

REVIEW OF THE IMPLEMENTATION OF THE EU WATER FRAMEWOK DIRECTIVE

Bart Schultz¹

ABSTRACT

In 2000 the European Water Framework Directive (EWFD) was approved by the European Parliament in which the at present 27 Member States are represented. In 2007 the Flood Directive was added to the EWFD. Under this Directive the Member States have to take into account flood management as well. In the past 20 years the Member States have been working to implement the requirements of the EWFD. An important aspect is that under the umbrella of the EWFD the riparian countries in the European River Basins jointly had to make River Basin Plans. In line with this they had to adapt their national legislation and to make National Plans for the part of the river basins in their territory, as well as sub-basin plans for the sub-basins in their territory. The river basin plans had to be ready in draft during 2009. The plans have a strong focus on environmental aspects. Over the past twenty years the Member State cooperation has substantially been strengthened.

In this paper a review is presented how the requirements of the Directives have been implemented. This is illustrated with reviews of the implementation in the two largest river basins, with most riparian countries, the Rhine and Danube River basins, with respectively eight and eleven riparian countries. It is shown that more or less all agreed activities have been implemented, which can be considered a major achievement. However, a lot still has to be done to fulfil all the agreed criteria.

INTRODUCTION

In 2000 the European Water Framework Directive (EWFD) was approved by the European Parliament in which the at present 27 Member States are represented. In 2007 the Flood Directive was added to the EWFD. Under this Directive the Member States have to take into account flood management as well. In the past 20 years the Member States have been working to implement the requirements of the EWFD. An important aspect is that under the umbrella of the EWFD the riparian countries in the European River Basins jointly had to make River Basin Plans. In line with this they had to adapt their national legislation and to make National Plans for the part of the river basins in their territory, as well as sub-basin plans for the sub-basins in their territory. The river basin plans had to be ready in draft during 2009. The plans have a strong focus on environmental aspects. Over the past twenty years the Member State cooperation has substantially been strengthened.

In this paper a review is presented how the requirements of the Directives have been implemented. This is illustrated with reviews of the implementation in the two largest river basins, with most riparian countries, the Rhine and Danube River basins, with respectively eight and eleven riparian countries.

EUROPEAN WATER FRAMEWORK DIRECTIVE AND RELATED DIRECTIVES²

Since the acceptance of the European Water Framework Directive (EWFD) on 23 October 2000 all Member States have committed themselves to apply integrated water resources management (IWRM) in practice within the framework of a river basin approach (European Commission, 2000). The purpose of the EWFD was formulated in Article 1:

The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- (a) *prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;*

¹ Prof. em. Land and Water Development IHE Delft, Lelystad, the Netherlands

² The texts of this section and the next section are mainly derived from the web site of the European Commission

- (b) *promotes sustainable water use based on a long-term protection of available water resources;*
- (c) *aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;*
- (d) *ensures the progressive reduction of pollution of groundwater and prevents its further pollution;*
- (e) *contributes to mitigating the effects of floods and droughts and thereby contributes to:*
 - ❖ *the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use,*
 - ❖ *a significant reduction in pollution of groundwater,*
 - ❖ *the protection of territorial and marine waters;*
 - ❖ *achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community action under Article 16(3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.*

In fact, the focus of the EWFD is on the protection of water and not on the need for water use in the riparian countries. In addition to this for quite a period the EWFD did not fully concern IWRM, while flood management was not yet covered under it. However, following the initiative taken under the Netherlands Chairmanship in the second half of 2004, also flood management came on the European political agenda. This has resulted in the adoption of the Directive on the Assessment and Management of Flood Risks (DAMFR) on 23 October 2007 (European Parliament and the Council of the European Union, 2007).

In Europe there were substantial pollution problems and, especially during the years preceding the adoption of the Flood Risks Directive, substantial cases of flooding. On the other hand urbanisation was still on going in combination with a decline of the number of the rural population due to the increase in farm sizes and the increased interest in nature protection. All these processes resulted in an increasing need for IWRM and in fact in the longer run for integrated environment management, by integrating land use, IWRM policies and planning mechanisms. To what extent this will in future be achieved is an open question. The first step is to try to achieve IWRM in practice as a result of the full implementation of the EWFD. A start was made with the preparation of the plans at river basin, national and sub-basin level. This set of plans and the adaptation of the legal frameworks were indeed ready within the agreed period. This has really been a challenge for the Member States, but when they indeed prove to be successful the benefits are substantial.

With respect to the DAMFR, especially interesting is Chapter III, Item 4. Chapter III describes the preparation of Flood Risk Management Plans by the Member States. These plans had to be ready by 22 December 2015. In Item 4 is stated:

In the interests of solidarity, flood risk management plans established in one Member State shall not include measures which, by their extent and impact, significantly increase flood risks upstream or downstream of other countries in the same river basin or sub-basin, unless these measures have been coordinated and an agreed solution has been found among the Member States concerned in the framework of Article 8.

Article 8 provides the details with respect to the conditions of the plans in relation to the territory that they cover, especially with respect to within one country or within several countries.

In the DAMFR two other steps are prescribed:

- (a) 2nd Preliminary Flood Risk Assessment, specific requirement on climate change Commission's first implementation report, due by 22 December 2018;
- (b) 2nd Flood hazard and risk maps, due by 22 December 2019;

So far with exception of Spain all Member States have fulfilled all the requirements. Spain has so far partly fulfilled them. Further it is stated that by 22 December 2021 there will have to be the end of 1st flood risk management cycle, 2nd Flood Risk Management Plans, specific requirement on climate change and the 3rd Water Framework Directive River Basin Management Plans.

In addition to the EWFD and the DAMFR, three related directives have to be taken into account as well in the implementation process of the EWFD. These are:

- (a) *Bird Directive*. The Birds Directive was unanimously adopted in April 1979. The considerations behind this Directive were that often migratory, wild bird species only can be protected by cooperation across borders. Urban sprawl and transport networks have fragmented and reduced their habitats, intensive agriculture, forestry, fisheries and the use of pesticides have diminished their food supplies, and hunting needed to be regulated in order not to damage populations. The Birds Directive is the oldest piece of European Union legislation on the environment. The Directive was amended in 2009. Habitat loss and degradation are the most serious threats to the conservation of wild birds. The Directive therefore places great emphasis on the protection of habitats for endangered and migratory species. It establishes a network of Special Protection Areas (SPA) including the most suitable territories for these species. Since 1994, all SPAs are included in the Natura 2000 ecological network, set up under the Habitats Directive;
- (b) *Habitats Directive*. The Habitats Directive was adopted at 21 May 1992. It ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right. With the Birds Directive it forms the cornerstone of Europe's nature conservation policy and establishes the European Union wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments. Certain articles of the Habitats Directive (Art. 6, 12, 16 and 17) require Member States to report on the conservation status of habitats and species, on compensation measures taken for projects having a negative impact on Natura 2000 sites or on derogations they may have applied to the strict protection measures. The Birds and Habitats directives have had to evolve to reflect successive enlargements of the European Union;
- (c) *Groundwater in the Water Framework Directive*. The components of the Water Framework Directive dealing with groundwater covered a number of different steps for achieving good quantitative and chemical status of groundwater by 2015. They require of the Member States to:
 - ❖ define groundwater bodies within sub-basins to be designated and reported to the European Commission. They must classify them by analysing the pressures and impacts of human activity on the quality of groundwater with a view to identifying groundwater bodies presenting a risk of not achieving EWFD environmental objectives. Member States were obliged to carry out this classification between 2004 and 2005 and to report the results back to the European Commission;
 - ❖ establish registers of protected areas within each sub-basin for those groundwater areas or habitats and species directly dependent on water. The registers had to include all bodies of water used for the extraction of drinking water and all protected areas covered under the following directives: Bathing Water Directive, vulnerable zones under the Nitrates Directive and sensitive areas under the Urban Wastewater Directive, as well as areas designated for the protection of habitats and species including relevant Natura 2000 sites designated under the Birds and Habitat directives. Registers have to be reviewed under the River Basin Management Plan updates;
 - ❖ establish groundwater monitoring networks based on the results of the classification analysis so as to provide a comprehensive overview of groundwater chemical and quantitative status. Member States were also obliged to design a monitoring programme that had to be operational by the end of 2006;
 - ❖ set up a river basin management plan (RBMP) for each sub-basin which must include a summary of pressures and impacts of human activity on the groundwater status, a presentation in map form of monitoring results, a summary of the economic analysis of water use, a summary of protection programmes, control or remediation measures, etc. The first RBMPs were published at the end of 2009. The updated RBMPs were due by the end of 2015 and their review is expected every six years thereafter;
 - ❖ take into account by 2010 the principle of recovery of costs for water services, including environmental and resource costs in accordance with the polluter pays principle;
 - ❖ establish by the end of 2009 a programme of measures for achieving EWFD environmental objectives (e.g., abstraction control, prevention or control of pollution measures) that would be operational by the end of 2012. Basic measures included, in particular, controls of groundwater extraction, controls (with prior authorization) of artificial recharge or augmentation of groundwater bodies (providing that it does not compromise the achievement of environmental objectives). Point source discharges and diffuse sources liable to cause pollution are also

regulated under the basic measures. Direct discharges of pollutants into groundwater are prohibited subject to a range of provisions listed in Article 11. The programme of measures had to be reviewed and if necessary, updated by 2015 and every six years thereafter.

Natura 2000 is the largest coordinated network of protected areas in the world. It is stretching over 18% of the European Union's land area and more than 8% of its marine territory. The network exists of core breeding and resting sites for rare and threatened species, and some rare natural habitat types, which are protected in their own right. It stretches across all 27 European Union countries, both on land and at sea. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive. Natura 2000 is not a system of strict nature reserves from which all human activities would be excluded. While it includes strictly protected nature reserves, most of the land remains privately owned. The approach to conservation and sustainable use of the Natura 2000 areas is much wider, largely centred on people working with nature rather than against it. However, Member States must ensure that the sites are managed in a sustainable manner, both ecologically and economically.

RECENT REPORTING ON THE IMPLEMENTATION OF THE EWFD AN DAMFR

In accordance with Article 18 of the EWFD and Article 16 of the DAMFR, the Commission must publish a report to the European Parliament and to the Council on the implementation of these Directives after each update of the River Basin Management Plans and Flood Risk Management Plans respectively. The Commission Report must include among other things a review of progress in the implementation of the Directives and an assessment of the Plans, including suggestions for the improvement of future Plans. The report also includes an assessment of the international cooperation under the implementation of the Directives. The 5th Implementation Report was adopted on 26 February 2019 and consisted of the following documents:

- (a) A Commission report to the European Parliament and the Council on the implementation of the EWFD (assessment of the second River Basin Management Plans) and the DAMFR (assessment of the first Flood Risk Management Plans), and recommendations to all Member States on both Directives;
- (b) A European Overview of the second River Basin Management Plans - Commission Staff Working Document accompanying the report;
- (c) A European Overview of the first Flood Risk Management Plans - Commission Staff Working Document accompanying the report;
- (d) Country-specific assessments for European Union Member States' second River Basin Management Plans - Commission Staff Working Documents per Member State accompanying the report;
- (e) Country-specific assessments for European Union Member States' first Flood Risk Management Plans - Commission Staff Working Documents per Member State accompanying the report;
- (f) Report on the international cooperation under the Water Framework Directive - Commission Staff Working Documents accompanying the report;
- (g) Report on the international cooperation under the DAMFR - Commission Staff Working Document accompanying the report.

The Commission report reveals significant improvements in knowledge and reporting on the EWFD compared to the previous cycle. More Member States reported in a timely manner, with more comprehensive, relevant and reliable information.

Two decades of European Union water policy and law have made a change. The trend of continuous decline of water quality has been reversed. Water quality throughout Europe has improved. Compliance with the EWFD objectives is increasing gradually. Although in a number of Member States the right policy measures were taken and a number of financial investments made, in many river basins improvements in water quality will still take some time. While a large majority of groundwater bodies have achieved good status, less than half of surface water bodies are in good status, although some individual underlying trends are more positive. Various European Union funds will continue to support these implementation efforts.

The path towards full compliance with the objectives of European Union water legislation before the end of the third cycle (in 2027) is now very challenging. Reporting shows that, although further measures will be taken until 2021, many others will be needed beyond 2021.

IMPLEMENTATION OF THE EU WATER FRAMEWORK DIRECTIVE IN THE RHINE RIVER BASIN³

The Rhine River Basin is located in (parts of) the territory of eight countries – Switzerland, France, Germany, Belgium, Luxembourg and the Netherlands. Together with the Danube River it is one of the largest rivers in Europe. Within the Rhine River Basin there is a long-standing cooperation among the riparian countries. Originally the cooperation focussed on navigation, but later other issues came up, especially water quality control and flood management. For many years the cooperation has been based on joint interest and on a voluntary basis. However, under the umbrella of the EWFD the cooperation has substantially been strengthened and the riparian countries have jointly made two editions of the Rhine River Basin Plan, the first edition of the Flood Risk Management Plan, their National Plans and the Sub-basin Plans.

Background

The Rhine River originates in Switzerland, with tributaries originating in the basin countries: Switzerland, Germany, France and the Netherlands. In addition, its entire river basin covers parts of the territory of Austria, Lichtenstein, Luxembourg and Belgium (Figure 1). The Rhine flows through Germany and the Netherlands to the North Sea. The river has a length of over 1,300 km and its basin covers a surface of 185,000 km². The Rhine is both a rainfed and a meltwater river. The relatively high summer water levels are due to the regulating effect of the snowfields in Switzerland. In this period the surplus precipitation downstream of Basel is low. In December the situation is just the reverse, when the river is fed by the precipitation surplus in the river basin downstream of Basel (van Boetzelaer and Schultz, 2005a).

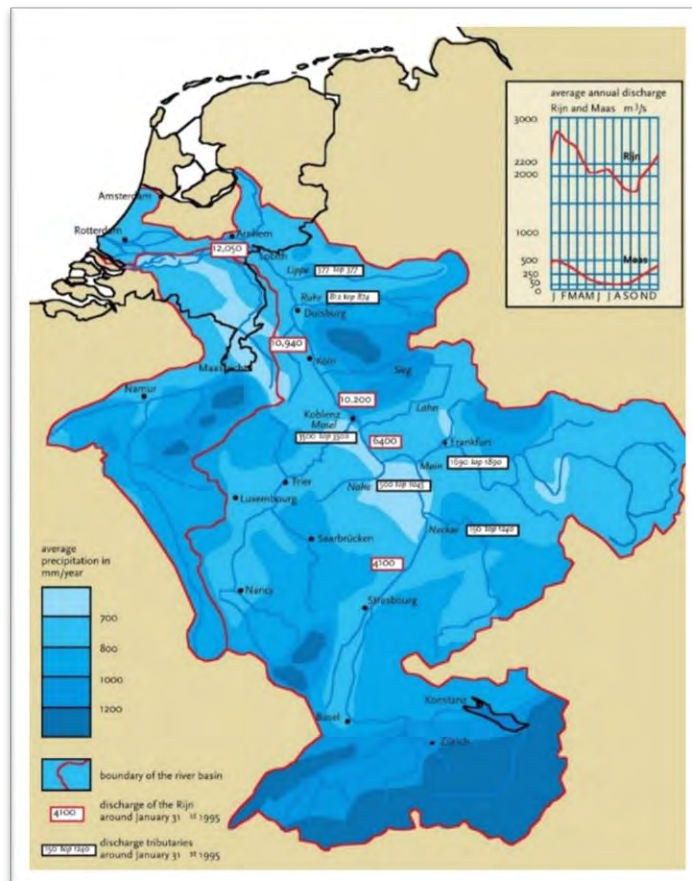


Figure 1. The Rhine and Meuse River basins (Van de Ven, 2004)

As an international trade route, shipping has always been important. Over the course of history, cultures and societies developed in the river basin, attracted and influenced by the way the river could be used for many purposes: political border, military defence, trade, industry, hydropower, agriculture, fisheries, extraction of

³ The text of this section of the paper is to a large extent based on a paper by the author as published in the Proceedings in the 7th Annual Mekong Flood Forum under the title *Development of trans-boundary cooperation in the Rhine River Basin*

building materials, domestic use, and more recently recreation and nature development (De Bruin, 2009).

High discharges and related high-water levels occur regularly. Over the centuries they have caused many cases of flooding. Especially in the Netherlands the possible impacts of floods have increased over the years due to land subsidence, population growth and the increase in value of buildings and infrastructure (De Bruin and Schultz, 2004). Over the centuries various measures have been taken and approaches followed to protect the lowlands against flooding up to certain levels of safety. Nowadays the whole part of the river basin in the Netherlands is flood prone and is protected by dikes with a relatively high level of safety (Technical Advisory Committee on Water Defences, 2000) (Figure 2). During the past decades discussions are taking place on the influence of climate change on very high discharges and related water levels. There is a scenario that by the end of this century extremely high-water levels might occur more often due to a substantial increase in high discharges (Van Boetzelaer and Schultz, 2005b). Measures have been agreed upon and are being implemented to increase the level of safety of the flood protection provisions (Schultz, 2019).

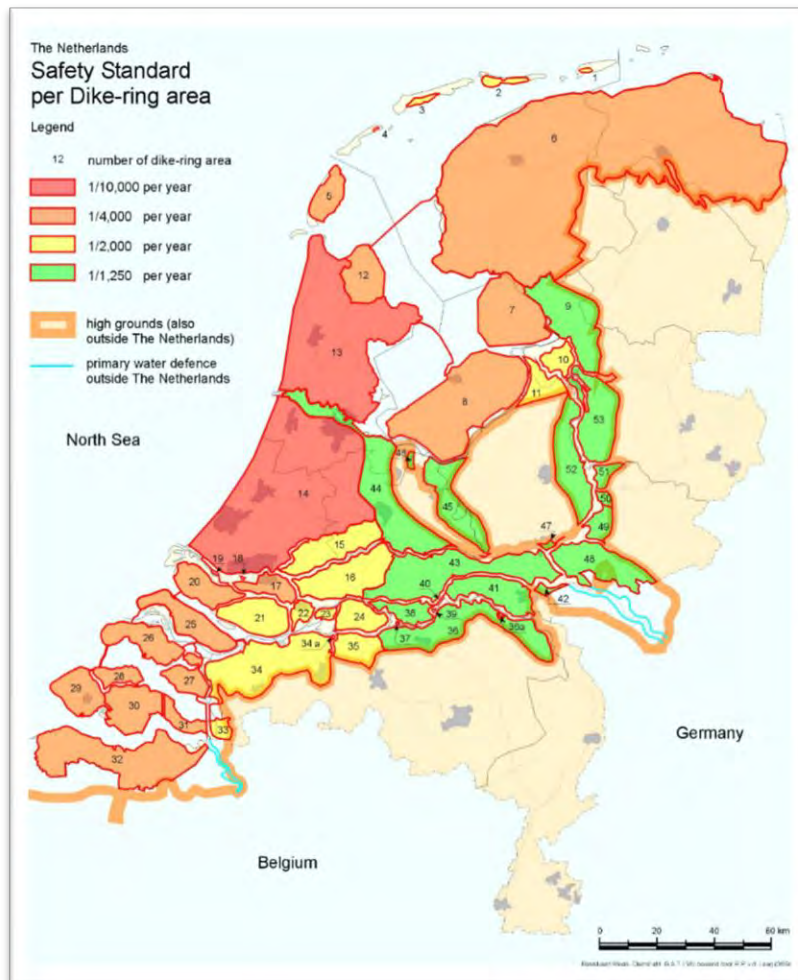


Figure 2. Dike ring areas and standards
(Technical Advisory Committee on Water Defences, 2000)

Stages in Water (Resources) Management

Through the history water management in the Rhine River Basin has gone through different stages. In the Netherlands first water management activities aimed at reclaiming lowlands by small-scale drainage systems. Due to the resulting subsidence providing safety against flooding followed this. This was initially realised by making artificial mounds where people in the flood prone areas lived on. In a later stage dike were built in combination with drainage systems to remove the excess water from the endiked area (De Bruin and Schultz, 2004). In the whole river basin, the start concerned primarily agricultural water management, which implied more or less controlled discharge of excess water during winter. Later it also included the provision of irrigation water. As a consequence, water storage became required, also in light of provision of hydropower. Due to this a significant number of dams were built. Especially in relation to ship transport sluices and weirs were built as well (Figure 3).

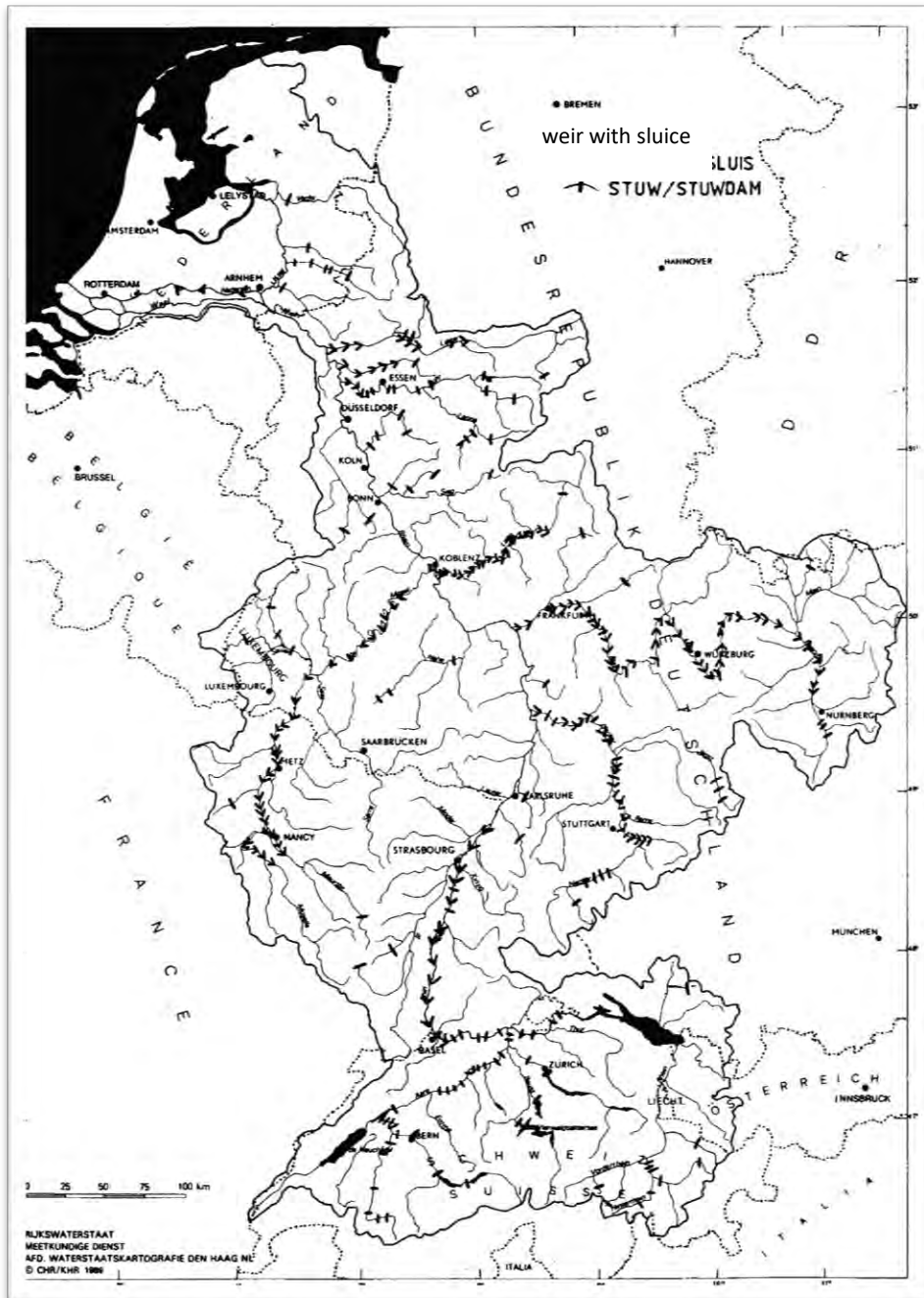


Figure 3. Rhine River Basin with its dams, sluices and weirs

In the twentieth century, a wide variety of water quality problems developed, which drew much attention in the seventieth and eightieth. In the ninetieth, attention was drawn to a wider concept of water management, called integrated water management. In this concept, account is taken of all function's waters fulfil, including those of nature and environment, so that these functions can be secured on the long-term. In the beginning of the twenty-first century the countries in the Rhine River Basin are still in this phase. However, in studies for future development even the approach is based on 'integrated environment management'. In this approach the developments in land use, water management, flood protection and environment are better integrated.

Need for integrated water resources management

Since the last decades of the twentieth century there is an increasing interest in and focus on Integrated Water Resources Management (IWRM), although in practice almost no country is really applying it.

As far as IWRM with respect to food production and sustainable rural development is concerned the issues that play a role in the Rhine River Basin are especially, drainage, irrigation, rural drinking water supply and sanitation, flood management and flood protection, but also issues like application of fertilisers and pesticides, manure due to cattle breeding and other rural sources of pollution. As far as drainage is concerned the quality

of the drainage water should not result in an exceedance of acceptable water quality levels of the receiving water bodies (Schultz, 2006).

As far as IWRM with respect to urban and industrial areas is concerned the issues that play a role in the Rhine River Basin are especially drinking water supply, sanitation, treatment of wastewater, urban drainage, flood protection, and water needs of the green areas. As far as water management is concerned these areas may discharge their surplus water directly to the river, or to the canal system in the surrounding rural area. Especially in the latter case due attention would have to be given to the different discharge patterns of the rural and urban area.

During the past decades there have been quite some debates regarding the possible impacts of climate change on respectively:

- (a) rise of the mean sea level;
- (b) change in river regimes and increase in peak discharges of rivers;
- (c) increase in average annual rainfall and in peak rainfalls;
- (d) increase in droughts.

With exception of the last item these developments may increase the risk of flooding of flood prone areas. However, although such developments may occur, it has to be realized that the possible changes in design standards for water management and flood protection schemes due to the impacts of climate change are generally in the order of magnitude of 10 - 30% over the forthcoming 100 year. Locally there may be exceptions that can have more far-reaching consequences, for example when drainage by gravity would have to be replaced by drainage by pumping. Therefore, the effects of climate change are generally such that in the modernization of water management and flood protection schemes - which normally takes place every 25 to 50 years - the impacts of such changes can be relatively easily accommodated.

If we, however, look at the increase in population and especially at the increase in value of public and private property - houses, buildings, infrastructure, public facilities, public and private property - in the lowland, flood prone areas, in the Rhine River Basin then such increases are much more significant than the possible impacts of climate change. Therefore, compared to the issue of climate change, these increases would have to significantly dominate decision-making on water management and flood protection measures. So far this has generally not been the case, but the understanding that these processes would indeed have to play a major role is rapidly growing and not only the issue of flood protection, but the much broader approach to flood management, which may be considered as a substantial element in IWRM, is getting increasing attention (Schultz, 2001, 2008, 2018, 2019 and German National ICID Committee, 2005).

We have to realise, however, that we will never be able to achieve complete control of the water resources. Nature has its extremes beyond the design criteria of our water management and flood protection schemes. What will be of utmost importance is that we better integrate land use planning with water management and flood protection. In the recent cases of flooding of New Orleans, along the Danube River and at many other places in the world the floods had a chance of occurrence of about 1/100 per year or less. We cannot really call this extreme flood, while they are expected to occur at least almost in once lifetime. The problem is that we increasingly are living and building in flood prone areas, often without implementing appropriate packages of structural and non-structural flood management measures. In fact, in such cases the managing of the water resource is not really the problem, but the management of the land use. We still see that with respect to this political and economic considerations are domination decision-making and not really IWRM.

How to achieve IWRM in practice?

The above sections show, that especially because of population growth, the higher standard of living, urbanisation and industrialisation there is an increasing competition for water and an increased need to make use of this valuable resource in a sustainable way. How to achieve this in practice is not easy to answer. In fact we have to analyse who can decide on such issues. In Figure 4 a general picture is given of who are in charge and who are contributing to rural water management. For urban water management a similar figure can be made, although in this case the municipal government will generally be in charge for the municipal water management.

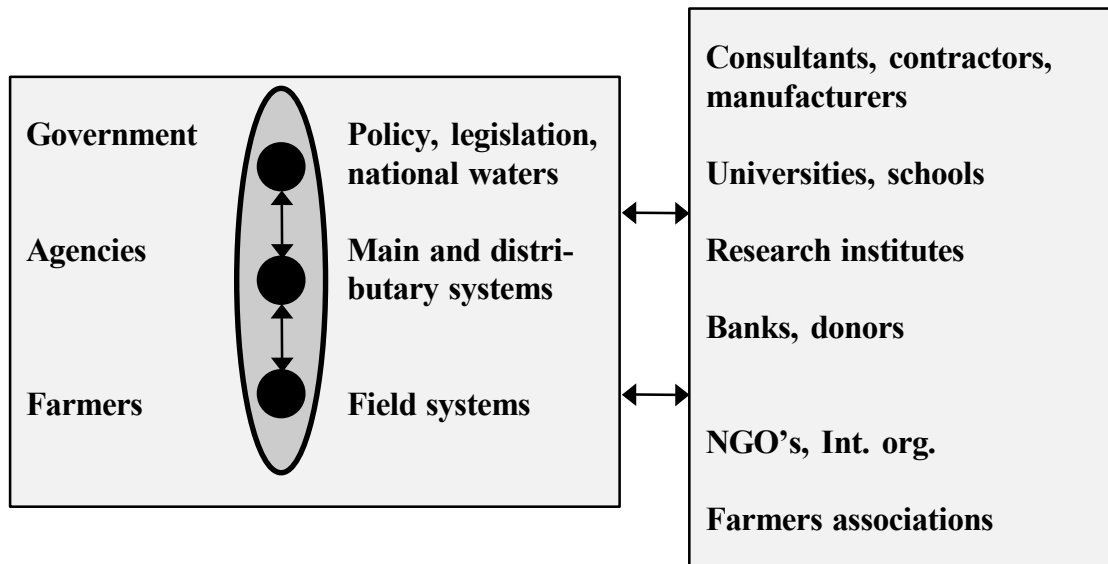
RESPONSIBLE**CONTRIBUTING**

Figure 4. Indicative schematisation of actors in rural water management (Schultz, 2001)

Basically, within a country the responsibility rest with three parties: the government, irrigation and/or drainage agencies and farmers/municipalities, each party with its own role and responsibility. For river basins that are shared by several countries these countries would need to agree on IWRM at river basin level and the policies, approaches and actions at country, regional and local level will have to fit in the overall river basin approach. This puts a very strong responsibility with the National Governments, especially with respect to policy making and legislation. In Europe we are in the middle of this process and coming years it will become clear whether we will be able to achieve IWRM at river basin level, especially for the Rhine and Danube rivers, which basins are shared by several riparian countries. However, this will be not enough. Within a country the government at different levels (National, Provincial ad Local), the agencies and the farmers/municipalities will have to agree on each role and responsibility within a sustainable framework. That is the real challenge. A special complication is the multiple land use that exists nowadays in most of the sub-basins, implying that responsibilities and costs will have to be shared among different types of land use and users as well. While societies are changing over time one may expect that this will need more or less continuous consultation and negotiation in a never-ending process. Therefore, no general recipe can be given and solutions will be strongly dependent on the local physical and socio-economic conditions (Schultz, 2006).

Why is IWRM needed and why will it increasingly be needed? In fact, this question can be easily answered, especially for the river basins with a large percentage of cultivated land and/or densely populated urban areas. It is required because of the increasing need for fresh water at an acceptable quality for the different purposes and the fulfilment of this need in a sustainable way. In fact, we are in Europe in a privileged position, while our population density (32 persons/km²) is below the average global level (46 persons/km²), population growth is relatively small, our standard of living is relatively high and our economic development follows a gradual process.

Development of the cooperation in the Rhine River Basin

The oldest formal cooperation with respect to the Rhine concerned free shipping and was developed by the coordination of the international Central Commission for Navigation on the Rhine (CCNR), founded in 1832. This organisation is the oldest still-functioning international river commission in the world. It acts in the interests of free and safe shipping and trade on the navigable Rhine between Switzerland and the North Sea (De Bruin, 2009).

Due to the increasing pollution in the 1960s and 1970s solutions were needed, requiring a new international strategy. The International Commission for preventing Pollution of the Rhine (ICPR) was founded in 1963. This is an advisory body on cross-border policies, originally focusing on pollution control. Later, flood control and ecological restoration were included in a new and expanded mandate. Reflecting this broader mandate is its updated name in 1999: the International Commission for the Protection of the Rhine (ICPR).

A third international commission in the Rhine River Basin, founded in 1970, has a mainly scientific charter: the Commission for the Hydrology of the Rhine (CHR). Its mission is: to acquire knowledge of the hydrology of the Rhine basin through joint research and publications and to contribute to the solution of cross-border problems through the formulation of information systems and models (e.g., CHR Rhine GIS and the Rhine Alarm model).

The emphasis in the 20th century on navigation and hydropower eliminated the fishery (based on migratory fish) and harmed the ecosystem. Pollution of the Rhine endangered water quality for households, industry and the environment. The pollution of the river became politically unacceptable in 1971. Since that year, trans-boundary co-operation and harmonization has begun to redress the problems. The efforts aimed to reduce pollution, to rehabilitate the ecosystem and to improve flood protection.

Mutual understanding and trust are key issues in the co-operation process. They create the conditions for formulating common policies and frameworks to surmount trans-boundary problems. Harmonization and co-operation are paving the road to balanced, sustainable development in the Rhine River Basin.

When water quality criteria were being formulated, discussions in the ICPR reflected the opposing positions of upstream and downstream countries. However, an international inventory of wastewater treatment and sanitation plans in 1972 created mutual understanding about the problems being addressed in the individual Rhine Basin Countries. Due to the mistrust between the individual Rhine Basin Countries and other members of the European Union in the 1970s, the Convention for the protection of the Rhine against chemical pollution contains detailed procedures. The Sandoz disaster (an accidental poisonous chemical spill at Basle) changed this agreement almost overnight. Instead of the troublesome negotiations on emission standards, the Rhine Basin Countries agreed that every country should reduce the actual pollution due to 47 dangerous and problematic substances by 50% in the period 1985-1995. The countries were free to select the most effective way to realise this aim. With that decision they did put the chemical convention and European Union-directive aside. The agreement does not really have a legal status, but it is a political commitment. It is based on mutual trust and has paid off. A report to the Conference of Ministers (January 1998) concluded that the Rhine target values had been reached for 39 substances. The concentrations of the other 8 substances were still above the target values. The ministers decided to strengthen efforts to reduce these substances also.

The Sandoz incident resulted in the Rhine Action Plan (RAP), adopted by the ministers in 1987. This plan contained the following phased activities:

- (a) measures to prevent accidents, by constructing storage capacity near large industries in a way that accidents such as Sandoz could not happen again;
- (b) a reduction of the 1985 pollution level by 50% over the following 10 years;
- (c) the rehabilitation and restoration of the Rhine River. This objective concentrated on three issues:
 - ❖ higher species such as salmon should return to the Rhine by the year 2000;
 - ❖ the future quality of Rhine water would have to be such that domestic water could (again) be produced with simple production methods;
 - ❖ the pollution of sediments had to be reduced to such a low level that the sediment could be applied on the land or dumped into the sea without negative impact on aquatic organisms;

In addition, measures to improve the ecological situation of the North Sea were added and adopted.

The measures with respect to the North Sea were added to the RAP in 1990 on behalf of the North Sea countries who are not a member of the ICPR (like United Kingdom and Denmark). The purpose was to ensure that the marine environment would benefit from the RAP-objectives. Today, nearly 10 years after the year 2000 goal of the RAP has passed, it is clear that the effectuation of the RAP has been successful.

Over many decades, the system of flood protection works (dikes, or levees) has been improved and extended in all the Rhine Basin Countries. Also, the design criteria have been adapted to safer norms.

In the mid-1990s, nature intervened. High floods were generated by intense rainfall in the entire Rhine River Basin in December 1993 and January/February 1995. Both events resulted in floods, statistically 1 in 150 years. The 1993 and 1995 floods along the Rhine gave a new opportunity to enlarge trans-boundary cooperation. In 1995, large areas along the Rhine were inundated, the confined floodplain was everywhere completely submerged, and at those stretches where the floodplain is not confined, damage was caused to houses and infrastructure. It led to social disruption on a large scale, which was unusual for the population of the Rhine basin. Dikes in the Netherlands were even on the point of collapse. Where they had not yet been adapted to the new standards, the situation became critical. As a precautionary measure, in the directly

threatened flood prone zone, about 240,000 people (and more than one million cattle) were evacuated. But fortunately, critical sections of the flood protection system did not breach so the adjacent land remained dry. People returned to their homes but insisted on quick action.

The ministers of the Rhine Basin Countries declared a number of measures to reduce the future risk posed by floods (Declaration of Arles, France). They decided to make maximum use of existing international institutions, to assure a rapid and integrated approach. Accordingly, they charged the ICPR with the development of strategies for flood protection referring to the RAP as an example of what was required. In concert with the various river management organisations in the Rhine Basin Countries, the ICPR produced a strategy paper for flood protection in December 1995. The ministerial conference of January 1998 approved that paper: the Flood Action Plan (FAP):

- (a) the Plan was to be implemented over a period of 20 years, being basin oriented;
- (b) it had an allocated budget of € 12 billion to work on flood reduction measures;
- (c) the plan should deliver a reduction of flood related damages by 25% in 2020;
- (d) the plan should restore floodplains and improve water storage everywhere;
- (e) the plan should reduce the flood height during extreme flood events in the Upper Rhine by 0.70 m in 2020.

IMPLEMENTATION OF THE EU WATER FRAMEWORK DIRECTIVE IN THE DANUBE RIVER BASIN

At present there are eleven countries - Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Romania, Russia, Serbia, Slovakia and Ukraine - in the Danube River Basin (Figure 1).



Figure 5. Map of the Danube River

Originally the Commissions of the Danube River were focussing on navigation, authorized by the Treaty of Paris of 1856. One of these international commissions was the European Commission of the Danube, which had authority over the three mouths of the river - the Chilia in the North, the Sulina in the middle, and the St. George in the South. This Commission was originally designed to last for only two years. Instead, it lasted eighty-two years. A separate commission, the International Danube Commission, was authorized to control commerce and improvements upriver beyond the Danube Delta and was supposed to be permanent, but it was not formally organized until after 1918.

The European Commission of the Danube was the first - and for a long time the only - international body to have serious police and juridical powers over private vessels and individual people. Without territorial possessions, it was nevertheless a distinct international entity, possessing sovereignty over the broad waters of the Danube. These functions did not need the sanction of nations, and there was no appeal from the edicts of the Commission. The lower section of the Danube was *more than an internationalized river* because the European Commission of the Danube wielded independent administrative powers. The European Commission of the Danube had its seat in the port of Galatz. Initially it had the mandate to:

designate and to cause to be executed the Works necessary below Isatcha, to clear the mouths of the Danube, as well as the neighbouring parts of the Sea, from the sands and other impediments which obstruct them, in order to put that part of the river and the said parts of the Sea in the best possible state for navigation. It is understood that the European Commission shall have completed its task within the period of two years.

At the end of the two years, the powers that signed the treaty were to *pronounce the dissolution of the European Commission*, and the so-called permanent, upstream, International Danube Commission was then to extend its supervision to the Lower Danube. The latter commission was supposed to consist of Austria-Hungary, Bavaria, the Sublime Porte (Turkey), Württemberg and the two Danubian principalities (Moldavia and Wallachia). The International Danube Commission did draw up an Upper Danubian Navigation Act in November 1857, but it was not accepted multilaterally because of opposition of all the powers except Austria. It was, however, applied to parts of the river by conventions between Austria, Bavaria, and Württemberg. The river-bordering countries were eager to get control of the river into their own hands, but the non-riparian countries were loath to lose control. As a result, the European Commission of the Danube was constantly strengthened, and the International Danube Commission never came into power, and was abandoned.

The European Commission of the Danube gradually extended its power until it became an international entity. It expanded its functions until it was ranked the most successful such agency until the United Nations. At the start, though, it had no funds, it had no basis for an opinion as to the best way to attack the river problem; it found river traffic paralysed. At the end of the two years large-draft vessels were unable to sail unimpeded up the meandering river. The meager results led the powers to extend the life of the commission for another two years, over the objection of Austria.

On November 2, 1865, a public act signed by Austria, Britain, France, Italy, Prussia, Russia, and Turkey placed the European Commission of the Danube, its officers, works and establishments under the protection of international law (Article I). Two annexes were appended - one on navigation regulations and the other on a tariff of navigation dues to be levied at the mouth of the Danube. The new tariff established a *Danubian rule* or *Danube rule* of measurement. The unique provision of the 1865 act was that either of the two annexes could be changed by a majority vote of the commission but the changes would be automatically binding on the member nations, without need for additional consent. Duties of the officers were spelled out, neutrality of the buildings, records, and funds was ordered, and certain portions of Turkish territory were reserved for exclusive use of the European Commission of the Danube. Its life was extended for another five years, but Russia protested that this should be the outside limit not to be exceeded in any case.

In 1871 at a conference in London, Russia agreed with Austria-Hungary, Britain, Germany, Italy, and Turkey to extend the commission's term for another twelve years, which coincided with the redemption period of a large loan floated in 1865. The conference also:

- (a) rejected Britain's suggestion to extend the commission's jurisdiction farther up the river;
- (b) agreed to a reassembling of the Riverain Commission - but at no set time;
- (c) gave Austria the authority to set up a toll-collecting agency at the dangerous Iron Gates section to pay for improvements there;
- (d) extended the neutrality spelled out in the Treaty of 1865 to the staff of the European Commission of the Danube, as well as the buildings and works.

In 1878, Romania, which had been an autonomous principality within the Ottoman Empire since 1861, was admitted to an expanded European Commission of the Danube as a free country as a result of the Treaty of Berlin of 1878. It replaced Turkey as the sovereign power on the delta and was given a seat on the European Commission of the Danube. Turkey remained a member of the body.

Russia was the winner of the Russo-Turkish War, and took over an old strip of Bessarabia that was detached from it in 1856. This placed Russia again on the banks of the Danube. The other Danubian arrangements were:

- (a) the jurisdiction of the European Commission of the Danube was extended from Isatcha to Galatz;
- (b) the powers agreed that regulations would be formulated for the upriver stretch from Galatz to the Iron Gates by a mixed European commission, assisted by Delegates of the Riverain countries, and placed in harmony with those which have been or may be issued for the portion of the river below Galatz. In the end, a new scheme was adopted for the International Danube Commission - Austria, Romania, Serbia, and Bulgaria would each have a representative on the International Danube Commission, and each of the members of the other commission, the European Commission of the Danube, would serve alternating terms on the International Danube Commission for six months at a time. Austria would be chair, but with no tie-breaking vote.

In 1881, the interested countries gathered at Galatz to promulgate another treaty, or, as it was termed, a public act, that spelled out details of the European Commission of the Danube's relations with Romania, which was striving for more authority. It was then that Russia withdrew her territory from the European Commission of the Danube's jurisdiction - the left bank of the Kilia. Russia's action was a last-minute affair, done through a reservation to the treaty.

In 1883, Austria, Britain, France, Germany, Italy, Russia, and Turkey were represented at another conference, this time in London. A majority decided to admit Romania and Serbia in a consultative capacity only and that Bulgaria could be represented only through Turkey, the nominal suzerain. Serbia accepted, but Romania and Bulgaria protested, taking no part in the conference. After a month of discussion, the delegates decided to:

- (a) extend the jurisdiction of the European Commission of the Danube from Galatz some twenty miles upstream to Brăila;
- (b) authorize the establishment of the reorganized International Danube Commission, with the hope that Romania and Bulgaria would agree;
- (c) prolong the term of the European Commission of the Danube for twenty-one years, after which it would continue for three-year periods, unless changes were proposed by one of the major powers;
- (d) accede to Russia's request regarding the Kilia - that is, allow that country and Romania joint control over the branch, provided the European Commission of the Danube reviewed any plans for improvement.

Detailed and liberal rules drawn up in this convention for the Danube between Brăila upstream to the Iron Gate were never applied. Romania did not agree, and the stretch of the Danube was administered by each riparian state, with due regard, however, to the principle of free navigation. As conditions in the delta improved, shipping increased and more funds were received by the European Commission of the Danube. Conditions improved: There were 111 shipwrecks of seagoing vessels between 1861 and 1881, but only five wrecks between 1909 and 1929.

The European Commission of the Danube continued functioning during at least the first two years of the First World War, and delegates from the Allies and the Central Powers continued to meet together. After Germany attacked Romania in 1916, the Central Powers - Germany, Austria-Hungary, Bulgaria, and Turkey - kept the Commission in operation for a short time - but without the British and the French. The Germans attempted to legalize a commission that would have perpetually excluded the Allied powers. on May 7, 1918, they concluded a separate peace with the Romanians, changing the European Commission of the Danube into a Commission of the Mouth of the Danube; its competence was maintained, but membership was restricted to Danubian or Black Sea countries. Upstream of Brăila, control was to be in the hands of the countries bordering the river - Romania, Bulgaria, Serbia, Austria, and Germany. Germany, Austria-Hungary, Bulgaria, Turkey. Rumania obtained the right to keep warships on the river. This led, as a reaction, to the internationalization of the river between Ulm and the Black Sea after the war. The same stipulations were included in the peace treaty between Germany and Russia in 1918. These treaties were negated upon Allied victory. In November 1918 the victors established a *Commandement de la Navigation du Danube*. The Allies' Supreme Committee decided on May 22, 1919, that despite the existing uncertainty concerning the frontiers and the ownership of the floating material, normal conditions of traffic on the Danube should be established as soon as possible, and an Inter-Allied Danube Commission was formed. Later in the year, non-enemy states were admitted on an equal footing with the great powers; the group met with some success in reopening the river, despite the difficulties.

Peace treaties imposed by the Allies set up new regulations for the river: The old European Commission resumed its power over the mouths of the river, but its membership was temporarily limited to Britain, France, Italy, and Romania - excluding, then, Russia and Turkey. In addition, an International Commission was thenceforth to regulate traffic on the Upper Danube from Ulm to Brăila. A general conference was planned for the future.

In September 1920 a conference was convened in Paris to draw up a definitive statute for the river. Represented were Austria, Belgium, Bulgaria, Czechoslovakia, France, Germany, Great Britain, Greece, Hungary, Italy, Romania, and Yugoslavia, Absent from a full-dress Danubian conference for the first time were Russia and Turkey. It took six months, but on July 23, 1921, the basic convention was signed. It followed to a large extent the temporary framework built just after the war. The European Commission of the Danube was re-established, and all the old treaties and regulations were confirmed.

The International Danube Commission (upriver) was finally given a permanent status, made a subject of international law like the European Commission of the Danube, and provided with regulations that gave it life. It, however, had no law courts of its own. It was obliged to surrender transgressors to the territorial authorities for trial and punishment. Members included all the riparian countries, as well as Great Britain, France, Italy, and Romania. The Statute was a somewhat unsatisfactory compromise between broad conceptions and narrow-mindedness. Its text gave rise to varying interpretations and some of its important stipulations were therefore not applied, as had been hoped, in the best interests of the river and of its navigation. The European Commission of the Danube, again in its quarters at Galatz, found things very bad indeed at the mouths of the Danube after the war. Silt had choked the channel again, and it seemed as though attempts to improve the situation was continually going awry.

Economic affairs along the entire river were so bad that the League of Nations instituted in 1922 an inquiry by a special committee. The report was issued in August 1925, stating that the river fleet carried 25% more tonnage than before the war, but traffic was only 56% of normal. This reduction was largely due to an economic depression but also by the breakup of Austria-Hungary's large duty-free area.

Despite the existence of the European Commission of the Danube and the International Danube Commission, the situation had changed but little since the end of the war. Meanwhile, Romania desired the outright abolition of the European Commission of the Danube, having made the suggestion for the first time in 1881 on the mouths being exclusively controlled by Romanian officials. This statement led to a break with Austria-Hungary. Romania renewed its demands in 1919 at the Paris Peace Conference and in 1921 at the Danube Conference. On both instances, it was overruled. Romania changed tactics, but not motives, at the Conference of Lausanne in 1923, when affairs of the Middle East were discussed. On this occasion, Romania suggested that the powers of the European Commission of the Danube should be expanded; it would also be given control over the Bosphorus and the Dardanelles. Acceptance of this proposal would have meant the end of effective control of the Danube, for the Commission, far from the mouths of the Danube and charged with new tasks, would have hardly been able to fulfil its primary tasks, and the actual control of the Lower Danube would have devolved upon Rumania.

In 1924, Romania suggested that the activities of the Commission be limited; that country would be charged with trial and punishment of shipping violators, similar to the method used by the newer, upriver International Danube Commission. This suggestion also was rejected by the other powers. Meanwhile, Romania resorted to a lawsuit to assert its jurisdiction over an upriver stretch. It noted that the jurisdiction of the European Commission of the Danube had been extended up the river from Galatz to Brăila by the Treaty of London of 1883, in the framing and signing of which Romania had not participated. Romania finally achieved effective control of the Lower Danube in May 1939, when the Sinaia Agreement of 18 August 1938 entered into force.

In 1938, a committee of experts inspected the Sulina and found it was almost impassable by that time. In August of that same year, the regime of the two commissions was swept away by rise of German power on the river. A series of treaties put control in the hands of the Germans, who maintained it until the Nazi retreat in 1944 and ultimate defeat in 1945. In 1948 a Danube River conference was held, and a new treaty was adopted, putting governance of the river under Commissions composed only of the riparian powers, ending more than four decades of Western European presence in the control of the important waterway.

By the Convention regarding the regime of navigation on the Danube signed in Belgrade on 18 August 1948 the Danube Commission was established as an international intergovernmental organization. The main objectives of the Danube Commission's activity are to provide and develop free navigation on the Danube for the commercial vessels flying the flag of all states in accordance with interests and sovereign rights of the Member States of the Belgrade Convention, as well as to strengthen and develop economic and cultural relations of the said states among themselves and with the other countries. The Member States of the Danube

Commission are: the Republic of Austria, the Republic of Bulgaria, Hungary, the Federal Republic of Germany, the Republic of Moldova, the Russian Federation, Romania, the Republic of Serbia, the Slovak Republic, Ukraine and the Republic of Croatia. Since 1954 the Commission has its seat at Budapest. The Danube Commission in its work rests upon wide historical experience of navigation control on the international rivers of Europe and the best practice of the international river commissions, including the European Danube Commission established under the Paris Peace Treaty of 1856. The Danube Commission's outlook is connected with the creation of the unified navigation system of inland waterways in Europe. With due consideration of the before mentioned, the priority areas of the Commission's activity are focused on unifying and providing mutual recognition of the basic regulatory documents, required for the navigation on the Danube and on the other sections of the unified navigation system, contributing to the improvement of navigation conditions and safety of navigation, creating requirements for the Danube integration into the European system as the significant transport corridor.

With a view to ensuring the said integration the Commission actively cooperates with the relevant international bodies, involved in different aspects of inland waterway transport, such as United Nations Economic Commission for Europe, Central Commission for the Navigation of Rhine, European Commission, etc. With the aim of enhancing the role of the Danube Commission in the international cooperation in the field of inland navigation, the Member-States of the Belgrade Convention intend to modernize Commission, by vesting additional powers in it and new functions, as well as to enlarge the circle of its members. It will become feasible when the ongoing process of the revision of the Convention will come to an end. Presently, France, Turkey and European Community declare determination to become members of the modernized Danube Commission.

In 1998 the International Commission for the Protection of the Danube River was established. The Commission works to ensure the sustainable and equitable use of waters in the Danube River Basin. The work is based on the Danube River Protection Convention, the major legal instrument for cooperation and transboundary water management in the Danube River Basin. The Commission is formally comprised by the Delegations of all Contracting Parties to the Danube River Protection Convention, but has also established a framework for other organisations to join. In 2000 the International Commission for the Protection of the Danube River contracting parties nominated the Commission as the platform for the implementation of all transboundary aspects of the EWFD. The successful implementation of the EWFD is therefore clearly high on the political agendas of the countries of the Danube River Basin District. In 2007, the International Commission for the Protection of the Danube River also took responsibility for coordinating the implementation of the DAMFR within the Danube River Basin.

At present national delegates, representatives from highest ministerial levels, technical experts, and members of the civil society and of the scientific community cooperate in the International Commission for the Protection of the Danube River to ensure the sustainable and equitable use of waters in the Danube River Basin.

Since its creation in 1998 the International Commission for the Protection of the Danube River has promoted policy agreements and the setting of joint priorities and strategies for improving the state of the Danube and its tributaries. This includes improving the tools used to manage environmental issues in the Danube basin, such as the:

- (a) Accident Emergency Warning System,
- (b) Trans-National Monitoring Network for water quality;
- (c) Information System for the Danube (Danubis).

Three key elements of the International Commission for the Protection of the Danube River's management plans provide the three pillars of action that are needed for the Danube to achieve:

- (a) *Cleaner Danube* - this means reducing pollution from settlements, industry and agriculture;
- (b) *Healthier Danube* - this means protecting rivers as ecosystems that provide a living environment for aquatic animals and plants, as well as services for people such as drinking water and recreation;
- (c) *Safer Danube* - this means a safer environment for people to live without the fear of major flood damage.

The International Commission for the Protection of the Danube River addresses the entire Danube River basin, comprising 19 countries, making it the most international river basin in the world. Including more than 300 tributaries and connected groundwater resources too, this makes the ICPDR one of the largest and most active international river basin management commissions in the world. Because of a requirement for at least 2,000

km² of national territory to be located within the Danube River Basin, only fourteen of these countries – and the European Union - are full contracting parties to the ICPDR.

The river basin covers 817,000 square kilometres and 83 million people live in its river basin area. Some 20 million people rely on the Danube for drinking water. The Danube passes through numerous large cities – including four national capitals, Vienna, Bratislava, Budapest and Belgrade. By the 1980s water quality was a serious issue due to the pollution originating from millions of individuals, agriculture and industry. The river is also critical for the generation of hydropower, navigation, agriculture, recreation and the natural environment. Currently just 24.7% of the Danube's water bodies are considered to have good ecological status. Of the many challenges faced by the ICPDR, the highest priority remains: organic substance pollution, nutrient pollution, hazardous substance pollution, hydromorphological alterations and Flood risk management.

The organisational responsibilities of the International Commission for the Protection of the Danube River are divided across various bodies. These include: Ordinary Meeting Group: taking the political decisions, standing Working Group: providing political guidance, Technical Expert Groups and Task Groups: preparing the technical background documents. The work of the ICPDR is supported by a Permanent Secretariat located in Vienna, Austria.

CONCLUDING REMARKS

History has shown that again and again new measures have to be taken in answer to new developments, droughts, cases of flooding, or unforeseen consequences of former interventions. There is no reason to suppose that in the future such reactions and activities will come to an end. Even if we achieve an IWRM approach it will not be static. Anticipating future developments - rather than only reacting to them - will be the challenge. New developments will have to be reckoned with and there is no prospect of a permanent situation. For the Rhine and Danube Basin Countries it will be of increasing importance to continue and expand their cooperation with respect to developments in land use, water management, flood protection and protection of the environment.

REFERENCES

- Boetzelaer, M.E. van and B. Schultz, 2005a. *Historical development of approaches and standards for flood protection along the Netherlands part of River Rhine*. In: Proceedings of the Workshop on Integrated Land and Water Resources Management in History, Frankfurt am Oder, 16th May 2005. Schriften der DWhG, Sonderband 2, Siegburg, Germany
- Boetzelaer, M.E. van and B. Schultz, 2005b. *Recent developments in flood management strategies and approaches in the Netherlands*. In: Proceedings of the 2nd Yellow River Forum, 17 - 20 October 2005, Zhengzhou, China.
- Bruin, D. de, 2009. *Integrated flood management. Cross border major river systems in Europe (with a focus on the Rhine)*, draft paper.
- Bruin, D. de and B. Schultz, 2003. A simple start with far reaching consequences. *Irrigation and Drainage* 52.1.
- European Commission, 2000. *EU Water Framework Directive*, Directive 2000/60/EC, Brussels, Belgium.
- European Parliament and the Council of the European Union, 2007. *Directive on the Assessment and Management of Flood Risks*. Directive 2007/60/EC of 23 October 2007, Brussels, Belgium.
- European Council, 1979. *Directive on the Conservation of Wild Birds*. Directive 79/409/EEC of 2 April 1979, Brussels, Belgium.
- European Parliament and Council, 2009. *Directive on the Conservation of Wild Birds*. Directive 2009/147/EC of 30 November 2009.
- European Union, 1992. *Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora*. Council Directive 92/43/EEC of 21 May 1992.
- German National ICID Committee, 2005. Proceedings 21st ICID European Regional Conference, Integrated land and water resources management: towards sustainable rural development, 15 – 19 May 2005, Frankfurt (Oder), Germany and Slubice, Poland (CD-ROM).
- Schultz, B., 2001. Irrigation, drainage and flood protection in a rapidly changing world. *Irrigation and Drainage*, vol. 50, no. 4.
- Schultz, B., 2006. *Need for integrated water resources management. But how to achieve it?* In: Proceedings International Expert Consultation-cum-Conference Towards integrated river basin management, Casta-Papiernicka, Slovakia, 29 May – 2 June, 2006.
- Schultz, B., 2008. *Extreme weather conditions, drainage, flood management and land use*. In: Proceedings of the 10th International Drainage Workshop, Helsinki, Finland and Tallinn, Estonia, 6 – 11 July 2008, Helsinki University of Technology, Helsinki, Finland.
- Schultz, B., 2018. Impacts of man-induced changes in land use and climate change on living in coastal and deltaic areas. *Irrigation and Drainage* 67.S1.

Schultz, B., 2019. *Role of safety standard and land subsidence in sustainable integrated development and management of tidal areas. An inventory.* In: Proceeding's 3rd World Irrigation Forum, Bali, Indonesia. International Commission on Irrigation and Drainage. New Delhi, India.

Technical Advisory Committee on Water Defences (TAW), 2000. *Towards a new safety approach. A calculation method for probabilities of flooding.* Delft, the Netherlands.

Ven, G.P. van de (ed.), 2004. *Man-made lowlands. History of water management and land reclamation in the Netherlands.* Utrecht, the Netherlands.

