries in terms of good practices in drought management. The long term goal of the centre is to promote European cooperation towards reducing droughts' impacts and effects on society, economy and the environment, and preventing the decline of water security caused by droughts (Lavaysse, 2015).

Water security in the Danube River Basin

Cross-border river basins are posing unprecedented challenges to integrated water management. Cross-border collaboration has been practised for centuries in the Danube River Basin (DRB) and the Danube River is frequently referred to as the "world's most international river basin" (ICPDR, 2016). The area is shared by as many as 19 countries and is home to more than 81 million people. It is about 20% of the EU's inland area (approx. 800,000 km^2), characterized by a wide variety of different landscapes, and massive social and economic differences among the countries concerned.

The Danube River Protection Convention

It was back in 1992 that the United Nations Economic Commission for Europe (UNECE) Convention on the protection and use of transboundary watercourses and international lakes (Helsinki Convention) was signed. In 1994 the convention served as a model for the drafting of the Convention on Co-operation for the Protection and Sustainable Use of the River Danube and it provided a legal framework for cooperation in water management. The adoption of an integrated approach to water management posed a major challenge in the preparation and implementation of the Danube River Protection Convention (DRPC), which took the participation of countries of different histories, languages, cultures and economic situations, as well as different needs in regard to water management (Ijjas, 2004a; 2004b).

A significant proportion of the water resources in the Danube River Basin has been damaged or is being threatened, and are, accordingly, in need of protection. Work in improving the quality of water is crucial if sustainable development is to be ensured. Each "Danube country" of the territory of which more than 2000 km^2 is located in the area of the Danube River Basin, participates in the Danube River Protection Convention. The EU itself also qualifies as a party to the Convention. *The International Commission for the Protection of the Danube River (ICPDR) is currently the largest international organization of experts on river basin management in Europe,* whose mission is to support and coordinate sustainable water management in the Danube River Basin.

Back in 1994 when the Danube River Protection Convention was signed, Germany was the only EU member state among the parties. By 1998, when the activities of the ICPDR were launched, Austria had also joined the EU. Today 9 of the 14 countries in the Danube Region are members of the Union. In 2000 every party to the convention agreed to coordinate the implementation of the WFD across the area of the Danube River Basin. The agreement was supplemented in 2007 by integrating flood risk management.

Cross-border river basin management and water security in the Danube river basin

The Danube River Protection Convention – which plays a major role in enhancing water security as well in the river basin and which profoundly affects Hungary's water security – is often referred to as an example of good practices in integrated international water manage-

ment (ICPDR, 2014b). The ICPDR is extremely effective in coordinating the implementation of the Convention. The first cross-border river basin management plan was prepared for the Danube River Basin in 2009. The plan was duly introduced and its revision, the second river basin management plan, has been completed recently (ICPDR, 2015a; 2015b). One of the most important achievements is that the world's first cross-border climate change adaptation strategy has been adopted in regard to the Danube River Basin (ICPDR, 2013b). As a member of the international network of river basins engaged in efforts towards climate change adaptation they share their experience accumulated in the Danube River Basin with others. The ICPDR is regarded as a pioneer in the coordination of water management with other sectors, particularly in view of the guides prepared with the involvement of various stakeholder groups for sustainable waterway planning and for the planning of sustainable utilization of hydropower (ICPDR, 2010; 2012; 2013a; IJJAS, 2014a; 2014c). It is highly rewarding that the methods outlined in the guides have also been recommended to other European countries, while the use of the manual on the planning of sustainable waterways has been recommended at a global level for the development of inland navigation. The development of methods for hierarchic river basin management planning and coordination in large river basin areas is an important achievement of the countries sharing the Danube River Basin (IJJAS, 2004a; 2004b). Three main levels of planning and coordination have been identified:

- the level of the Danube River Basin (issues affecting the entire Danube River Basin),
- bilateral or multilateral level (problems with bilateral or multilateral cross-border impacts),
- national level (all problems and issues relating to river basin management, other than the above two).

The Joint Danube Survey *(JDS)* is a good example for the methods of collaboration in large international river basin areas. The survey has been carried out once in every 6 years since 2001. It is the report on the third survey, conducted in 2013, that contains the largest amount of information ever to have been gathered in the Danube River Basin in a single document, concerning the status of the Danube River. It took 6 weeks for an international group of 20 scientists to collect information from measurements carried out and samples taken at 68 places along the river. The data were assessed from three interrelated perspectives (biological, chemical and hydromorphological status) to see whether the status of the water has improved or deteriorated. The most important result of the third survey was the finding of the fact that the chemical status of the Danube River had improved considerably but its ecological and hydromorphological status had not improved as much as expected.

The following five Danube countries are not members of the EU: Bosnia-Herzegovina, Moldova, Montenegro, Serbia and Ukraine. These countries are under no obligation to implement the Water Framework Directive (WFD) or any of the associated EU legislation. Nonetheless, *every one of the countries sharing the Danube River Basin have undertaken to adopt and introduce the provisions laid down in the WFD.*

A total of four major cross-border issues were identified in the Danube River Basin management plan. Each of the issues is to be managed at a river basin level, and each affects both the Danube River and the Black Sea:

- nutrient load, leading to eutrophication and the development of eutrophic circumstances,
- organic substance load, causing low dissolved oxygen levels,
- dangerous substances, leading to toxic circumstances from an environmental aspect,
- hydromorphological changes, leading to the loss of wetland habitats and negative impacts on natural flow conditions, creating obstacles to migrating fish.

More than 80% of the entire length of the Danube River has been regulated for flood protection. The hydromorphological and ecological status of the water bodies have been changed by hydropower plants in 30% of the length of the river. About half of the Danube tributaries are used for hydropower generation. The total output of the power plants operating in the river basin is some 30,000 MW, which is an important factor of the implementation of the renewable energy policy. A total of 1018 dams have been constructed on the watercourses of the Danube River Basin whose own specific river basins are larger than 4000 km2. 598 of them are barrages, 296 sills or spillovers, and the remaining 124 are other facilities blocking passability. A total of 47% of the blockages cause less than 5 metres of difference between the surface levels on the upstream and the downstream sides in normal circumstances. 21% cause differences between 5 and 15 metres and 6% of the dams produce water level differences exceeding 15 metres. Up to 2015 a total of 335 of the blockages had to be supplemented with fish stairs according to the plans (no information is available as yet on how many have actually been constructed), while the remaining 628 will continue to block fish migration in the rivers. These must also be rendered passable for fish if ecosystem security is to be achieved. According to UN-Water's definition of the concept (UN-Water, 2013) the security of aquatic ecosystems is a key element of water security. Accordingly, securing passability is a basic prerequisite for achieving an acceptable level of security in aquatic ecosystems.

The EU's Danube Region Strategy

In 2009 the EU worked out a "macro regional" economic strategy for the Baltic Sea Region, followed, in 2011, by the development of a similar strategy for the Danube Region (EC, 2010). In 2014 the European Council asked the European Commission to work out a strategy for the Adriatic Region and the Ionian Region as well. Macro regional strategies are aimed at working out new projects and initiatives to promote joint implementation of development projects in the interest of the region concerned, thereby improving the utilization of the EU funds allocated to such projects. The Union's Danube Region Strategy lays emphasis on the WFD and flood risk management (FRM), and it applies a much wider interpretation of the concept of integrated water management than does the WFD (Ijjas, 2013).

The strategy identifies a total of 11 priority areas. The activities carried out in regard to each priority area are jointly coordinated by two participating countries. Hungary participates in the coordination of both water management related priority areas. The fourth priority area (water quality) is coordinated by Hungary and Slovakia, while the fifth one (environmental risks) is coordinated by Hungary and Romania. *The actions in both priority areas contribute to the accomplishment of water security of an acceptable level.*

Importance at the level of the river basin as a whole is the key criterion for the selection of projects and activities. This involves questions and issues necessitating joint actions planned and coordinated by countries sharing the river basin's area at the level of the river basin as a whole, along with the application of cooperation mechanisms between ministries and/or sectors, together with the integration of different sector policies. The Danube Strategy supports projects promoting sustainable development, whose implementation is in the interest of multiple regions and/or countries of the Danube River Basin. *The actions and projects of the strategy improve the statuses of waters and mitigate environmental risks (risks of floods, inland excess water, water scarcity and droughts), thereby playing an important role in accomplishing water security in the Danube River Basin.*

Water security in Hungary

Water security has so far been generally interpreted in Hungary as drinking water security in its strict sense. At the same time, we have carried out, and are performing at present, a variety of activities that are aimed, at accomplishing water security according to the general interpretation applied by UN-Water (2013), but we do not emphasize the roles played by such activities in enhancing water security. We are facing a wide variety of water management related problems that necessitate enhancement of water security in the general sense of the term (Somlyódy, 2011; OVF, 2015a; 2015b). For this reason, it is crucially important that we join international water security enhancement programmes and realize the vision of a "water-secure Hungary." We are working on a significant proportion of the tasks aimed at increasing water security in the sense defined by UN-Water (2013) together with EU member states, or the countries sharing the area of the Danube River Basin, based on shared principles, methods and work programme(s), as noted in previous chapters. At this point we are only discussing domestic specifics of water security.

Drinking water security in Hungary

Hungary had made significant efforts towards drinking water security even before global and EU-wide security programmes were launched: for instance by introducing an obligation for the development and adoption of water resource protection plans [Government Decree 123/1997. (VII. 18.) on the protection of water resources, prospective water resources and water facilities for drinking water supply]. Back in the 1980s Hungary was the second country in Europe to introduce fines in a system introduced with the aim of protecting water quality, a proof of the expertise and foresight of Hungarian professionals even in spite the difficulties of application in practice and certain flaws of the scheme. It is beyond doubt, however, that EU directives and actions pertaining to drinking water security were highly effective in promoting the enhancement of drinking water security (EU CIS, 2007).

Terrorist acts, as well as certain disasters caused by human activity or natural factors, played a very important role across the globe in triggering programmes towards strengthening drinking water security and water security. A variety of acts and other pieces of legislation were adopted in response to such acts and disasters with the aim of affording

protection to vital water management system elements and water facilities, in the context of the protection of critical infrastructure (Homeland Security – Environmental Protection Agency, 2007; EC, 2012d; Berek–Rácz, 2013; Bocsok–Borbély, 2012; Bognár, 2012; OKI, 2009a; 2009b).

The most important pieces of legislation in place for enhancing drinking water security and for protecting critical water infrastructure:

- Directive 2000/60/EC establishing a framework for Community action in the field of water policy (commonly known as: the Water Framework Directive)
- Government Decree 201/2001. (X. 25.) on quality requirements for drinking water and the regime of controlling
- 2008/114/EC of 8. December, 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, 23.12.2008 Official Journal of the European Union L 345/75
- Government Resolution 2080/2008. (VI. 30.) on the national programme for the protection of critical infrastructure
- Act CLXVI of 2012 on the identification, designation and protection of critical systems
- Government Decree 541/2013. (XII. 30.) on the identification, designation and protection of critical water management system elements and water facilities

Further progress was enabled in enhancing drinking water security by Government Decree 201/2001. (X. 25.) which defined the concept of drinking water security as follows: "Drinking water security is a quality and operational characteristic relating to drinking water consumption and use, that than be achieved in the system in place for the extraction of drinking water, for the treatment and for the supply of water, in the household drinking water network and at places where water can be drawn, entailing the lowest possible risk to human health." This definition reduces the general concept of water security, worked out by UN-Water (2013), to drinking water security, and it means the application and enforcement of the relevant strict regulations.

Protective zones of drinking water abstraction sites

Protection of water resources from which drinking water is abstracted is one of the most critical elements of achieving drinking water security. The environmental action plan adopted by Government Resolution 3058/3581/1991. (XII. 9.), which prescribed the development of an action programme for the protection of drinking water resources, played a key role in this aspect. The rules on the protection of water resources were laid down in Government Decree 123/1997. (VII. 18.). A targeted development programme was launched in 1995 with the aim of determining and designating the protective areas and protective zones specified in the Government Decree, performing status assessment activities and developing a monitoring network. Although much of the tasks prescribed at that time were carried out, the second river basin management plan still contains references to quite a number of actions that need to be executed.

The above regulation of the protection of water resources is in line with the provisions of the Water Framework Directive calling for protection of the environment of water abstraction sites on which drinking water supply relies. In Hungary this means the protection of a total of 1933 public operating, reserve and prospective groundwater resources and 19 surface water abstractions.

Drinking water security planning in Hungary and in EU member states

Government Decree 201/2001. (X. 25.) prescribed the preparation of drinking water security plans. The term "drinking water security plan" is defined in the Government Decree as follows: "A drinking water security plan is the water security governance regime of a drinking water supply system providing consumers with water exceeding 10 m^3/day on an annual average, or a drinking water supply system providing more than 50 permanent residents with water. A drinking water security plan may be approved if its operation ensures the supply of the population with healthy drinking water."

It was from the end of 2003 that the European Commission was calling on member states to apply the WHO's "water security planning" initiative in order to ensure the quality of water for human consumption. Therefore the EC DG Environment worked out the following recommendations:

(1) The member states should provide the continuous operation of a risk assessment and management system for their water supply systems
(2) A drinking water risk management system should comprise at least the following elements:
   (a) description of the water supply system,
   (b) hazard analysis and risk assessment,
   (c) measurements and their evaluation, to control risks,
   (d) installation of a monitoring system for controlling,
   (e) assessment of the drinking water risk management system,
   (f) continuous revision of elements (a)–(d).
(3) Operational documentation must be prepared of the elements listed in paragraph (2).
(4) The member states should ensure that all competent authorities and stakeholders can participate in the development of the drinking water risk management system and in the process of risk assessment.

The drinking water security plans prepared pursuant to the relevant Hungarian statutory regulations are in line with the above recommendations.

The Országos Közegészségügyi Intézet (National Public Health Institute, Hungarian acronym OKI) – in agreement with the relevant institutes of the WHO – considered the preparation and execution of drinking water security plan systems based on hazard analysis and risk assessment *(Water Safety Plans)* to be the most effective method for maintaining the security of drinking water supply (OKI, 2009a; 2009b). For this reason, the National Public Health and Medical Officer Service (Hungarian acronym: ÁNTSZ) – using manuals and aids worked out by the WHO, IWA and the Water Safety Working Group Hungarian

Water Utility Association – prepared a guide for the development and operation of drinking water security plan systems (or *Water Safety Plans*).

Assessment of the drinking water security situation

Hungary has practically fully comprehensive piped water supply coverage. Some 95% of all households – that is, 4.1 million households – are provided with piped water supply. Any demand can be met by the supply systems, in terms of quantity. The quality of water from certain drinking water resources, however, do not meet the requirements in regard to certain parameters. The situation is being improved by the ongoing drinking water resource protection and drinking water quality improvement programme (GWP Magyarország, 2016). *The current situation and the outlooks of drinking water security are regarded to be favourable in the light of the above and good status can be maintained in the long term.*

The role played by the provisions of the Water Framework Directive concerning protected areas in the accomplishment of water security

The main purpose of the WFD is *to accomplish and preserve the at least good status of all surface waters and groundwaters.* At the same time, the Directive also lays particular emphasis on the different types of protected areas. All areas and underground spaces designated as such quality as protected areas for the purposes of the WFD. These include the protected areas and protective zones of drinking water abstraction sites, nutrient and nitrate sensitive areas, natural bathing places, areas protected for their natural values and surface waters designated as habitat for fish. The second river basin management plan contains an assessment of the statuses of such protected areas and specifies actions and measures required for ensuring and/or preserving their good status. Some of the actions and measures ensuring good status of such areas are related to drinking water security, the rest of them are related to water security as the term is construed generally (UN-Water, 2013).

Flood security in Hungary

A total of nine record high floods passed down Hungary's large rivers during the 18 years since 1998, after only two such floods recorded in the preceding fifty years. Negative records were broken in 2015 by the rivers Rába, Hernád, Sajó, Szamos, Tisza and Sebes-Körös – where the all-time low or even lower water levels were reached; while the levels of water in other six of our rivers (including the Danube in some segments) came within 20 cm of the respective all-time low levels.

In response to floods in a number of its member states in the early 2000s the EU adopted legislation prescribing the preparation of flood risk management plans and thereby the improvement of flood security in the member states with significant flood risks. From its central funds the EU provides funding support to the implementation of the planned flood risk management actions. Accordingly, the EU's flood policy and regulations play an

important role in achieving flood security in Hungary. Floods occurring in Hungary are heavily influenced by human activities carried out in the Danube River Basin in countries upstream (and, to some extent, downstream) from Hungary, together with the hydrological and hydromorphological conditions in the river basin upstream from Hungary. In the first step the Danube countries prepared flood protection action plans for the entire river basin and for specific parts of the same, and then they worked out flood protection action plans in accordance with the EU's flood directive. These plans are of relevance to the flood security of the river basin as a whole, because they ensure collaboration among the countries sharing the river basin, as required for effective flood risk management.

In Hungary it was the further development of the Vásárhelyi Plan (that is, the development of the flood protection system of the Hungarian segment of the Tisza River) marked the launching of the most important flood risk management programme. Hungary's flood risk management programme is noted – besides the Dutch *Room for the Rivers* and the British *Making space for water* programmes – as one of Europe's largest integrated flood protection programme meeting the criteria of sustainability (Defra, 2005; OECD, 2014; SPKD, 2006a; 2006b). For the Vásárhelyi Plan extension programme to be an increase flood risk management programme of a scale, importance and standard the like of the *Room for the Rivers* and *Space for the Waters* programmes it should have designed (in addition to the construction of reservoirs to attenuate flood peaks), all actions to enable floods of the design levels to pass downriver, at lower water levels without raising the levels of, or strengthening the flood protection embankments. It may also be safe to say that at present the whole of Europe – but this may equally apply on a global scale – is busy seeking for the good practices that will be sufficient for tackling the challenges to be brought on by the 21st century, together with the expected climate change effects, as well as for regulation ensuring the application of such practices.

Extraordinary flood phenomena may occur increasingly frequently as a consequence of the ongoing climate change, therefore maintaining an acceptable level of flood security will continue to be one of the most important tasks of water management in the coming decades. The same applies to inland excess water security in the achievement and maintenance of which the retaining of water where it is produced (by rainfall or snowmelt) will play a particularly important role. In the case of watercourses of smaller river basins it is the increasingly frequent occurrence of extremely violent flash floods, affecting relatively small areas (e.g. the deluge in Northern Hungary in 2010 and in Budapest in 2015), calls for the development of infrastructure and actions for dealing with flash floods. Safe rainwater drainage and management in municipalities – already an important challenge facing water management in Hungary – will grow in importance.

Drought and water scarcity security in Hungary

In view of the amount of water flowing through the territory of Hungary, together with the amount of precipitation and the likely increase in the demand for water, no critical water scarcity or water stress needs to be expected to come about in this country. At the same time, severe droughts and local water scarcities require major actions to be taken to ensure the security of water supply in the broader sense of the term. Despite the fact that no critical

levels of water stress need to be expected at a national level, owing to the uneven distribution of Hungary's water resources in time and space *a growing number and variety of signs are pointing to an increasing need for regional water distribution to supply areas of water scarcity* (e.g. by channelling water from the Tisza River to the Körös Valley, operation of the Tisza Lake with the aim of keeping up the Tisza River as a natural live river and of supplying the town of Szolnok with water, replenishing Lake Velence from the reservoirs above it and replenishing the Szigetköz region).

Efforts made towards flood risk management have, during the past decades, been sidelined to some extent besides the river basin management planning activities as prescribed in the WFD and the focus on flood risk management planning. The so-called Kvassay Jenő Plan (OVF, 2015b) marks a turning point in this regard because it also deals with the future of drought management, particularly in view of the ongoing climate change. At present the main emphasis is laid on early drought forecasting, but sufficient actions will hopefully be taken towards the prevention of drought damage as well, during the coming 5-10 years. This is made all the more likely by the fact that the Rural Development Programme comprises a variety of funding sources for use in implementing drought risk management actions (e.g. irrigation development, reservoir construction).

The quantity statuses of Hungary's surface and groundwaters, falling short of "good" as prescribed in the Water Framework Directive necessitate additional actions for improvement, which will be made even more urgent by the threats of climate change. To achieve water security in agricultural production – primarily in areas where irrigation infrastructure was already put in place earlier – *there is a need for major irrigation development projects* for which funding is available in the context of the Rural Development Programme. Strict requirements and criteria are in place however, to ensure that irrigation infrastructure can only be installed in places where it does not jeopardize the water security of ecosystems.

Sanitation security in Hungary

Large-scale development projects implemented in recent years ensure that all municipalities of over 2000 population equivalent are adequately supplied with wastewater collection and treatment services. The most recent survey – of 2012 – shows that the proportion of untreated wastewater discharged into water bodies has been reduced to 0.8%, while the proportion of waste water undergoing only mechanical treatment before discharge into receiving water bodies is only 1.8%. The development projects increased the annual waste water treatment capacity by 300 million cubic metres between 2000 and 2013. Some 17% of the total Hungarian population live in municipalities of less than 2000 population equivalent, without wastewater treatment facilities. About 425,000 people living in 845 small municipalities are not provided with wastewater treatment services today (GWP Magyarország, 2016). Work is in progress towards resolving this issue.

Cross-border water security in Hungary

Some 95% of Hungary's water resources come from abroad, therefore the quantitative and qualitative statuses of our waters, that is, the degree of water security in Hungary, depend to a large extent, on the hydrological conditions and the activities carried out in countries upstream from us. *Improving what is called "cross-border water security" is a major challenge for Hungary.* Boundary water agreements have been in place for quite some time between Hungary and the seven neighbouring countries, in the context of which a wide variety of joint efforts have taken place. Work has got under way, during the past decade, on extending these agreements and collaborations from the water bodies constituting state borders to the entire areas of the shared river basins. International treaties and, particularly, the Water Framework Directive, may play an important role in cooperation. Despite the positive results so far (including, for instance, the shared river basin management plan covering the Danube River Basin, together with its renewal, the Danube River Basin's flood risk management plan etc.) *a lot has still to be done towards the application and enforcement of the provisions of the agreements and the enhancement of cross-border water security.*

The role of integrated water management in creating water security

Recent decades have seen the adoption of a number of water policy documents concluding that *integrated water management and integrated water management planning are important instruments to be applied in creating water security* (EC, 2012c; 2015a; EEA, 2012b; 2015; 2016a; OECD, 2013a; UN, 2012; GWP, 2015; Sadoff, 2015; Shah, 2016). Integrated water management plans (IWMP) and river basin management plans (RBMP) had been prepared in the United States and in European countries (including Hungary) for decades even before the UN and the GWP launched a global programme to spread and improve the practice of integrated water management planning. Meanwhile Europe *saw the adoption of the Water Framework Directive in the way of a global innovation, introducing a mandatory obligation in the whole of the European Union for authorities to work out river basin management plans (RBMP).* The river basin management plans prepared pursuant to the WFD integrated a variety of factors from a variety of aspects, but only to promote the aquatic environmental objectives laid down in the WFD. No measures or actions required for achieving economic or social goals however, therefore they cannot be regarded as fully integrated water management plans (GWP, 2015; Ijjas, 2014b).

A unique feature of water management in Europe is that EU member states prepare river basin management plans for their respective territories on the basis of a set of standardized principles. The plans so prepared lay down actions and measures whereby they can improve the statuses of all of their surface and groundwaters to reach the level categorized as "good" and/or keep up such good statuses, by 2015 at the latest (or, where justified, by 2021 or 2017). It is Europe's great achievement that the first river basin management plans had been worked out by the end of 2009 for nearly the whole of the territory of the Union and that the implementation of the first ones of them had been revised by end-2015, on the basis of whose results the member states worked out the revised second versions of their river basin management plans. The results are overshadowed by the fact that many of the

targets set to be reached by end-2015 could not be accomplished by the member states and that some of the provisions of the Water Framework Directive were not implemented by nearly any of the member states (GWP, 2015), such as the environmental assessment of the feasibility of the new investment projects on the basis of the WFD 4.7 test.

Achieving good status and protection of waters is a crucial task for human health and environmental security; however, Europe has in recent decades failed to lay adequate emphasis on satisfying the society's and the economy's demand for water, including the management of the risks of floods and droughts as well (GWP, 2015; Ijjas, 2014b). Owing to the criticality of the integrated water management process, analyses were worked out at global level, as encouraged by the UN and the GWP (UN, 2012), and at the level of different regions of the world, of the status of the application of integrated water management, its good practices, development possibilities and instruments. The report on the Central and East European region (CEE) refers to the special nature of the situation in Europe, even in its sub-heading: *Integrated Water Management vs. Water Framework Directive* (GWP, 2015). Its key authors (Janusz Kindler, István Ijjas and Danka Thalmeneirova) describe in the report the importance of river basin management as prescribed in the Water Framework Directive together with what other tasks need to be carried out in addition to those prescribed by the WFD and other related pieces of legislation to make sure that water management fulfils the functions expected of it by society and achieves water security in line with the definition of the term as developed by UN-Water (UN-Water, 2013).

The concept and importance of integrated water management

The past quarter of a century has seen profound changes in water management both globally and in Hungary. Concerted efforts were made at a global scale with the aim of tackling challenges in water management. The coordinated activities of countries all over the world affected water management in Hungary as well. Major changes in water management in Hungary were induced primarily by the efforts made towards adaptation to the European Union's water management policy and action programmes. This had a lot of positive effects but they were undoubtedly accompanied by some adverse consequences as well, when proven, up-to-date, effective methods well-adapted to the domestic environment were replaced by procedures of more general applicability, adopted by the member states of the European Union. On the whole however, the positive impacts of European collaboration far outweighed their negative consequences.

Integrated water management was to be based on an integrated water management strategy and planning. Global achievements and recommendations and those of the European Union have to be utilized in water management in Hungary, however, we must also rely on our own existing rich body of experience in integrated water management. The concept of integrated water management is interpreted by most countries and at most forums across the globe in accordance with the definition worked out by the GEP (GWP–TAC, 2000: 22.):

"Integrated water management is a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

The importance of and need for integrated water management is also reflected by changes in the EU water policy. The European Union has responded to existing and expected future challenges of water management by adapting its water policy. The essence of the changes is set forth in the *Water Blueprint* (EC, 2012c). To bolster water management the EU has developed a new strategy aimed at *ensuring good quality water in sufficient quantities* for all legitimate uses. According to the *Water Blueprint* (EC, 2012c) at present the general objective of the EU's water policy is to provide access for all Europeans to good quality water of sufficient quantity and to achieve and preserve good status of all waters in the whole of Europe. In fact, these efforts are aimed at achieving what is referred to as water security in UN-Water's interpretation (UN-Water, 2013).

Integrated water management planning in the European Union

The purpose of the river basin management plans prepared in accordance with the WFD is to prescribe action programmes for achieving and preserving good status of waters. For "fully integrated" river basin management such plans need to be supplemented and coordinated with protection against damage by waters and with action programmes aimed at attaining economic and social goals relating to water use. Water management needs to be integrated with plans, programmes and policies of various economic sectors also in the river basin management plans prepared on the basis of the WFD and with plans ensuring the achievement of economic and social objectives (GWP, 2015; Ijjas, 2014b; EC, 2016).

Integrating water management into the plans of an economic sector means the planning of action programmes ensuring the satisfaction of the need of the economy and reducing or eliminating economic damage, while having only such negative impact on the statuses of waters that still qualify as "acceptable" from the aspect of the WFD. The key is to produce plans satisfying the sectors' water management related needs that are at the same time in line with the WDF.

Relationships and interactions between water policy and water management planning, along with other policies and planning processes, need to be taken into account if integration is to be successful:

- water policy is closely linked to natural boundaries (river basins), while other policies are linked more to administrative and/or political borders;
- the effectiveness of the policy is influenced by a host of processes taking place by chance;
- the application or assertion of water policy is particularly complicated in large river basins such as that of the Danube, Tisza or Dráva rivers, where countries sharing the river basins need to coordinate their activities for many of the water management objectives to be accomplished.

The right choice of the level of integration is key:

- in some cases integration is required at the level of the river basin concerned (e.g. in water quality regulation, in coordinating nature conservation with flood protection);

- in other cases integration is required at a national level, in accordance with state boundaries (e.g. coordinating water resource management and environmental regulations);
- while in some cases integration is required at the level of the European Union (e.g. in coordinating the WFD, the Common Agricultural Policy and the Structural Funds).

Waters accumulating in a river basin bring together the effects of human activities affecting the status of waters all over the whole of the area. Such activities influence the quantity and quality of the water accumulating in the river basin, together with the status of the water dependent flora and fauna. Accumulating water carries sediment and pollutants. Most pollutants are bound to sediment particles while being carried by water. Part of the pollutants decompose while being carried by water, depending on run-off conditions, including travelling time, or they accumulate in plants and animals, or just settle with the sediment. The contaminated sediment deposited in river beds may, through a series of transformations, turn into "time bombs." For this reason, the actions required for satisfying water-related needs and for achieving the prescribed good status of waters may, if they involve activities having negative impacts on larger segments of the basin, only be worked out through integrated water management planning covering the whole of the river basin concerned.

Water management planning must be aimed at working out actions whereby good status of water resources can be achieved and maintained and whereby it is possible to satisfy water-related needs that are in line with the relevant economic and social objectives without unacceptable impairment of the statuses of waters. Actions may be "structural" (like the construction of hydraulic engineering structures) or "non-structural" (like the introduction of legal or economic regulations, the improvement of people's water and environmental awareness).

Planning within the meaning of the WFD integrates a host of perspectives, but for the most part only with the aim of achieving good status of waters. This cannot be regarded as a deficiency, since the WFD is aimed at achieving and preserving the good status of waters, which is, at the same time, a fundamental prerequisite for sustainable development. According to the basic documents governing its operation (primarily owing to the principle of subsidiarity) the EU cannot make it a mandatory obligation for its member states to apply the planning requirements pertaining to integrated water management. The WFD requires the preparation of river basin management plans to protect the aquatic environment and it sets out the contents and methods of such plans. The content and methods of the other component of planning may be determined by the member states themselves. The EU-level policies and strategies jointly adopted by the member states must be taken into account in this second part of water management planning, however, these do not entail such strong and legally binding obligations as do the provisions laid down in the WFD. It is by way of its aid policy that the EU encourages member states to apply and comply with strategies and sector policies formulated at the level of the Union.

The experts who drafted the Water Framework Directive narrowed the concept of river basin management to actions aimed at achieving and preserving the good status of waters. Wider interpretations of the concept of river basin management are used outside Europe, where the term is used for water management practices specifying and implementing actions

required for satisfying environmental, economic and social needs as well. EU membership entails an obligation for Hungary to prepare river basin management plans in line with the Framework Directive; on the other hand, we must work out our own integrated water management planning system, one that will provide for the planning of actions taking care of the water management tasks that are required reaching economic and social objectives as well.

Water and the future – a world of water security

World Water Forum for a water-secure world

The way people think of and about water has been changing for the better in the last decades. A significant proportion of the population, together with politicians, have been gradually and increasingly realising how water security and economic growth are interrelated and are now seeking for mitigating risks caused by social and economic processes as well as extreme weather phenomena.

A World Water Forum has been held once every three years since 1997, where experts, together with prominent leaders of the participating states, discuss how water management challenges can be tackled. The seventh Forum took place in 2015. The growing importance of water is indicated by the fact that this was the largest ever organized event focusing on water management, with 46,000 participants and 106 high ranking state leaders of 168 countries discussed, in as many as 400 different sections, what role water will be playing in the future (with *Water for Our Future* being the key topic of the forum) and how the world can get prepared for it.

The seventh world forum proposed four action programmes for responding to challenges of water management. The first of the action programmes is entitled *Water security for all.* A total of four sub-themes were designated within this topic for the work programme: 1. Enough safer water for all; 2. Integrated sanitation for all; 3. Adapting to Change: Managing Risk and Uncertainty for Resilience and Disaster Preparedness; 4. Infrastructure for Sustainable Water Resource Management and Services (WWC, 2015a; 2015b; 2015c).

World Economic Forum (WEF) for a water-secure world

The *Global Risks Report* (World Economic Forum, 2016) discussed at the 2016 World Economic Forum on global economic challenges and risks ranked water-related problems among the most sever risk factors to be faced during the next 10-year period. It warned decision makers that without good policy decisions climate change would make the situation even worse than it currently was. The report pointed out that water is a critical problem for mankind, one of the central issues of both sustainable development and climate change. The most conspicuous effects of climate change as regards water management are longer periods of droughts, coupled with more and more devastating floods. Climate change challenges cannot be managed without dealing with water problems (World Economic Forum, 2016).

According to the *Global Risks Report* at present the five most profound risks include the risks of adaptation to the effects of climate change, weapons of mass destruction, the water

crisis, mass migration and energy price changes. The report points out that the potential climate change may have a fundamental impact on water crisis which, in turn, may lead to conflicts and increasingly intensive migration. This necessitates improvements in water administration, to enable better adaptation to the effects of climate change, population growth and economic development, together with the management of risks entailed by the global refugee crisis and the fourth industrial revolution. In addition to risks stemming from the close nexus between water security and climate change the WEF report regards the mutually related risks of food security and climate change to represent the highest priority threats.

Water and food security in 2050

The High Level Panel for Water and Food Security organized by FAO and WWC worked out a paper in preparation for the World Water Forum of 2015, on the expected situation in terms of water and food security in 2050 (FAO–WWC, 2015). The paper drew attention to the following, among other things:

- Some 9-10 billion people will be living on Earth in 2050; feeding them will take major actions in both the public and the private sectors. *At a global scale there might be enough water for producing the required amount of food but the uneven distribution of water resources in space and time will be causing severe water scarcities in many more places than are faced today.* The situation will be aggravated by the expected unfavourable effects of climate change.
- The population of cities primarily in developing countries will be growing substantially up to 2050, leading to growing urban demand for water and food. Agriculture will still be the biggest global user of water in 2050.
- At present some 20% of the world's farmlands are irrigated, accounting for 40% of the total global produce. These ratios will increase substantially up to 2050, despite efforts aimed at improving the efficiency of water use.

The price of a water-secure world

Achieving water security is one of the key prerequisites for sustainable growth. This requires the management of a variety of risks, including water scarcity (too little water), floods (too much water), inadequate water supply and sanitation, poor water quality and degradation of aquatic ecosystems. *Full water security can never be achieved*, and the level to be targeted depends on the levels to which the above risks need to be mitigated for society to find them acceptable and affordable. The construction of the infrastructure required for achieving water security is a costly process. It was in awareness of this that the high level panel of the World Water Council and the OECD prepared a report on the expected costs of the infrastructure required for the realization of the vision of a water-secure world, and the possibilities of financing it (WWC–OECD, 2015).

A review of the scenarios of expected future needs for water shows that the available water resources will, in many regions of the world, not be sufficient for satisfying the demand. According to scenarios examined by the OECD the total global demand for water

will grow by 55% up to 2050. Growth will be most dramatic in the BRICS countries (Brazil, Russia, India, China and South-Africa). On the other hand, demand for water in the OECD countries will decrease somewhat.

A wide variety of estimates of different results have been worked out concerning the costs of the infrastructure required for accomplishing a water-secure world, due to the multitude of different factors taken into account (for example, the use of a narrower interpretation of the concept of water security, meaning only the security of drinking water supplies and sanitation, or a broader interpretation). The minimum and maximum amounts of the global annual cost of the infrastructure concerned are, according to the above estimates:

- providing for water supply and sanitation corresponding to the millennium development goals: USD 27–205 billion;
- adapting water infrastructure to climate change in developing countries: USD 75–100 billion;
- global wastewater treatment: USD 123–135 billion;
- all infrastructure elements increasing water security at a global level: USD 500–1037 billion;

The above annual costs – with the exception of the last item – reflect only the investment costs, which may be increased substantially by the costs of operation and maintenance. Accordingly, the total cost of the water infrastructure is estimated to be about USD 11,700 billion between 2013 and 2030. This amount is similar to the cost of the infrastructure required for the production of the necessary energy (USD 12,200 billion), somewhat smaller than the cost of road construction (USD 16,600 billion) and larger than the cost of the telecommunication infrastructure (USD 9,500 billion). Despite the uncertainties lying in the above estimates it may be concluded from the results of the WWC and OECD panel that the realization of the vision of a water-secure world will require massive amounts of funds during the coming decades, more even than the amounts being spent on the same today. The fact that various global and international forums are busy working on finding possible ways to cut these costs, may give rise to some measure of optimism.

Science for water security

Research activities on the more distant future of water management have been growing increasingly intensive in recent years. For example, the International Institute for Applied Systems Analysis (IIASA) scrutinized – with the help of global water management scenario models – the interactions between water, food, energy, climate and environment, to establish future hotspots of water insecurity along with possible effects on food and energy security. Difficulties relating to projections on the future of water resources are reflected by the wide range of the IIASA estimates of the amount of water that will be required in 2050: industry's demand for water is expected to increase from 750–900 km^3/year today to 1200–2000 km^3/year, while household water consumption will – factoring in the estimated population growth as well – is expected to grow from today's 400–450 km^3/year to 700–1500 km^3/year (IIASA, 2016).

One of the most important research programmes currently under way towards achieving a water-secure world is called *Sustainable Water Future Programme*, which is based on the recommendations set forth in the *Bonn declaration on global water security* of 2013. The programme is part of the global programme called *Future Earth*, aimed at facilitating adaptation to the global climate change. The active involvement, and the recognition of the achievements, of Hungarian scientists in tackling global water management challenges is reflected by the fact that three of the members of the Planning Committee working out the foundations for the programme come or originate from Hungary: András Szöllősi-Nagy, János Bogárdi and Charles Vörösmarty. The programme played a leading role in the preparation of the scientific programme of the 2016 Budapest Water Summit (Sustainable Water Future Programme, 2015).

Research efforts seeking for new ways to solving water problems are of outstanding importance. For example, an increasing number of experts are now convinced that rather than water scarcity, the main risks for the world include weaknesses in the systems of state administration in charge of water management, calling for improvements in the institutional framework of water management. We are not managing water resources frugally enough and do not afford adequate protection for the available resources. It is also said the vast quantities of food (and so water) wasted would be enough for feeding 2 billion people. Water consumption could also be reduced by changing the menu, replacing food produced with a high water input with products of smaller water footprints. A sustainable global virtual water market could be put in place, whereby the world's renewable water resources could be utilized more efficiently, producing foodstuffs of higher water requirement in regions where there is enough water for doing so.

Hungary for a water-secure world – Budapest Water Summit 2016

At the end of 2016 Hungary – together with the World Water Council – organized a global water summit in Budapest. The patron of the event was János Áder, President of the Republic of Hungary. The aim of the conference was to turn water from a source of conflicts and risks in the 21st century into a source of cooperation, peace and development, for all countries striving for sustainable development. The organization of the Budapest Water Summit 2016 and the participation of the representatives of science in Hungary in the preparation of the scientific forum of the summit shows how Hungary wishes to make its contribution to resolving global water problems and realising the vision of a water-secure world. It is hoped that this strong intent and political commitment will also result in resolving Hungary's own water problems, and in efforts aimed at creating general domestic water security that is acceptable to society, in the entire field of water management, that is, a "water-secure Hungary."

Conclusions and proposals

Our paper discusses certain high priority issues relating to water security, without intending to provide a comprehensive, all-encompassing overview of the different challenges. Our

analysis may, however, form the basis of such a comprehensive study. Our most important conclusions and proposals concerning water security are as follows:

- In view of the available literature the global water situation is more than disconcerting and the prevailing trends are unfavourable. This conclusion is even more apt in view of regional variability and its indicators. Therefore *there is a case for performing a comprehensive analysis of water security, and for involving it in decision making at different levels.* This will make it possible to take into consideration a range of complex and new impacts and effects.
- Hungary made considerable efforts and achieved a lot of progress towards water security in earlier years too but even more has been achieved in this field since the system change (the 1990s and, in particular, since Hungary's EU candidacy and membership).
- *One of the most important factors in enhancing water security was the introduction of the EU Water Framework Directive,* and other related legislation, together with the preparation and revision of river basin management plans. The actions laid down in the river basin management plans ensure protection of human life and health, along with the statuses of waters and aquatic ecosystems in each EU member state on the basis of harmonized, mandatory regulations, with shared objectives that are to be achieved by joint efforts.
- The EU Directives have created the regulatory framework for the achievement of drinking water and outdoor bathing water security and of ecosystem security of a level that is acceptable for the society. *Adequate sanitation* plays an important role in achieving and preserving the good status of waters, *the ensuring of which is prescribed by the Water Framework Directive.* Major developments have been made in this field during the past decade.
- The strict and standardized regulations on drinking water and outdoor bathing water as well as ecosystem security are regarded as outstanding European achievements. Compliance with the rules is, however, challenged by the fact that the system of the prescribed environmental assessments is too complex, difficult to overview and carry out, and that it is extremely resource-intensive.
- *Flood risk management plans and the riverbed management plans for high waters supplementing the flood risk management plans, have been worked out for the whole of the European Union, the Danube River Basin and Hungary* based on the EU flood risk management directive, in accordance with the river basin management plans. The implementation of the planned actions will ensure that flood security is raised to a reasonable level.
- *Activities aimed at strengthening inland excess water security* are as a specific Hungarian solution, are under way in parallel with the efforts made in the way of flood risk management, but the expected results have not, for the time being, been clarified.
- Preparations for solutions to problems in *municipal rainwater management* are also in progress. Solutions enabling the enhancement of water security to an acceptable level in these fields will hopefully be found for preventing and eliminating damage caused by floods, inland excess water and excess municipal rainwater.

- Having joined the EU's drought management actions Hungary is laying increased emphasis on the *management of the risks of droughts*. It seems at present that similarly to EU-level actions emphasis will be laid on the early forecasting of drought phenomena. Experience shows that actions preventing damage by drought may be even more important than early forecasting in dealing with drought damage.
- The provisions laid down in the Water Framework Directive ensure protection of the qualitative and quantitative status of surface and underground waters, including the water resources available for use. However, the WFD does not (and is not meant to) regulate how the security of water services can be ensured for the users. This will have to be provided for in separate *water resource management plans* integrated with the river basin management plans prepared in accordance with the provisions of the WFD.
- According to the definition adopted by UN-Water *the concept of water security includes the security of the satisfaction of welfare related requirements and those relating to spending spare time on coasts and beaches as well* (in addition to outdoor bathing water security). These are not covered by current water security programmes. The satisfaction of such requirements must also be put on the agenda.
- It is crucial for all aspects of water security that the effects of climate change be taken into account and that "climate resilient" methods of adaptation are sought for and applied. Emphasis must be laid on such tasks in the research and development programmes and climate adaptation plans of the coming decade.
- There are critical environmental aspects to flood and inland excess water risk management, municipal rainwater management, drought management and climate adaptation, but in essence these are not *activities for environmental but economic and social purposes*, which may also only be based on sound foundations by integrated river basin planning.
- It should be noted that before the entry into force of the WFD a number of EU member states – including Hungary – had well-established integrated water management planning systems, but *no integrated water management planning system adapted to the WFD has been put in place as yet*. Effective integrated water management is an important prerequisite for water security as well. There are two ways for going about it:
  - The Water Framework Directive should be transformed and turned into a general EU-level water management framework directive comprising provisions ensuring the attainment of social and economic goals as well. This solution is unlikely to be adopted in the next decade.
  - A water management system integrated with the WFD should be worked out, one that deals with water management issues that are important for society but the WFD does not envisage actions for resolving them.

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