Danube River Basin

Updated Transboundary Diagnostic Analysis (2006)

Based on EU Water Framework Directive Analysis Report

Global Environment Facility

icpdr iksd
International Commission for the Protection of the Danube River
Internationale Kommission zum Schutz der Donau

UNDP I GEF
DANUBE REGIONAL PROJECT

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GLOSSARY

AQC	Analytical Quality Control
AT	Austria
BAP	Best Agricultural Practice
BAT	Best Available Technique
BEP	Best Environmental Practice
BG	Bulgaria
BH	Bosnia and Herzegovina
BOD	Biological Oxygen Demand
BSERP	(UNDP/GEF) Black Sea Ecosystem Recovery Project
CAP	EU Common Agricultural Policy
CARDS	European Commission assistance for former Yugoslavia
CCA	Causal Chain Analysis
COD	Chemical Oxygen Demand
CS	Serbia and Montenegro (now two countries)
CZ	Czech Republic
DE	Germany
DEF	Danube Environmental Forum
DPRP	UNDP/GEF Danube Pollution Reduction Programme
DPSIR	Drivers-Pressures-State-Impact-Response
DRB	Danube River Basin
DRP	(UNDP/GEF) Danube River Project
DRPC	Danube River Protection Convention
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEA	European Environment Agency
EG	ICPDR Expert Group
EIB	European Investment Bank
EU	European Union
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographical Information System
HMWB	Heavily Modified Water Bodies
HR	Croatia
HU	Hungry
ICPDR	International Commission for the Protection of the Danube River

IRBM	Integrated River Basin Management
JAP	ICPDR Joint Action Plan
JDS	Joint Danube Survey
MD	Moldova
MONERIS	Modelling Nutrient Emissions in River Systems
MS	Member State of the EU
N	Nitrogen
NGO	Non-Governmental Organisation
NW	Northwest
P	Phosphorus
Phare	European Commission assistance programme for Eastern Europe
RBM	River Basin Management
RBM	River Basin Management
RBMP	River Basin Management Plan
rkm	River kilometre (for the Danube 0 rkm is the mouth of the river)
RO	Romania
RR	Roof Report – Danube Basin Analysis Report completed for EU WFD
RS	Serbia (previously Serbia and Montenegro)
SAP	Strategic Action Plan
SAP	Strategic Action Plan
SI	Slovenia
SIP	SAP Implementation Plan
SK	Slovakia
t/a	Tonnes per year
TDA	Transboundary Diagnostic Analysis
TNMN	Trans-National Monitoring Network (water quality programme of ICPDR)
UA	Ukraine
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
WB	World Bank
WFD	EU Water Framework Directive
WWTW	Wastewater Treatment Work

1. SUMMARY

As the 'most international river basin in the world', the Danube River Basin has been subjected to considerable environmental pollution over many years. Whilst the main problems associated with this pollution were observed in the Black Sea northwest shelf, seen through the frequent anoxic events as resulting from nutrient and organic pollution, the majority of the Danube Basin has also been impacted, by nutrients, organic pollution, hazardous substance pollution and hydromorphological alterations (resulting in the loss of wetlands/floodplains and interrupting fish migration).

The Danube River Basin has also been the subject of many investigations and studies funded by a wide range of organisations, with the GEF and the European Commission providing the most sustained inputs. In addition the countries of the Danube River Basin have actively supported and contributed to these investigations. These previous studies have resulted in a number of key assessments and recommendations, in particular a Strategic Action Plan (1994), Transboundary Diagnostic Analysis (1999), a Joint Action Plan (2000) and most recently in compliance with the EU Water Framework Directive, a Danube River Basin Analysis (2005). This updated Transboundary Diagnostic Analysis (2006) is based on the results of the UNDP/GEF Danube Regional Project and these previous assessments, most significantly, the 2005 Danube Basin Analysis/

The collapse of the former Eastern economies had a beneficial impact on the environment of the Danube and the Black Sea as industry and agriculture declined. However the region was left with a legacy of poor infrastructure (for example municipal wastewater treatment works and low connectivity of the population in some areas to sewer networks) and out-dated environmentally unfriendly agricultural practices. Efforts to improve the situation have been underway for a number of years. Wastewater treatment plants are under construction and the upper Danube (the new EU Member States) improvements in nutrient concentrations and loads are starting to be observed. The situation in the lower Danube is still to show signs of improvements in the nutrient loads, but the processes are being introduced for investments, changes in legislation and EU accession that can be expected to show benefits in a number of years.

Improvements in the environment of the Northwest Black Sea have been observed in recent years showing positive signs of recovery from the historical pollution. Dissolved oxygen has improved and the diversity and number of benthic organisms have increased.

The Danube Basin still has many environmental problems, but a mechanism exists through the International Commission for the Protection of the Danube River (ICPDR) to discuss these issues and to collectively define the priorities. The EU and the accession process have undoubtedly assisted the implementation of IRBM throughout the Danube Basin in the form of the EU Water Framework Directive (WFD). But the contribution of UNDP/GEF and other donors should not be underestimated in assisting with the accession process.

The implementation of the EU WFD and the strict time-line required by this legislation to achieve 'good status' should be seen as a catalyst to the future improvement of the Danube River and the reduction of impacts on the Black Sea. In 2009 a River Basin Management Plan will be submitted by the ICPDR covering transboundary issues and by each country addressing national issues. These plans will contain concrete specifications to reduce the pollution and the European Commission will be monitor the implementation of the plan. Failure to follow the agreed plans will result in EC legal actions against the Member State.

Not all countries of the Danube Basin are EU Member States. The non-EU countries still have many challenges. Importantly, all the countries have agreed to adopt and implement the WFD, but it would be unrealistic to assume that this implementation will be to the same level in the non-EU countries due to obvious financial limitations.

This updated Transboundary Analysis (based largely on the findings of the 2005 Danube River Analysis) identified four key concerns that are a priority for the Danube River Basin and the impact of the Danube River on the Black Sea.

- **Nutrient Pollution** – potentially leading to over enrichment by nutrients and eutrophic conditions. The main sources were identified as point emissions (both municipal wastewater and industrial discharges) and diffuse sources, predominately from agriculture.
- **Organic Pollution** – potentially leading to low dissolved oxygen levels in the receiving water. The main sources were identified as inadequate wastewater treatment from municipalities and from diffuse sources.
- **Hazardous substances** – potentially leading to environmentally toxic conditions. The main sources were identified as industrial (both active and from previous industrial sites) and accidental pollution from shipping or mining activities.
- **Hydromorphological Alterations** – that have led to a loss of wetlands, impact on natural aquatic conditions and present migration barriers for fish. Hydromorphological alterations are the result of engineering works in rivers and lakes for navigation, hydropower generation, flood prevention, etc.

The main focus of the GEF interventions in the Danube River Basin have been directed towards nutrient pollution and its reduction. This is reflected in the level of information on this specific topic in this updated Transboundary Diagnostic Analysis.

The future priorities to be addressed in the Danube River Basin with respect to nutrient pollution can be summarised as:

> The decrease of the Danube River nutrient loads in the last decade is partly a positive side effect of the economic crisis in the middle and lower Danube Basin. The ongoing economic recovery will potentially result in increasing nutrient loads to the Black Sea. However, the economic development in these countries is a social necessity, even if an increase in the level of production probably will lead to an increase of nutrient emissions to the environment in the future. Therefore, the challenge is to compensate these possible increases by a decrease of emissions from point and diffuse sources and to level the increase of emissions.
>
> From the present state of knowledge we can derive that future emission control efforts can best be concentrated on phosphorus (being the limiting nutrient). Furthermore, measures directed at dissolved P-compounds, which are easily available for algae growth, are most effective.
>
> The introduction of P-free detergents, P-removal at municipal and industrial wastewater treatment plants and the avoidance of agricultural point sources are such measures. In the same time, nitrogen removal from point sources (treatment plants) will play an important role in nitrogen management, as diffuse sources from agriculture in the Eastern Danubian countries are bound to increase as a result of the expected economic growth.
>
> The ICPDR and the UNDP/GEF have been actively supporting actions to address diffuse nutrient sources through a range of interventions including the introduction and piloting of Best Agricultural Practice in the lower Danube Basin and the promotion of wetlands for nutrient retention (together with the other benefits of flood mitigation, groundwater recharge and biodiversity). In addition the DRP has also been supporting activities addressing reduction of P in washing detergents. This has recently led to a recommendation by the ICPDR for the

introduction of P-free detergents across the Danube River Basin and that this will be initiated in Romania.

Under the EC DABLAS programme a priority list of projects has been identified that would lead to nutrient reduction from municipal, industrial and land-use sources. The implementation of these projects seeking investments would have a positive impact on the nutrient pollution.

An agreement has been reached between the International Commissions of the Danube and the Black Sea for the reversal of nutrient loads to those in 1996 as a long-term objective and to achieve the mid-1990s levels in the short term. Based on recent work by the MONERIS model it is expected that full implementation of the EU UWWT Directive (including nutrient removal in all WWTW larger than 10,000 pe) will result in acceptable loads of phosphorus being discharged to the Black Se. However this estimate does not take account of any increases from agricultural sources that can be expected as economic conditions improve. The model also indicated that additional measures (above those required by the EU directives) may be needed to ensure that nitrogen loads return to the 1996s levels.

2. INTRODUCTION

The Danube River Basin is the second largest basin in Europe and the most international in the world with 18[1,2] countries within the basin. The last fifteen to twenty years have seen significant changes in the regions, with the collapse of the former eastern economies and the accession of some of these of these countries to the European Union. GEF assistance has been provided to the region since 1991 and together with the EU accession process has significantly assisted with the implementation of Integrated River Basin Management. An important additional driver for the considerable interest in the Danube Basin has been the concern on the impact of the Danube River on the northwest Black Sea shelf in the last decades.

The Danube Countries have had a long history of collaboration and co-operation on the Danube River. From the Danube Navigation Convention signed in Belgrade in 1948 (which had its roots in the Paris conferences in 1856 and 1921), the recognition of the importance of water management with the signing of the Bucharest Declaration (1984), the UNECE Transboundary Water Convention (Helsinki Convention), the establishment of the Danube River Protection Convention (DRPC) to the latest European Union water directive – the Water Framework Directive (WFD). The principles enshrined in the UNECE Convention and the DRPC clearly established the importance of Integrated River Basin Management (IRBM) within the Danube basin.

The Danube Basin has been a story of unique co-operation between UNDP/GEF IRBM support and the EU accession process. The EU accession (and in particular the EU WFD) has greatly assisted in accelerating the implementation of IRBM within the basin supported by all the Danube countries. The support provided by UNDP/GEF has complemented the overall accession process by providing strengthening of institutions and experts involved in IRBM necessary for EU membership.

This document provides a current assessment of the main issues that are considered to be a threat to the Danube Basin environment based on extensive work undertaken by the countries in meeting the EU WFD with support from the UNDP/GEF Danube Regional Project.

2.1. Background to Danube Basin interventions

The Danube River Basin has been the subject of extensive investments, research and capacity building initiatives from a wide range of international donors (and basin national governments) over the last 15 years, and is now at a stage of comparative maturity with respect to understanding the issues affecting the basin. Complementing this international assistance there has been the development and implementation of a clear legal basis for co-operation in the region (the DRPC) and the establishment of a strong, mature and sustainable International Commission (the ICPDR).

GEF through UNDP has been heavily involved in the Danube Basin since 1991. Together with the European Commissions PHARE programme (and other donors) they created the Danube Programme Co-ordination Unit that focussed on the implementation of the *Environmental Programme for the Protection of the Danube Basin* (EPDRB). These interventions led to the preparation in 1994 of the Strategic Action Plan (SAP) for the Danube River that was then transformed into an operational implementation plan. The understanding of the key pollution issues within the basin was further

[1] Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Slovenia, Slovakia, Serbia and Montenegro, Germany, Hungary, Romania, Moldova, Ukraine, Bulgaria, Albania, Italy, Macedonia, Poland, Switzerland

[2] Recently Serbia & Montenegro have elected to split into two countries. The total number of the countries in the Danube Basin is now 19.

refined under the UNDP/GEF Danube Pollution Reduction Programme that identified the significant 'hotspots' in the basin and prepared a detailed *Transboundary Diagnostic Analysis* in 1999. The findings of the TDA were instrumental in developing the objectives of the current UNDP/GEF Danube Regional Project. Linked to these activities, the newly (1998) ratified Danube Convention, through the ICPDR, prepared an update of the 1994 SAP in the form of the *Joint Action Plan* (2000) which contained the findings of the TDA and pollution 'hot-spots' within the basin and provided recommendations for their mitigation. These outputs were transformed into a prioritised list of pollution reduction investment opportunities, aimed at a range of funding institutions, covering municipal, industrial, land use and wetland restorations focused on nutrient and organic pollution reduction. With the implementation of the EU WFD in 2000 the ICPDR, with significant support from the UNDP/GEF Danube Regional Project, prepared an *Analysis Report* (or characterisation assessment) for the whole basin. This Analysis Report is an important precursor to the development of a legally binding *river basin management plan* for the Danube Basin.

In summary the key successes within the Danube River Basin include:

- The support of the EPDRB jointly by GEF and EC PHARE;
- The development of the Strategic Action Plan and it implementation;
- The preparation and signing of the Danube River Protection Convention;
- The establishment of a strong and sustainable Commission for the Danube Basin;
- The preparation of a TDA;
- The preparation of the Joint Action Plan;
- The prioritisation of investments needed to reduce pollution in the basin (DABLAS);
- Support of the Countries and the ICPDR by UNDP/GEF Danube Regional Project in a wide range of pollution reduction activities;
- Preparation and submission of the EU WFD Danube Basin Analysis report.

These (and other) successes have contributed to the current situation of a well-understood and characterised river basin within an International Convention agreement and supported by a well developed and mature Commission. The ICPDR's Joint Action Plan, with support from the EC DABLAS initiative, has prepared a prioritised list of investments that, when implemented, would address many of the pollution issues within the basin, including those that are transboundary in nature. The estimated total costs of these projects are in excess of 4,000 M USD which is expected to result in a reduction of nitrogen emissions > 50 kt/a and of phosphorus emissions of 9 kt/a. To date (end of 2005) estimates for projects completed or underway are expected to result in a nutrient reduction of 25 kt/a of nitrogen and 4 kt/a of phosphorus. (To put these figures in context: the total emissions to the Danube Basin are estimated as 758 kt/a for nitrogen and 70 kt/a for phosphorus, with the measured loads to the Black Sea estimated as 400 kt/a for nitrogen and 12 kt/a for phosphorus.

Within the EU WFD there is a clear timescale where these remaining pollution issues have to be addressed. The detail of the investments and the actions needed to achieve the 'good status' required by the WFD will be developed over the next two years as a 'Programme of Measures' to be included in the River Basin Management Plan to be submitted to the European Commission as a binding intention of action in 2009.

2.2. The need for this updated TDA

The Danube River Basin and the activities that have been undertaken are of interest to a broader audience – particularly outside the region. Whilst the Danube is the 'most international basin in the world' it has benefited in recent years from the cohesive influence, and financing not only from GEF but also from the European Union. A key environmental driver in Europe has been the introduction of the Water Framework Directive that imposes legal requirements on the EU Member States to achieve 'good ecological status' in its water bodies by 2015.

The WFD Analysis Report has many similarities to the GEF Transboundary Diagnostic Analysis as a stepping-stone to the development of an agreed Strategic Action Plan (or its EU WFD equivalent - the River Basin Management Plan). This similarity includes the objectives, methodology and outputs of the assessment. In addition, the objectives of the WFD are analogous to the more widely adopted concepts of IRBM, and the tools used to implement the WFD (e.g. the Danube Basin Analysis and River Basin Management Plan) are comparable with those used by GEF International Waters (TDA and SAP). The common ground between these two policy approaches also includes the requirement for a continuous process of adaptive management to review and refine the management plans on a five or six year cycle.

Although these conditions (EU accession) in the Danube make the region unique, there are many lessons that can be learnt for International Waters programmes elsewhere and this document aims at portraying the Danube Analysis report in the more familiar global TDA format as the 'Danube River Basin updated TDA (2006).

The Danube Basin Analysis has been a significant achievement by the countries of the basin coordinated by the ICPDR and, technically and financially assisted by the UNDP/GEF Danube Regional Project. A detailed assessment of the basin has been completed, endorsed at a senior national level and submitted as a legal requirement to the European Commission, providing the first detailed overview of issues of transboundary importance. Whilst not all countries within the Danube River Basin are EU Member States or in the process of acceding to the EU (nine out of the thirteen[3,4] countries of the Danube River Basin will be EU members) all the Contracting Parties to the ICPDR (all thirteen countries) asserted that the implementation of the WFD would have the highest priority within the ICPDR. In 2006, all the environment ministers of the Danube River Basin reaffirmed this in writing.

This updated TDA does not offer a comprehensive assessment of the Danube Basin as a stand-alone document. It builds on the previous many studies and makes reference to them (including TDA, SAP and more recent action plans by the ICPDR) but utilises the WFD Danube Analysis to express the analysis in a GEF International Waters context.

2.3. UNDP/GEF Danube Regional Project

In 2001, GEF launched their final basin-wide intervention to support the activities of the Danube countries and the ICPDR with a particular focus on IRBM, nutrient reduction and transboundary co-operation in the basin, consistent with implementing the Danube River Basin SAP. The project was implemented by UNDP and co-executed by UNOPS and the ICPDR. The UNDP/GEF Danube Regional Project (DRP) has provided considerable support to the countries and the ICPDR for the preparation of the Danube Basin Analysis. An overview of the main activities and achievements of the UNDP/GEF DRP is provided on data DVD, containing all the project activities.

[3] Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Slovenia, Slovakia, Serbia and Montenegro, Germany, Hungary, Romania, Moldova, Ukraine, Bulgaria.

4 Five of the Danube Basin countries (Poland, Italy, Switzerland Albania and Macedonia) are not Contracting Parties to the ICPDR as the area of the Danube Basin on their territory is less than 2000 km^2

2.4. GEF Danube – Black Sea Strategic Partnership

Until the 1960s, the Black Sea was known for its productive fishery, scenic beauty, and as a resort destination for millions of people. Since that time, as with other water bodies around the world, massive over fertilisation of the sea by nitrogen and phosphorus from agriculture, municipal, and industrial sources has seriously degraded the ecosystem, disrupted the fisheries, reduced biodiversity, posed health threats to humans, and resulted in billions of dollars of economic losses to the economies of the 6 countries.

The Danube River as one of the main sources of nutrients flowing to the Black Sea is also facing a problem of pollution by nutrients and toxic substances due to industrial activities, extensive agriculture, growing municipal communities that have a negative impact on the river including its, water quality, water uses (e.g. water supplies for inhabitants), aquatic life, etc.

Pollution from the Danube Basin countries has created this transboundary water quality problem. Since 1992, efforts have been underway with European Union and GEF support to gradually reverse the situation in the Danube and the Black Sea Basin.

Through its Operational Strategy the GEF identified that there is a need to: (a) build the capacity of countries to work together, (b) jointly understand and set priorities based on the environmental status of their water body, (c) identify actions and develop the political commitment to address the top priority transboundary problems, and then (d) to implement the agreed policy, legal, and institutional reforms and investments needed to address them.

Following the previous GEF assistance and building on the achieved results and efforts of the participating countries in the Danube Black Sea Region, a Strategic Partnership was developed, with aim to accelerate implementation of nutrient reduction measures and policy/legal/institutional reforms in the basin.

GEF and its Implementing Agencies are implementing the Strategic Partnership consisting of capital investments, economic instruments, development and enforcement of environmental law and policy, strengthening of public participation, and monitoring of trends and compliance over the period of 2001-2007 for the countries of the Danube/Black Sea basin.

This Partnership is composed of three complementary parts:

1. The Black Sea Ecosystems Recovery Project - a GEF Black Sea Regional capacity building and technical assistance element implemented (in cooperation with the Black Sea Commission under the leadership of UNDP and with the assistance of UNEP for defined components;
2. The Danube Regional Project - a GEF Danube River basin regional capacity building and technical assistance element implemented (in cooperation with the ICPDR) under the leadership of UNDP;
3. The GEF/World Bank Partnership Investment Fund - a GEF / World Bank supported Investment Fund for Nutrient Reduction focused on single country nutrient reduction investments.

In addition, activities of the countries, EC, EBRD, EIB, and bilateral support aimed at similar objectives targeting reduction of nutrients and toxic pollutants, as well as the ongoing Dnipro project, are considered as contribution to the Strategic Partnership.

Both, the Danube Regional Project and its sister project based in Istanbul - the Black Sea Ecosystems Recovery Project will strengthen the respective Commissions and will assist countries in their efforts to adopt necessary policy, legal and institutional reforms and enforcement of environmental regulations (with particular attention to the reduction of nutrients and toxic substances). The GEF/World Bank Nutrient Reduction Investment Fund is entailing direct investments aimed at concrete reductions in pollution, primarily nutrients, at the national level that can then be replicated throughout the Danube and Black Sea region.

2.5. Structure of the updated Transboundary Diagnostic Analysis Report.

This updated TDA is largely based on the EU Water Framework Directive 'Danube River Basin Analysis' report that was prepared by the countries of the basin and submitted to the European Commission as a legal obligation in 2005. As there has been an initial TDA (1999, prepared by the UNDP/GEF Danube Pollution Reduction Programme), this document updates the most critical parts of this initial TDA with information available from the Danube River Basin Analysis report. In addition the approach adopted for this update has been to follow as closely as possible the terminology and conclusions accepted by the Danube countries for the Danube Basin Analysis Report, but attempts to present these conclusions within the structure of a TDA.

There are a number of 'gaps' in this report as compared to a traditional TDA. For example, a full stakeholder analysis is not presented (although as a requirement for the EU WFD, full stakeholder engagement and public participation has been an integral part of the Danube Basin Analysis). Limited socio-economic information has also been collected in the region for the WFD report (this only addressed socio-economic aspects of water and water use in the basin).

The most important aspect of this report is that it is based on reports that have been prepared and endorsed by the countries, under the guidance of the ICPDR, and consequently the information it contains has a high level of national acceptance.

The structure of this report follows that recommended for a TDA as:

- **Methodology:** This section provides an understanding of the process (political, institutional and technical) leading to the submission of the EU WFD Danube Basin Analysis to the European Commission. The considerable support that was provided by the UNDP/GEF DRP is summarised. The four key transboundary concerns (nutrient pollution, organic pollution, hazardous substance pollution and hydromorphological alterations) are covered.
- **Description of the Danube River Basin:** This section provides an introduction to the basin characteristics including the environmental status and institutional arrangements within the basin.
- **Priority Transboundary Concerns:** The section begins with an assessment of the whole basin in terms of the 'risk' of failing to meet the WFD expectations of 'good ecological status' by 2015. Each of the four issues is addressed in detail, based on the information collected for the Danube Basin Analysis. An important component of the work of the ICPDR and the UNDP/GEF DRP has been an assessment of the impact of the Danube on the Black Sea. A recent report, prepared for the GEF Council is used to supplement the information available in the Danube Basin Analysis report.
- **Stakeholder Involvement in the Danube River Basin:** As explained above, a full stakeholder analysis as expected within a TDA is not reported. However the key activities that have been undertaken in the basin involving a wide range of stakeholders including the broader public are summarised in this update.
- **Analysis of Institutions, Legislation and Investments:** This section provides an introduction to the water and environmental management within the Danube River Basin, both at a national and at the transboundary levels to identify causes of the transboundary concerns.

3. METHODOLOGY

3.1. Introduction

This updated TDA has been developed using material developed in previous and on-going programmes including:

> SAP (1994) – Strategic Action Plan developed under the Environmental Programme for the Danube River Basin (EPDRB) managed by the Danube Programme Co-ordination Unit (PCU) and funded by UNDP/GEF and the EC Phare environment programme;

> SIP (1995) - SAP Implementation Plan;

> UNDP/GEF Danube Nutrient Reduction Programme (1997 –1999)

> TDA prepared under UNDP/GEF Danube Nutrient Reduction Programme (1999),

> ICPDR Joint Action Plan 2000- 2005,

> EU WFD submissions co-ordinated by the ICPDR and in particular the 'Danube Basin Analysis' approved by the ICPDR in December 2004 and submitted to the EC in March 2005;

> EC supported DABLAS programme (specific reports in 2002 and 2004),

> UNDP/GEF Danube Regional Project (2001 – 2006)

The key source for this TDA has been the EU WFD Danube River Analysis (the full report is available on the DRP data DVD and is also available to download from www.icpdr.org).

This section of the Transboundary Analysis Report provides a brief description of the process that led to the submission of the EU WFD Danube River Analysis together with a synthesis of this report with other sources to provide an understanding of the key transboundary issues.

3.2. Guidance on TDA

A Transboundary Diagnostic Analysis (TDA) is an objective, non-negotiated analysis using best available verified scientific information that identifies key transboundary concerns and their root causes . It provides the factual basis for the formulation of a Strategic Action Programme (SAP), which will embody specific actions (policy, legal, institutional reforms or investments) that can be adopted nationally, usually within a harmonised multinational context, to address the major priority transboundary concerns identified in the TDA, and over the longer term enable the sustainable development and environmental protection of the specific transboundary system.

Historically, advice on TDA and SAP approaches given by GEF has been rather limited. However, the experiences of senior IA portfolio managers, IW Chief Technical Advisors and practitioners from a number of IW projects, together with GEF IW Focal Area Programme Study, provided an opportunity to develop more formal guidelines to assist with the preparation of TDAs and to ensure inter-regional comparability.

Consequently a GEF guidance document was developed to provide a road map for best practice in formulating a TDA and a SAP as part of a GEF IW project. It was prepared on the basis of discussions between specialists from UNDP, UNEP and the GEF Secretariat, together with practitioners who had completed the process in freshwater and marine systems. The final document reflected the experience obtained in developing TDA/SAPs between 1996 and 2003 but was not intended as a prescriptive formula, merely a guide that should be adapted to the cultural socio-economic and political realities of each region.

The GEF IW TDA/SAP "best practice" approach consists of the following steps:

- **Identification and initial prioritisation** of transboundary concerns;
- Gathering and interpreting information on **environmental and water resources impacts** and **socio-economic consequences** of each priority concern;
- **Causal chain analysis** (including root causes)
- Completion of an **analysis of institutions, laws, policies and projected investments**

It focuses on transboundary concerns without ignoring national ones, sets priorities and identifies information gaps, policy distortions and institutional deficiencies. The analysis is cross-sectoral and examines national economic development plans, civil society (including private sector) awareness and participation, the regulatory and institutional framework and sectoral economic policies.

This TDA update, based on the EU WFD analysis, attempts to follow the overall concept for a TDA but clearly the source material and the objectives within the ICPDR and the UNDP/GEF DRP have some differences.

3.3. Preparation of the EU WFD Danube Basin Analysis

3.3.1. Background to IRBM in the Danube Basin

The Danube River Protection Convention forms the overall legal instrument for cooperation and transboundary water management in the Danube River Basin. The main objectives of the Convention are to ensure that surface waters and groundwater are sustainably and equitably used, and that the basin's riverine ecosystems are conserved and restored. (See sections 4.6 on Institutional setting and ng and Governance Analysis respectively.)

3.3.2. The EU Water Framework Directive

The EU Water Framework Directive (WFD) is the legislative framework for water management in Europe (all EU member states are legally bound by this legislation). It sets clear objectives that a good water quality status must be achieved by 2015 and that sustainable water use is ensured throughout Europe. Specifically, the WFD

- Sets uniform standards in water policy throughout the European Union and integrates different policy areas involving water issues,
- Introduces the river basin approach for the development of integrated and coordinated river basin management for all European river systems,
- Stipulates a defined time-frame for the achievement of the good status of surface water and groundwater,
- Introduces the economic analysis of water use in order to estimate the most cost-effective combination of measures in respect to water uses,
- Includes public participation in the development of river basin management plans encouraging active involvement of interested parties including stakeholders, non-governmental organisations and citizens.

The EU WFD requires Member States to individually comply with the Directive and to actively co-ordinate their compliance with other countries (both members and non-members) within a river basin.

3.3.3. Activities undertaken

To prepare the Danube Basin Analysis the ICPDR created a River Basin Management Expert Group (RBM EG) to lead and co-ordinate the inputs from a number of other ICPDR Expert Groups (see Figure 28). The RBM EG requested technical assistance from a range of national and international experts to assist with the analysis of basin and to develop new methodologies for assessing the pressures and their impacts on the aquatic environment.

The preparation and submission of the WFD analysis (in accordance with Article V of this directive) was divided into two sections.

- Part 'A' – Issues of basin-wide or transboundary importance co-ordinated by the ICPDR (referred to as a 'Roof Report'); and
- Part 'B' – National reports prepared and submitted by each country to the EC.

The Danube Basin Analysis (and this TDA update) is associated with Part A, reporting on issues of transboundary importance.

The UNDP/GEF Danube Regional Project provided significant resources to assist with this work, including the provision of experts, workshops and meetings. The main technical assignments conducted by the DRP in the preparation of the Danube Basin Analysis includes:

- Identification of heavily modified water bodies (HMWB);
- Hydromorphological pressures, impacts and risk assessment;
- Characterisation of groundwaters;
- Nutrient loads and eutrophication;
- Significant point and diffuse sources of pollution;
- Identification and characterisation of water bodies;
- Preparation of maps;
- Economic analysis on water use;
- Agrochemical inventories.

In addition the DRP supported a wide range of technical meetings and workshops leading to the final agreement of the Danube Analysis Report.

The WFD and the first main output (Danube Basin Analysis report) provide considerable broadening of the information traditionally assembled for a TDA. Significantly the WFD is a legal requirement for the majority of the Danube Basin countries that places clear obligations on the implementation of the actions identified to reduce pollution. In addition the WFD requires the countries to periodically review and update their plans in process similar to the 'adaptive management' framework recommended by the GEF.

3.4. Identification of priority transboundary concerns

The key tools used in the identification of the priority transboundary concerns included:

- Results of environmental and water monitoring programmes;
- Risk assessment of meeting the required good status of the WFD
- Expert judgement in the absence of appropriate data.

3.4.1. Water-related Environmental Monitoring

The ICPDR has created a monitoring network that was designed to detect changes of transboundary significance. The Trans-National Monitoring Network (TNMN) is a monitoring programme for chemical and biological variables at 79 monitoring sites on the Danube and its major tributaries. The TNMN was established in 1996 and all countries contribute data to this programme. An analytical quality control (AQC) system (for chemical determinands) is in place to ensure the comparability of results. In addition to the in-laboratory routine AQC, a programme of inter-laboratory check-samples is operated covering all the main determinands

In 2001 the ICPDR initiated an integrated river survey – the Joint Danube Survey (JDS). This exercise, which will be repeated every 5 – 6 years, has contributed a significant data set that was utilised in the preparation of the Danube Basin Analysis report. In particular, it provided considerable data on biological determinands.

3.4.2. 'Risk of failure' to meet good status

The WFD requires Member States to carry out an assessment of the likelihood that water bodies will fail to meet the environmental quality objectives by 2015. The objectives include both the overall objective to achieve good status by 2015, and additional specific objectives that apply to protected areas as defined by other legislation. The objectives also depend on the current status of the water body, since Member States must generally prevent any deterioration in the status.

Failure to achieve the objectives on surface waters may be the result from a very wide range of pressures, including point source discharges, diffuse source discharges, water abstractions, water flow regulation and morphological alterations. These and other pressures5 that could affect the status of aquatic ecosystems must be considered in the analysis. The risk assessment is therefore based on information collected in the pressure and impact analysis.

3.4.3. Priority Transboundary Concerns

On the basis of the data from the TNMN, the risk assessment and expert judgement, the ICPDR's River Basin Management Expert Group (RBM EG) identified the main pressures (immediate causes) in the Danube River Basin as:

- **Point source pollution** (e.g. from urban and industrial wastewater treatment plants or management sites). Impacts on water bodies can result from the input of nutrients, organic substances and hazardous substances;

[5] The equivalent GEF terminology would be 'stresses' rather than 'pressures'.

- **Diffuse source pollution** (e.g. from agriculture and urban use activities). Impacts on water bodies can result from the input of nutrients (e.g. fertilisers), organic substances (e.g. from manure) and hazardous substances (e.g. pesticides and herbicides).
- **Hydrological alterations** (e.g. water abstraction, hydro-peaking, flow regulation). Impacts on water bodies can result from changes to the hydrological conditions and the impact of this on, for example, biological communities;
- **Morphological alterations** (e.g. impoundments, weirs, bank reinforcements, channelling). Impacts on water bodies can result from hydraulic engineering measures altering the structural characteristics of the water body, for example restricting fish migration due to dams.

From these main pressures (or stresses) on the Danube River Basin the RMB EG identified the four priority transboundary concerns as:

- **Nutrient pollution** – from diffuse (e.g. agriculture) and point sources (e.g. municipal wastewater);
- **Organic pollution** - from diffuse (e.g. agriculture) and point sources (e.g. municipal wastewater);
- **Hazardous substances** – from point sources (e.g. industry) or diffuse sources (e.g. agriculture or contaminated sites); and
- **Hydromorphological alterations** – from flood defences, hydropower, navigation etc.

3.5. Pressure and Impact Assessment / Causal chain analysis

The approach used in the Danube Analysis followed the 'DPSIR' – Drivers, Pressures, State, Impact and Response[6] that is used extensively by the EC and EEA to assess the performance of policy initiatives. This has much similarity to the Causal Chain Analysis (CCA) more usually undertaken in a TDA. The approach adopted in the Danube (to establish the pressures on the environment and their impact on the ecology) has been accepted by all the countries and is an important precursor to the river basin management plan and the 'programme of measures', where the issues identified in the Danube Basin Analysis are mitigated. This mitigation will require significant policy reforms and investments from the countries endorsing the Danube Basin Analysis report.

The Danube Basin Analysis identified gaps in the existing information in the assessment of pressures and their impacts. The Danube countries are currently working to address these gaps prior to the submission of the WFD River Basin Management Plan in 2009. This plan, through the agreed 'Programme of Measures' will detail the activities that will be undertaken by the countries to achieve the required 'good status' for the Danube Basin water bodies.

The pressures and impacts assessment adopted for the preparation of the Danube River Analysis followed a four-step process:

1. Describing the driving forces, especially land use, urban development, industry, agriculture and other activities which lead to pressures, without regard to their actual impacts;
2. Identifying pressures with possible impacts on the water body and on water uses, by considering the magnitude of the pressures and the susceptibility of the water body;
3. Assessing the impacts resulting from the pressures; and

[6] In GEF terminology, drivers equate to underlying causes, pressures to immediate causes, status to environmental impacts and impacts to socio-economic impacts

4. Evaluating the likelihood of failing to meet the objective.

While pressures from sources resulting from a large number of human activities (e.g. households, industrial activity, power generation, agriculture, forestry, fish farming, mining, navigation, dredging, etc.) have an impact, only those pressures that have significant impacts on the basin-wide level were addressed in the 'Roof Report' of the Danube River Analysis.

3.6. Governance analysis

The overall management and co-ordination of the Danube River Basin is the responsibility of the ICPDR. The ICPDR is composed of the countries of the Danube Basin and the structure of this institution is described later. A number of studies have been conducted over the last 15 years that describe the progress of the Danube countries in migrating their environment legal and policy instruments to be compliant with EU and other international obligations.

The UNDP/GEF DRP, within the period 2002-2006, conducted a thorough analysis of institutional and policy frameworks in all Danube countries, which enabled policy reform recommendations to be developed addressing overall water governance.

Specific analytical studies on inter-ministerial coordination and government decision-making mechanisms, on policy, legislation and institutional set-ups have been carried out with focus on agricultural and industrial pollution and wetland management. The analysis of existing situation, capacities and structures, and policy reform recommendations for economic analysis of water resources and further development of public water infrastructure were also developed.

The UNDP/GEF DRP and the ICPDR studies and analysis addressed policy development and implementation, legislative reforms and environmental laws enforcement as well as mechanisms and conditions for resource allocation and investment needs for elimination of major transboundary environmental issues by the main stakeholders.

4. DESCRIPTION OF DANUBE RIVER BASIN

4.1. Introduction

This section provides an overview of the Danube River Basin, covering the physical characteristics of the basin, a summary of the status of the main water bodies and an introduction to the institutional arrangements within the basin.

4.2. Physical and geographic characterisation

The Danube River Basin[7] is the second largest river basin in Europe after the Volga covering 801,463 km². It lies to the west of the Black Sea in Central and South-eastern Europe (see Figure 1, Figure 2).

Due to its geologic and geographic conditions the Danube River Basin can be divided into 3 main parts.

- The Upper Danube Basin is from the sources in the Black Forest Mountains to the Gate of Devín, to the east of Vienna.
- The Middle Danube Basin is from the Gate of Devín to the impressive gorge of the Danube at the Iron Gate, which divides the Southern Carpathian Mountains in the north and the Balkan Mountains in the south.
- The Lower Danube Basin covers the Romanian-Bulgarian Danube sub-basins downstream of Cazane Gorge and extends to the Danube Delta and the Black Sea.

The Danube River Basin shows a tremendous diversity of habitats through which rivers and stream flow including glaciated high-gradient mountains, forested midland mountains and hills, upland plateaus and through plains and wet lowlands near sea level.

4.2.1. Climate and hydrology

Due to its large extension from west to east, and diverse relief, the Danube River Basin also shows great differences in climate. The upper regions in the west show strong influence from the Atlantic climate with high precipitation, whereas the eastern regions are affected by Continental climate with lower precipitation and typical cold winters. In the area of the Drava and Sava, influences from the Mediterranean climate, can also be detected. The precipitation ranges from < 500 mm to > 2000 mm in the region.

[7] The area of the DRB was determined digitally with GIS. If other sources are consulted this value may vary slightly, because other methods of calculation have been used.

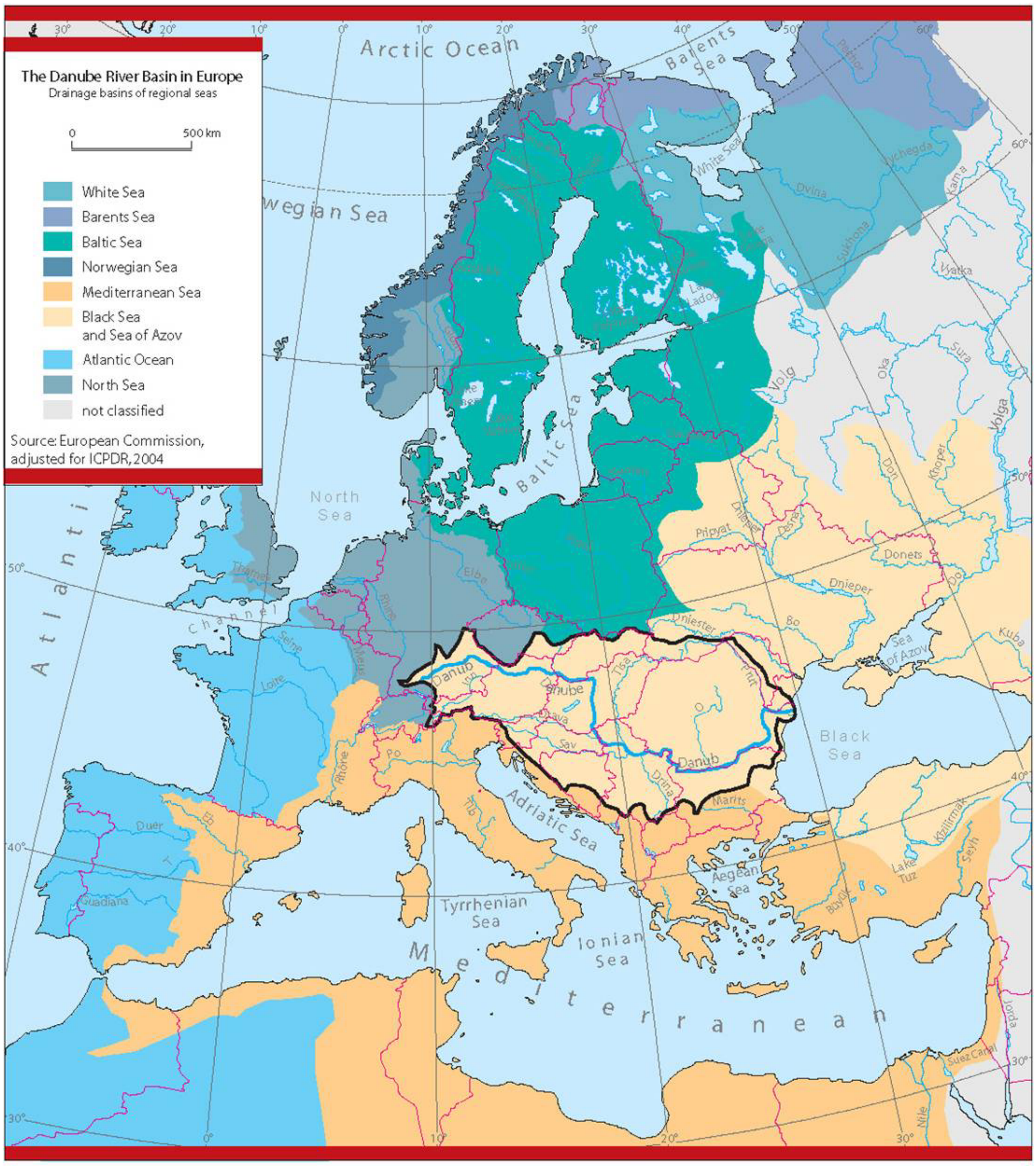


Figure 1: Location of the Danube River Basin

The hydrologic regime of the Danube River is distinctly influenced by the regional precipitation patterns. This is well illustrated in Figure 3, which shows the surface water contribution from each country to the cumulative discharge of the Danube. Austria shows by far the largest contribution (22.1 %) followed by Romania (17.6 %). This reflects the high precipitation in the Alps and in the Carpathian mountains. In the upper part of the Danube the Inn contributes the main water volume adding more water to the Danube than it has itself at the point of confluence of the two. In the middle reach it is the Drava, Tisza and Sava, which together contribute almost half of the total discharge that finally reaches the Black Sea.

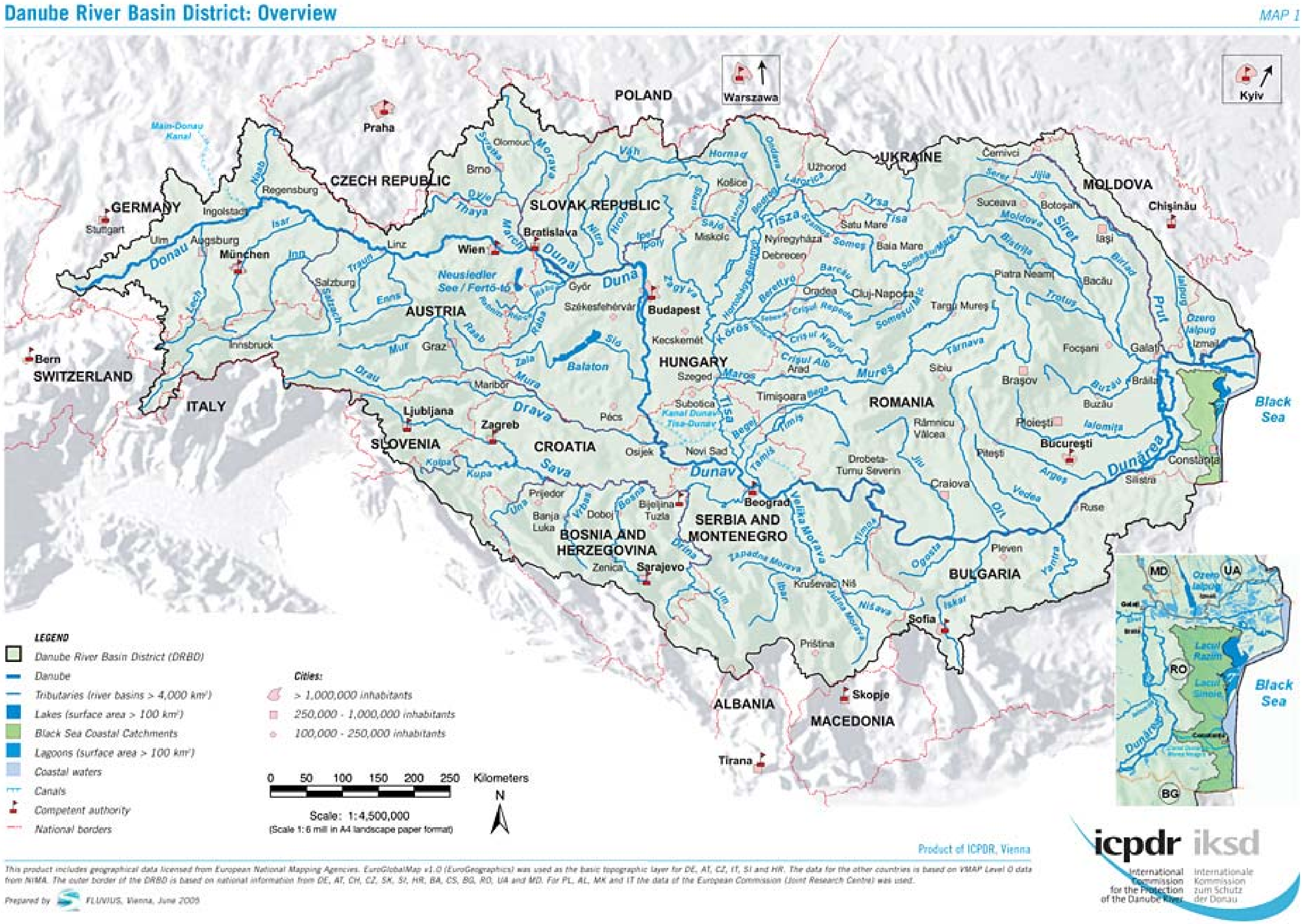


Figure 2: The Danube River Basin

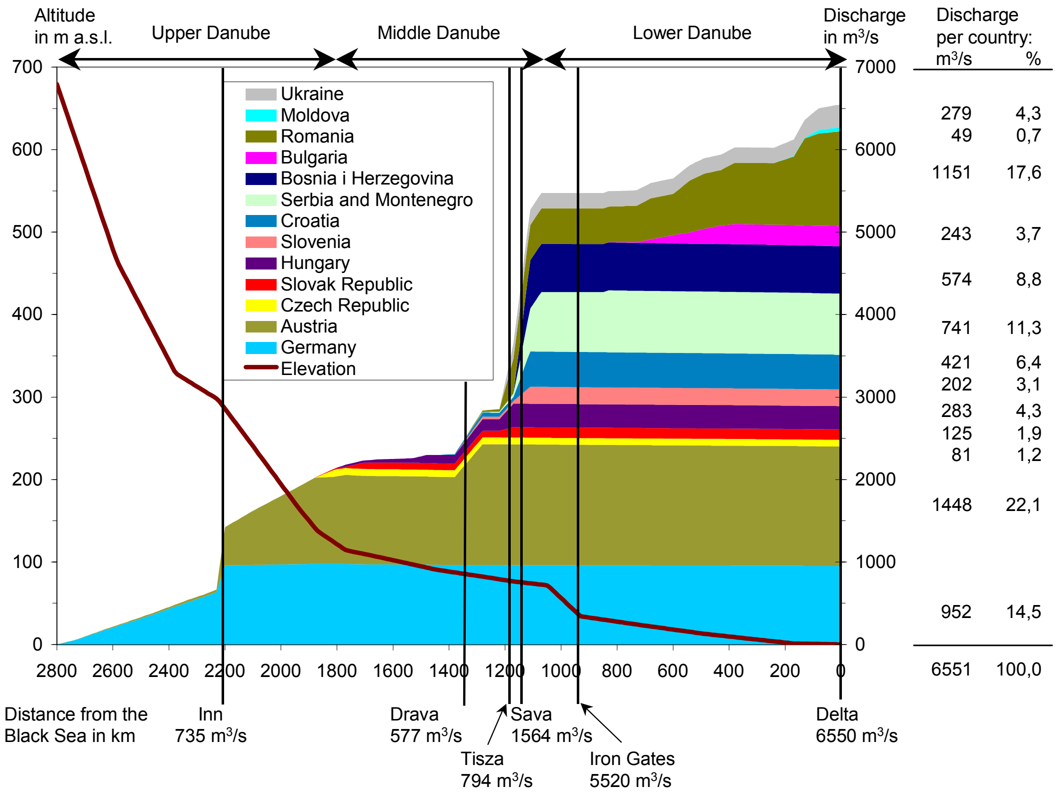


Figure 3: Longitudinal profile of the Danube River and contribution of water from each country (in %) to the cumulative discharge of the Danube (in millions m^3/year), based on data for 1994-1997 using the Danube Water Quality Model[8]

4.2.2. The Danube River and its main tributaries

The **Danube** rises in the Black Forest (Schwarzwald) in Germany at an altitude of about 1,000 m. The Danube river and receives its name at the confluence of Brigach and Breg in Donaueschingen. The Danube flows predominantly to the south-east and reaches the Black Sea after 2,780 km where it divides into 3 main branches, the Chilia, the Sulina, and the Sf. Gheorghe Branch. At its mouth the Danube has an average discharge of about 6,500 m^3/s. The Danube Delta lies in Romania and partly in Ukraine and is a unique "World Nature Heritage". The entire protected area covers 675,000 ha including floodplains, and more than 600 natural lakes larger than one hectare, and marine areas. The Danube is the largest tributary into the Black Sea.

The most significant tributaries of the Danube River include:

- The **Tysa/Tisza/Tisa** River basin is the largest sub-basin in the Danube River Basin (157,186 km^2). It is also the longest tributary (966 km) of the Danube. By flow volume it is second largest after the Sava River.
- The **Sava** River is the largest Danube tributary by discharge (average 1,564 m^3/s) and the second largest by catchment area (95,419 km^2).
- The **Prut** River is the second longest (950 km) and the last tributary of the Danube, with its mouth just upstream of the Danube Delta.

[8] Developed during the Danube River Pollution Reduction Programme in 1999, UNDP/GEF (1999b).

A list of the main tributaries and their characteristics are presented in the WFD Danube River Basin Analysis.

4.2.3. Important lakes in the Danube River Basin

In the Danube River Basin there are a multitude of natural lakes. Most of them are small, but some are also very large, with areas of several square kilometres. The middle Danube region shows some characteristic steppe lakes, of which the most prominent ones are Neusiedlersee / Fertő-tó and Lake Balaton.

4.2.4. Major wetlands and other Protected Areas in the Danube River Basin District

Floodplain forests, marshlands, deltas, floodplain corridors, lake shores and other wetlands are essential components in the Danube River Basin's biodiversity and hydrology. Many of the larger wetland areas are transboundary in nature. The wetlands in the Alps and Carpathians also represent valuable drinking water reserves for millions of people.

The current extent of wetlands in the DRB is only a remnant of the former wetland systems and it is estimated that over 80% of former wetlands and floodplains have been lost. The main wetland and protected areas of transboundary importance are shown in Figure 4.

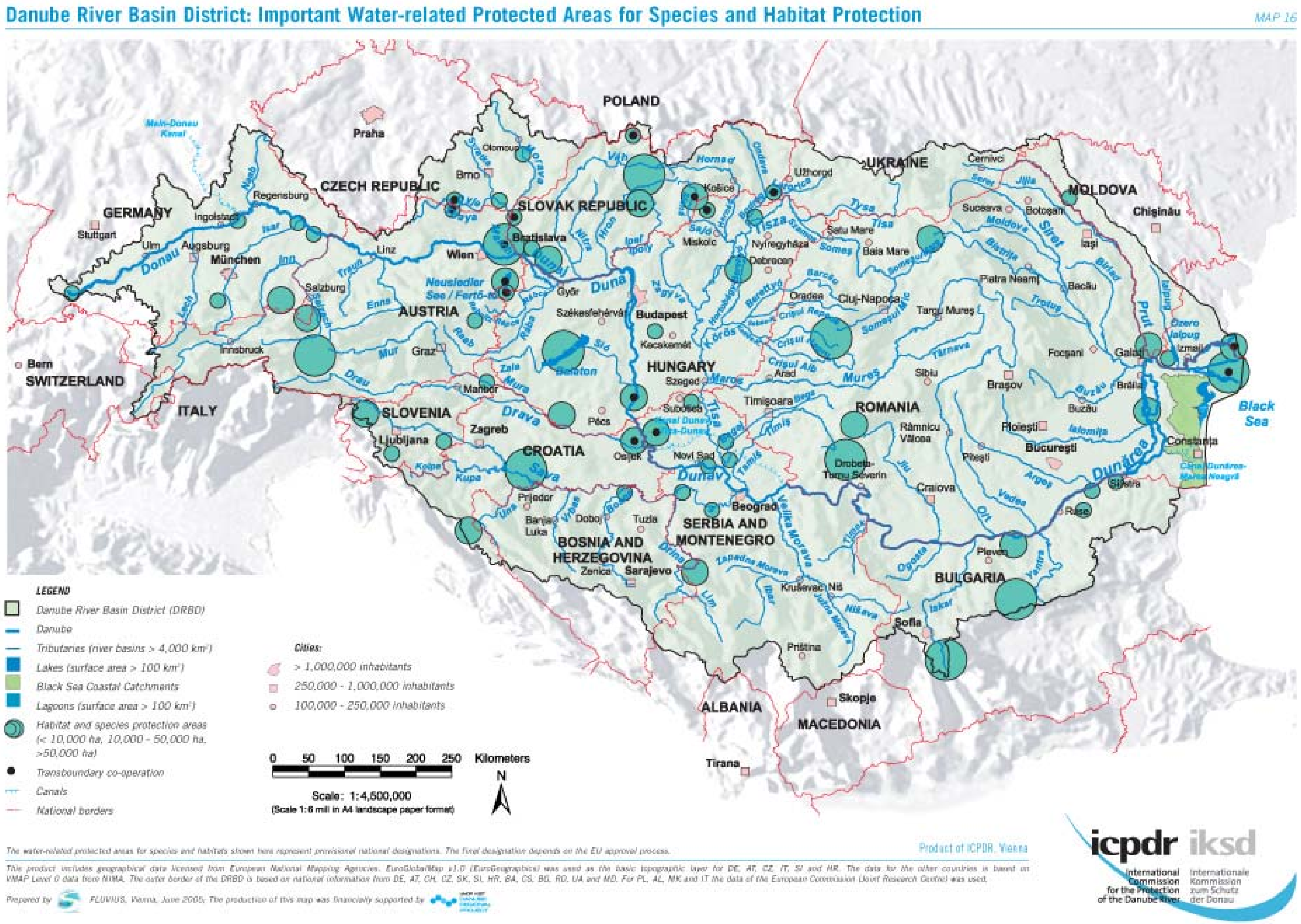


Figure 4: Major Protected Areas within the Danube River Basin

4.2.5. Groundwater in the Danube River Basin District

Besides porous aquifers there are many karstic aquifers in the DRB. Due to their high permeability karstic aquifers are highly vulnerable to contamination. The percolation time for contaminants is very short and therefore natural purification processes are very limited. For selected countries such as Bulgaria, Croatia, and Serbia and Montenegro, groundwater resources represent as much as 30 % of total internal renewable water resources.

A large number of transboundary aquifers exist in the region. Not much is known at present about the availability of groundwater or potential extraction capacity in many countries, although aquifers are the main sources for drinking and industrial water.

4.3. Ecological status

Some sections of the Danube River are still rather untouched ecosystems and, despite possible pollution problems, constitute a unique heritage to be preserved. In addition, the Danube River Basin still hosts many species and habitats of outstanding ecological value and unique importance for biodiversity. In particular the Danube Delta is of global significance. The future management of the river basin needs to ensure that the focus of measures is not only the restoration of affected water bodies but equally important is the preservation of those few areas that are still ecologically intact.

The current analysis shows that, in the last two decades, considerable improvements in environmental conditions in the Danube basin have been made. Where investments, e.g. in wastewater treatment, have taken place, the improvement of the water quality is visible. However, a major part of pollution reduction can be attributed to the decline of industries and agricultural activities in the middle and lower parts of the basin since 1989. In these areas investments for a sustainable reduction of pollution levels has just started and will have to continue for another 10 to 20 years.

The Danube River Basin contains a large number of wetlands offering unique habitats for a rich and diverse aquatic community. Many of these areas have high protection status such as the large wetland complexes protected under international conventions, others still deserve to be designated as protected areas, but have not been granted such status. 80 % of the historical floodplain on the large rivers has been lost during the last 150 years mainly from significant hydromorphological alterations, and many already protected areas deteriorate due to new human interventions. Still today, many wetlands are under pressure (stress) from navigation, hydropower plants, intensive agriculture and forestry as well as from new infrastructure projects. Wetland restoration can bring many benefits, in particular for flood protection. As a first step, an inventory of the most important water-related protected areas for species and habitat protection has been established for the Danube River Basin.

The Danube Delta has suffered significant impacts from anthropogenic activities in the last 50 years. These were caused in part by high nutrient loads and heavy metals from the Danube. Nutrient inflow has led to eutrophication of the delta arms and its lakes; elevated concentrations of heavy metals occur especially in the delta lakes. In addition, severe hydromorphological alterations and intensive agriculture and forestry have led to the loss and deterioration of large areas of land formerly unused and interconnected within the delta. As a consequence species and habitat diversity has declined. The large number of hydraulic structures on the Danube and its tributaries has also considerably reduced the sediment transport thereby bringing the growth of the Danube Delta into the Black Sea in parts to a halt.

Although considerable restoration measures have been undertaken in the last decade new canalisation projects are still being planned and implemented. Sound environmental impact assessments need to be carried out and alternative solutions found in order to protect this unique natural heritage of global importance.

4.4. Socio-economic situation

4.4.1. Social Economic Indicators

There are significant differences in the GDP between the western Danube Basin (Austria and Germany) and the eastern region (Moldova and Ukraine). These historic differences have an obvious impact on the country's ability to address the environmental issues identified in the Danube Basin Analysis report.

Table 1: General socio-economic indicators

	GDP	Total population	GDP per capita	GDP per capita
	(in million EUR)	(million)	(in EUR per capita)	(in PPP EUR per capita)
Albania	14	<0.01	1,390	na
Austria	198,611	7.7	25,795	25,521
Bosnia i Herzegovina	3,493	2.9	1,204	na
Bulgaria	7,266	3.5	2,076	8,010
Croatia	12,942	3.1	4,175	7,460
Czech Republic	15,247	2.8	5,461	13,226
Germany	285,075	9.4	30,321	29,215
Hungary	50,663	10.1	5,016	11,243
Italy	403	0.02	20,225	22,457
Macedonia	19	<0.01	1,921	6,020
Moldova	394	1.1	358	na
Poland	187	0.04	4,672	9,230
Romania	38,908	21.7	1,795	5,264
Serbia and Montenegro	8,628	9.0	959	na
Slovak Republic	21,077	5.2	4,059	11,157
Slovenia	17,182	1.7	9,892	14,696
Switzerland	739	0.02	37,258	na
Ukraine	1,840	2.7	686	3,706

4.5. Climate Change

To date there relatively limited assessments of the potential scenarios of climate change linked the Danube River Basin. However the suggestion from hydrological and climate modelling (globally) is that the probability and extent of extreme drought events during summer and extreme rain events in winter is expected to increase. This is believed to also apply to the Danube River Basin and in response the ICPDR initiated the development of a Flood Action Programme[9].

There is also need for a better understanding, for example, of the impacts of climate change on the nutrient loads within the Danube Basin. It is well known that under high discharge conditions as a

[9] ICPDR 2004: Flood Action Programme – Action programme for sustainable flood protection in the Danube River Basin.

result of floods, sediment transport increases significantly (an issue in itself) and that phosphorus is often associated with the particulates in sediments. More data is required in flood events on nutrient loads to provide better estimates of the likely impacts on the Black Sea as a result of these extreme events.

Climate change could be a contributory factor in increasing nutrient concentrations in the Black Sea, with internal loading of nutrients in the NW Shelf appearing to be linked to wind speed, direction and duration. This may be a direct effect of physical mixing at the sediment-water interface and/or a indirect effect caused through changes to the dissolved oxygen status of shallow benthic areas: at higher dissolved oxygen levels less phosphate is released from sediments, nitrification is promoted and dentrification is inhibited.

All countries of the Danube Basin are committed to the issue of climate change and are signatories to the UN Framework Convention on Climate Change.

4.6. Institutional setting

The interest of Danube countries in improving basin-wide cooperation in water management began in the 1980s. The first important agreement, the **'Bucharest Declaration on Water Management of the Danube River'**, was signed in 1985. Danube countries agreed to coordinate water management activities on an international level and to protect the Danube and its tributaries from pollution. The goals were ambitious but the political and economic situation in the region at the time hindered effective implementation. One key outcome was the establishment of an international monitoring system for water quality.

After 1989, massive regional political changes in Central and Eastern Europe (CEE) opened the door for new opportunities including regional environmental cooperation. In June 1991, the idea to create a '**Danube River Protection Convention (DRPC)'** was supported by countries at the first UNECE **'Environment for Europe'** conference held at the Dobris Castle in the Czech Republic.

The need for a DRPC was further driven by Danube countries becoming Parties to the new **UNECE Convention on the Protection of Trans-boundary Rivers and Lakes** signed in Helsinki in March 1992. It obliged Parties to take action to prevent trans-boundary impacts on watercourses and encouraged them to cooperate through river basin management agreements. In effect, the Helsinki Convention became the framework for the DRPC.

In 1992, the first GEF Danube River Basin project was funded. Two years later, on June 29, 1994 in Sofia, Bulgaria, 11 Danube countries and the EU signed the DRPC. It became the overall legal framework and instrument for cooperation in protecting and sustainable use of water and other shared ecological resources.

The DRPC came into force on October 22, 1998. The first subsequent formal meeting on October 27 in Vienna led to the establishment of the **International Commission for the Protection of the Danube River (ICPDR)** and its **Permanent Secretariat**. The ICPDR became the legally responsible institution for further development of Danube water management and related international laws, and for regional cooperation in Danube IRBM.

The EU formally adopted the **Water Framework Directive (WFD)** in 2000. The WFD is the operational tool of a thoroughly restructured European Water Policy. Setting the objectives for water protection well into the 21^{st} century, it covers surface and ground waters and aims to achieve **"good status"** for all waters by 2015.

It obliges Member States and accession countries to fulfil the WFD and use a river basin approach for managing water resources. It requires cross-border cooperation and encourages multi-stakeholder cooperation including from NGOs and local citizens. It aims to ensure both good water quality and ecosystem health.

It obliges every EU river basin, including the Danube, to develop a 'River Basin Analysis' by 2004, followed by a 'River Basin Management Plan (RBMP)' by 2009 which specifies the 'Programme of Measures' required to meet the 2015 WFD objectives.

At its 3rd Ordinary Meeting on November 27-28, 2000 in Sofia the ICPDR made the following resolutions:

- The ICPDR will provide the platform for the coordination necessary to develop and establish the River Basin Management Plan for the Danube River Basin.
- The Contracting Parties ensure to make all efforts to arrive at a coordinated international River Basin Management Plan for the Danube River Basin in line with the requirements of the WFD.

These resolutions were supported by both EU and non-EU members of the ICPDR. In addition countries that are in the Danube Basin but not formally Contracting Parties of the ICPDR due to the area of the Danube within their countries (Poland, Switzerland, Macedonia, Italy and Albania) have also agreed to co-operate on the development and implementation of the EU WFD with the ICPDR. These resolutions made by the Heads of Delegation to the ICPDR was reconfirmed in writing by ministers of environment / water management from all countries.

5. PRIORITY TRANSBOUNDARY CONCERNS

5.1. Introduction

This section provides an overview of the four agreed priority concerns of transboundary importance in the Danube River Basin, *viz.* Nutrient pollution, organic pollution, pollution from hazardous substances and hydromorphological alterations. An important source of information for this identification has been the TNMN – the Trans-National Monitoring Network (see Section 3.4.1). An additional source of information for this priority setting has been the estimation of water bodies 'failing to meet the objectives of the WFD by 2015'. The procedure adopted in these risk estimations is briefly described in Section 3.4.2.

The evaluations of the risk analysis for the Danube are based on the length of the water bodies that have been identified. The information about the risk of failure is presented in disaggregated form, i.e. evaluation of the single risk categories.

The following summary of the results can be made:

- The **upper Danube**, where chains of hydropower plants exist, is mainly impacted by hydromorphological alterations.
- The **Middle Danube** is classified as "possibly at risk" due to hazardous substances for the largest part.
- The Danube section **shared by Slovakia and Hungary** is classified as "at risk" due to hydromorphological alterations.
- The part of the Danube **shared by Croatia, and Serbia and Montenegro** is "possibly at risk" in all categories since not enough data is available for a sure assessment.
- The **lower Danube** is "at risk" due to nutrient pollution and hazardous substances, and in large parts due to hydromorphological alterations. It is "possibly at risk" due to organic pollution.

Based on the analysis the percentages of river length were calculated that are "at risk", "possibly at risk" and "not at risk".

- 58 % of the Danube is "at risk" or "possibly at risk" due to organic pollution (Figure 5);
- 65 % of the Danube is "at risk" or "possibly at risk" due to nutrient pollution (Figure 6);
- 74 % of the Danube is "at risk" or "possibly at risk" due to hazardous substances (Figure 7);
- 93 % of the Danube is "at risk" or "possibly at risk" due to hydromorphological alterations (Figure 8).

This summary is shown on the following maps (figures 5 – 8) and represented graphically for the main Danube River in Figure 9.

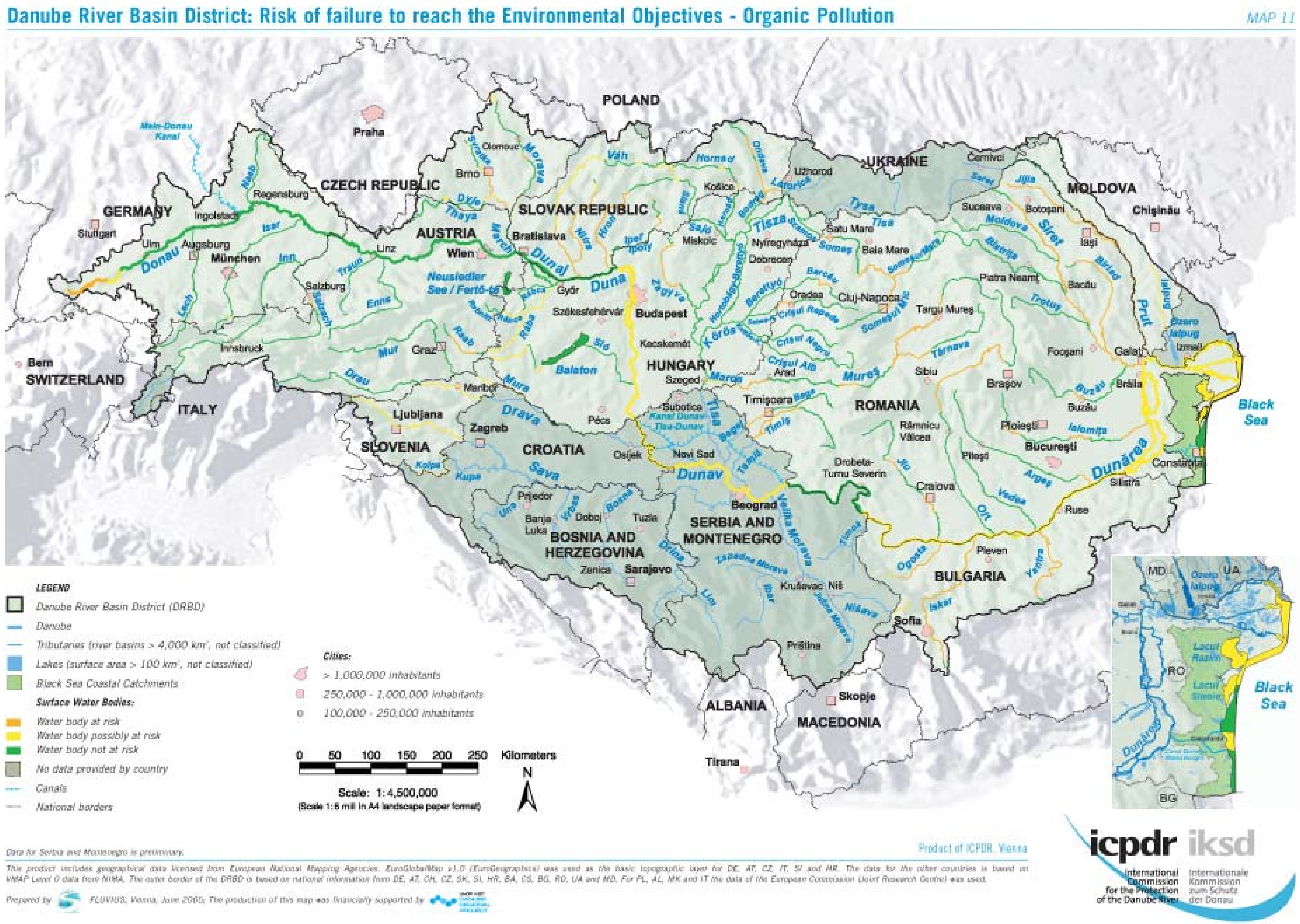


Figure 5: Risk of Failure to Reach Environment Objectives – Organic Pollution

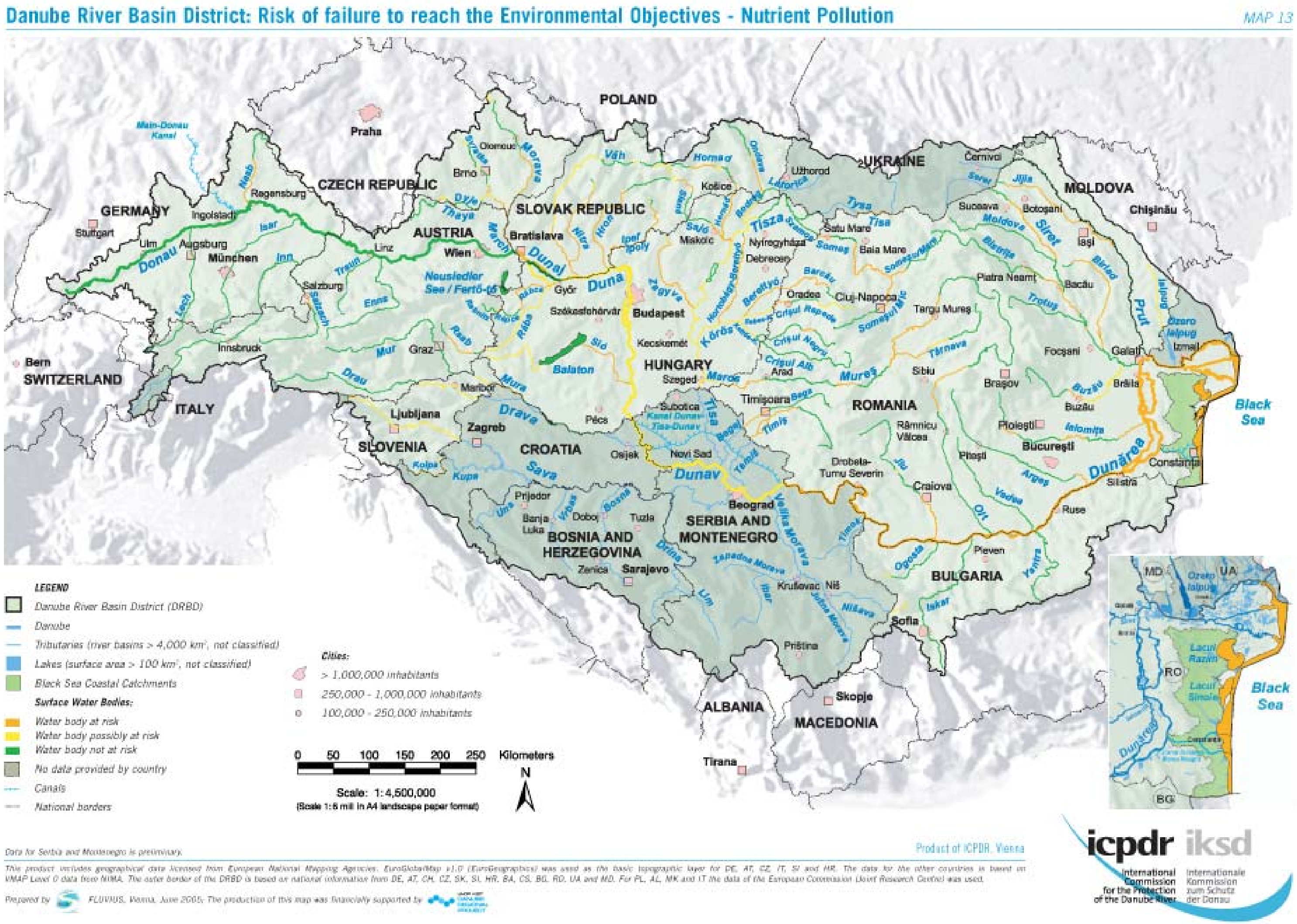


Figure 6: Risk of Failure to reach Environmental Objectives – Nutrient Pollution

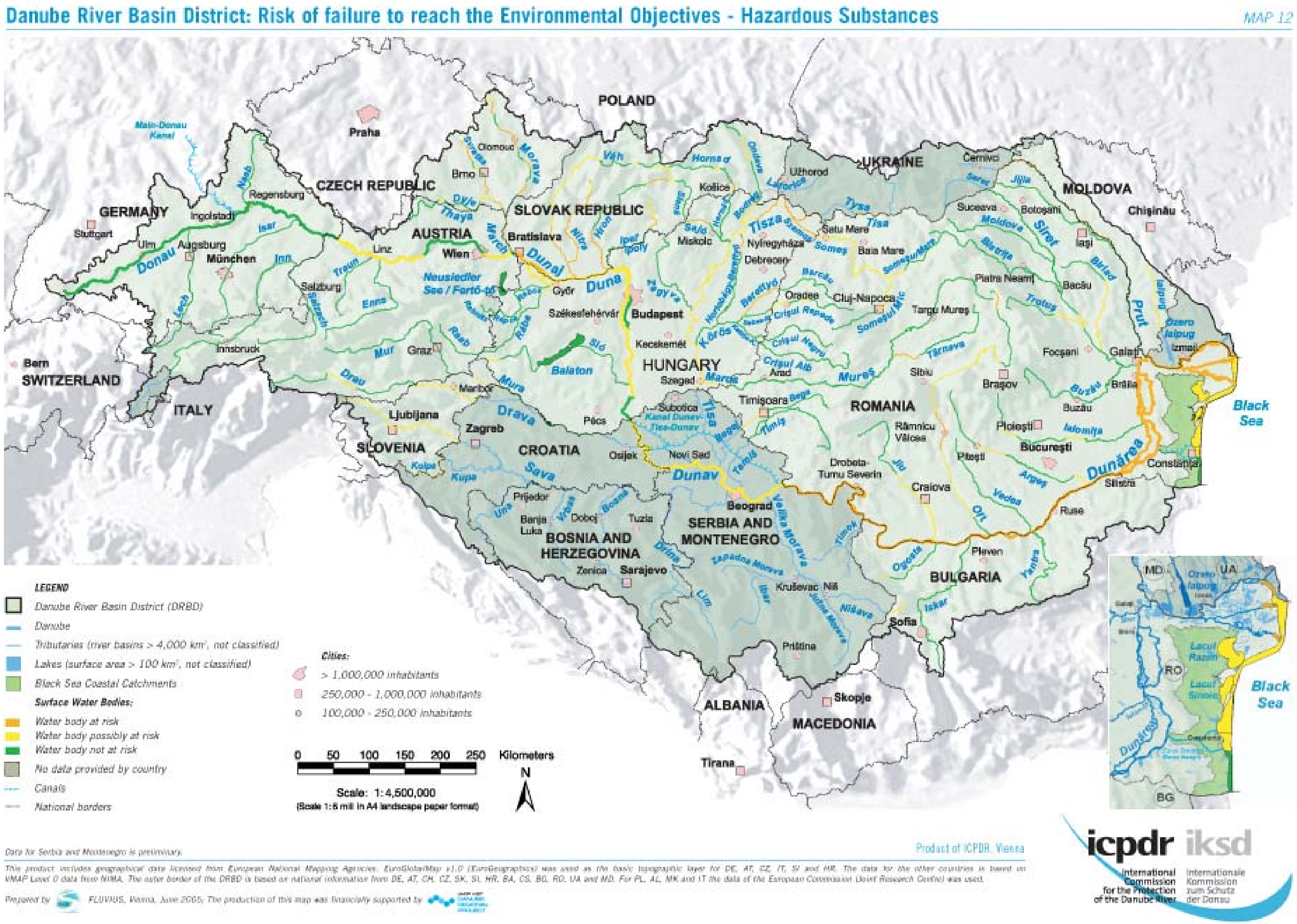


Figure 7: Risk of failure to reach Environmental Objectives –Hazardous Substances

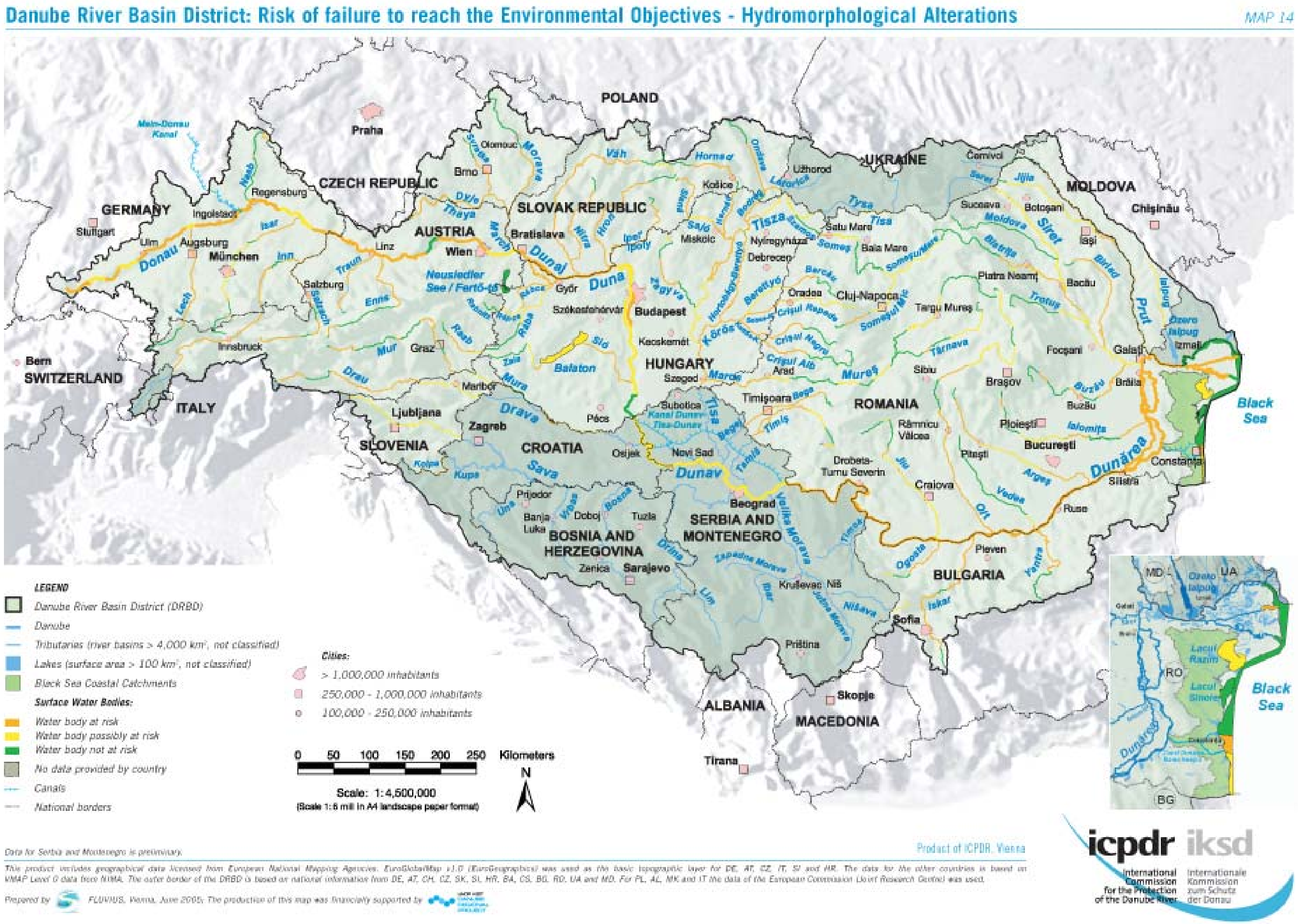


Figure 8: Risk of failure to reach Environmental Objectives – Hydromorphological Alterations

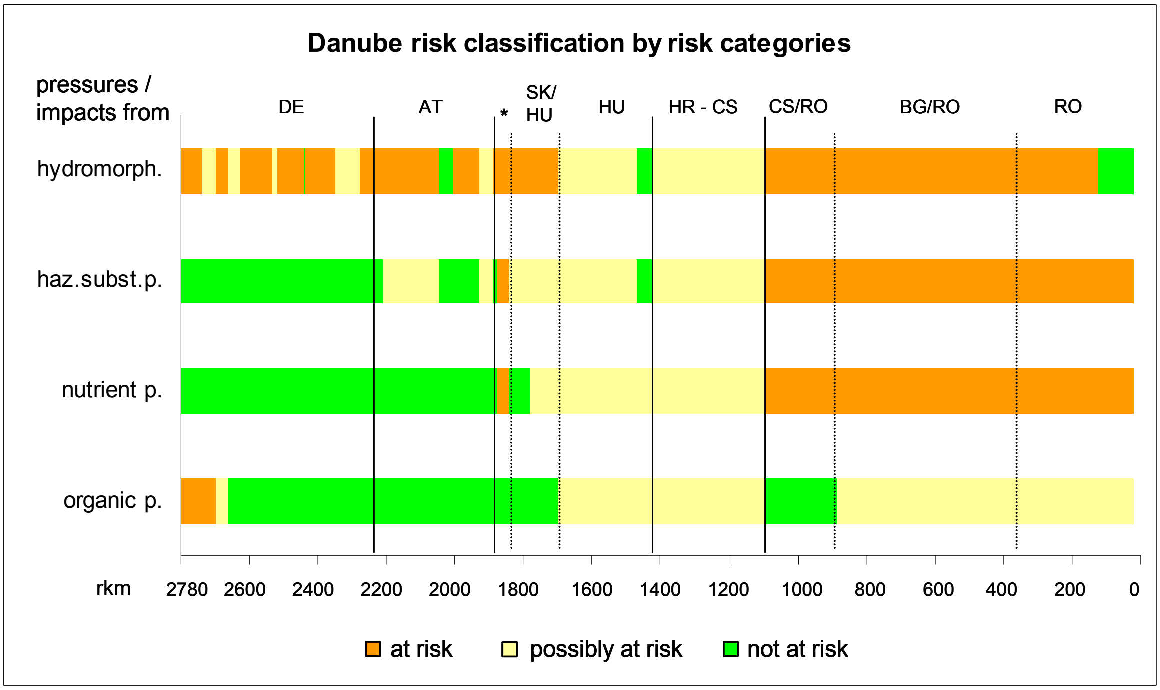


Figure 9: Risk classification of the Danube, disaggregated into risk categories. Each full band represents the assessment for one risk category (hydromorphological alterations, hazardous substances, nutrient pollution, organic pollution). Colours indicate the risk classes. * SK territory.

These results cover about 85 % of the tributaries (based on the length of the tributaries in comparison to the total length of tributaries). For the other tributaries there was insufficient data available and these were therefore classified as being "possibly at risk".

The summary statistics for the tributaries (based on overall length) showing the risk of failure are:

- 50% of tributaries are at risk or possibly at risk from nutrient pollution
- 43% of tributaries are at risk or possibly at risk from organic pollution[10]
- 36% of tributaries are at risk or possibly at risk from hazardous substances;
- 78% of tributaries are at risk or possibly at risk from hydromorphological alterations.

5.2. Significant Point Sources of Pollution

The analysis of the point source pollution in the Danube River Basin requires the availability of complete inventories of point sources with data of high and homogenous quality covering the whole catchment area. This analysis is based on the ICPDR Emission Inventory.

The criteria for the identification of the significant point sources for the basin-wide overview are given in Table 2. These criteria refer especially to substances mentioned in Annex VIII WFD, to the Urban

[10] The upper Danube basin shows a comparatively low percentage of risk due to organic pollution (5 to 20 % of the length), while in the middle and lower Danube basin the percentage is much higher (ranging between 20 to more than 90 % of the length

Waste Water Treatment Directive (91/271/EEC), to the Integrated Pollution Prevention and Control Directive (96/61/EC) and to the Dangerous Substances Directive (76/464/EEC).

Within this report the focus of the analysis is on the significant point sources of pollution.

Table 3 gives an overview of the significant point sources identified in the Danube River Basin. The locations of the significant point sources are shown in Figure 10.

Table 2: Definition of significant point source pollution on the basin-wide level

Discharge of	Assessment of significance
Municipal waste water	
any municipal waste water from • agglomerations with < 10,000 PE • WWTPs with < 10,000 PE	not significant
untreated municipal waste water from • agglomerations with > 10,000 PE	significant
only mechanically treated municipal waste water from • WWTPs with > 10,000 PE	significant
mechanically and biologically treated municipal waste water without tertiary treatment from • WWTPs with > 100,000 PE	significant if at least one parameter is exceeded: – BOD > 25 mg/l O_2 – COD > 125 mg/l O_2 – N_{total} > 10 mg/l N** – P_{total} > 1 mg/l P
Industrial waste water	significant if at least one parameter is exceeded: – COD > 2 t/d – pesticides > 1 kg/a – heavy metals and compounds: • As_{total} > 5 kg/a • Cd_{total} > 5 kg/a • Cr_{total} > 50 kg/a • Cu_{total} > 50 kg/a • Hg_{total} > 1 kg/a • Ni_{total} > 20 kg/a • Pb_{total} > 20 kg/a • Zn_{total} > 100 kg/a
Waste water from agricultural point sources (animal farms)	significant if at least one parameter is exceeded: N_{total} > 50,000 kg/a P_{total} > 5,000 kg/a

Table 3: Significant point sources of pollution in the Danube River Basin District according to the criteria defined in Table 2.

	DE	AT	CZ	SK	HU	SI	HR	BA	CS	BG	RO	MD	UA
Municipal point sources:													
• WWTPs	2	5	1	9	11	3	10	3	4	6	45	0	1
• Untreated wastewater	0	0	0	2	1	3	16	15	14	31	14	0	0
Industrial point sources	5	10	10	6	24	2	10	5	14	4	49	0	5
Agricultural point sources	0	0	0	0	0	1	0	0	0	0	17	0	0
Total	7	15	11	17	36	9	36	23	32	41	125	0	6

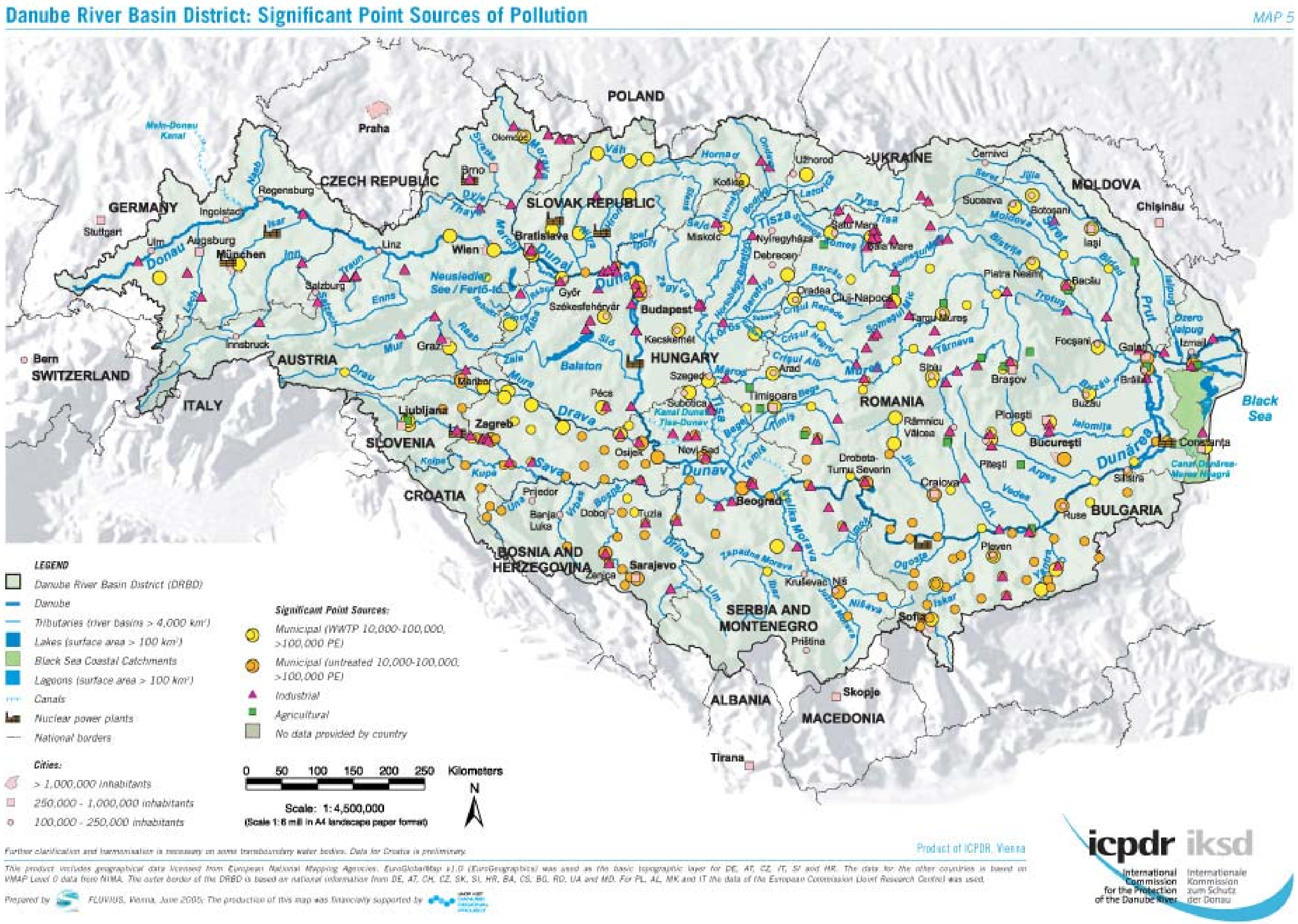


Figure 10: Significant Point Source of Pollution

5.3. Contribution of sub-basins to the total point source pollution of the Danube

Table 4 shows the results of the point source inventory for the main sub-catchments of the Danube river basin district for the year 2000. The selection of the sub-catchments is based on the results of the Transboundary Analysis within the UNDP/GEF Danube Pollution Reduction Programme (1999) and is not related to the subdivision of the Danube river basin within the framework of the WFD.

Additionally the table includes the results of the estimated point source discharges for nitrogen and phosphorus. The base for this study was data on the total point source nutrient emissions from municipal wastewater treatment plants (WWTPs) of Germany, Austria, Slovak Republic and Hungary. For the other countries the total point source discharges were estimated from the ICPDR Emission Inventory and additional data for total national point source emissions.

Table 4: Municipal, industrial and agricultural point source discharges of COD, BOD, total nitrogen and phosphorus from significant sources according the criteria of Table 2 (based on ICPDR Emission Inventory data of 2002)

Sub-catchment	**COD** t/a	**BOD** t/a	**N** t/a	**P** t/a
Municipal sources				
01 Upper Danube	3,100	550	2,200	80
02 Inn	1,037	160	288	30
03 Austrian Danube	604	130	248	14
04 Morava	898	100	189	20
05 Váh-Hron	14,899	4,248	2,102	349
06 Pannonian Central Danube	94,759	32,304	11,618	1,495
07 Drava-Mura	14,970	5,802	2,291	418
08 Sava	83,649	37,102	6,005	1,358
09 Tisza	37,507	14,327	4,883	1,029
10 Banat-Eastern Serbia	13,261	4,247	2,679	619
11 Velika Morava	na	na	na	na
12 Mizia-Dobrudzha	64,057	29,149	5,064	1,254
13 Muntenia	59,917	29,861	15,602	1,844
14 Prut-Siret	25,314	9,869	2,751	215
15 Delta-Liman	744	272	50	4
16 Romanian Black Sea Coast	10,297	2,801	910	87
Total DRBD	425,013	170,922	56,880	8,816
Industrial sources				
01 Upper Danube	7,346	49	20	8
02 Inn	8,469	375	305	20
03 Austrian Danube	4,825	196	12	9
04 Morava	1,911	136	130	19
05 Váh-Hron	8,294	2,681	96	4
06 Pannonian Central Danube	16,424	3,515	352	13

Sub-catchment	COD t/a	BOD t/a	N t/a	P t/a
07 Drava-Mura	29,718	6,083	185	52
08 Sava	33,965	6,772	310	374
09 Tisza	16,622	3,315	331	32
10 Banat-Eastern Serbia	1,158	120	20	2
11 Velika Morava	na	na	na	na
12 Mizia-Dobrudzha	9,244	na	na	na
13 Muntenia	16,173	5,166	2,312	5
14 Prut-Siret	4,456	903	136	1
15 Delta-Liman	982	na	24	15
16 Romanian Black Sea Coast	842	242	390	na
Total DRBD	160,427	29,555	4,625	555
Agricultural sources				
07 Drava-Mura	2	1	na	1
08 Sava	191	41	107	3
09 Tisza	2,263	579	749	na
10 Banat-Eastern Serbia	357	104	57	16
13 Muntenia	2,040	1,085	881	57
14 Prut-Siret	285	1,074	326	5
15 Delta-Liman	901	206	na	na
Total DRBD	6,039	3,089	2,121	82

Na – not available

5.4. Nutrient Pollution

5.4.1. Introduction

The most relevant impact of high nutrient loads is *eutrophication*. This has been defined by the EC 'as *the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned*[11]'. This accelerated growth of algae can cause depletion of the dissolved oxygen concentration with consequential impact on other biological species.

The main sources of nutrients within the Danube Basin have been identified as point sources (principally municipal wastewater treatment works) and diffuse sources (principally agriculture).

Impacts from nutrients can mainly be seen in the receiving coastal waters of the Black Sea but also in many lakes and groundwater bodies throughout the basin. While in rivers nutrients generally cause fewer problems due to turbulent flow conditions, some slow flowing river stretches such as the middle Danube, impounded river sections, the Danube Delta and lakes show effects of eutrophication.

[11] EU Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment (UWWT-Directive).

Overall, nutrient loads into the Danube basin have significantly decreased over the past 20 years, however, they are still well above the levels of 1955. In the future there is a threat that this improvement in the reduction of nutrient pollution may be lost because of an increase in diffuse pollution from agriculture.

The economic development in the middle and lower parts of the Danube region will inevitably increase diffuse nutrient inputs. It should be ensured that best environmental and agricultural practices are being developed and applied in order to create a sustainable agriculture in the long term. In this respect, there is still room for reduction of nutrient loads in the upper part of the Danube basin. The EU Common Agriculture Programme has recently been reformed to provide direct assistance on rural development issues that are environmentally friendly whilst removing some of the historic inducements for over production by farms. The impact of this has still to be established.

For the development of the Danube Basin Analysis report a risk assessment approach was adopted to identify those water bodies at risk of not meeting the WFD's ecological 'good status' criteria. It was not possible to define common criteria for risk assessment for nutrient pollution, on the basin-wide level, due to the heterogeneity of the surface water types. Almost all countries used chlorophyll a to define threshold values for the risk assessment. In some countries, threshold values for nutrients (phosphorus and nitrogen) were used as alone-standing criteria or as a supplement to chlorophyll a values. Special attention was given to the dislocation effects between the source of pollution and the impact area. The recognition of past high risk, lower current risk, and potential increase of risk in the future, was integrated in the analysis.

5.4.2. Transboundary importance of nutrients in the Danube River Basin

The main concern of nutrients as a priority issue within the Danube Basin is the impact (eutrophic status) on the northwest shelf of the Black Sea. A comparison of the total **emissions** of N and P in the Danube River Basin with the river **loads** to the Black Sea, indicate an apparent *loss* or *storage* of the nutrients in the Danube Basin. Loss processes imply the permanent removal of nutrients from the hydrosphere, while storage processes are of a temporal nature: remobilisation may be relevant depending on the time scale under consideration.

Loss and storage processes are concentrated in the small river systems, where there is an intensive contact between the water and the aquatic sediments and wetlands. In this respect a natural river system with wetlands and floodplains is more efficient than a strongly canalised (artificial) one. The River Danube and its main tributaries play a minor role for nitrogen losses due to the significant hydromorphological alterations that have occurred resulting in the loss of 'lateral connectivity' to wetlands. In respect to phosphorus the Iron Gate backwater area represents a *major storage* area due to net sedimentation of P in particles. Recent research indicates that about 1/3 of the incoming load is semi-permanently stored. It can be expected that this storage function is limited in time (< 100 years).

The losses and storage of nutrients in the small-scale river networks in the Danube Basin show strong geographical differences. This is the result of the natural morphological and hydrological gradients in the basin. Generally speaking, areas with a relatively high specific runoff show relatively low losses and storage and consequently convey a relatively high share of the nutrient emissions downstream.

5.4.3. Drivers and Pressures [12] for Nutrient Pollution

Drivers of Nutrient Pollution

The main drivers for excess nutrients in the Danube River Basin have been identified and assessed in the TDA prepared in 1999. These can be summarised as:

- Agriculture;
- Municipalities;
- Industry.

Pressures / Stress[13] from Nutrient Pollution

These drivers result is pressures or stress on the environment. The pressures are predominately from diffuse (non-point) sources of nutrients (for example, inappropriate storage of manure) and from point sources (for example, inadequate treatment of municipal and industrial wastewater).

Extensive use was made of the modelling tool MONERIS during the data assessment for the Danube Basin Analysis. This model enabled assessments to be made in the absence of sufficient measured data and allowed an evaluation of both sources and pathways of nutrients to the river environment to be estimated.

The estimated contribution of phosphorus and nitrogen emissions from all sources (including point and diffuse sources) is shown in Figure 5. In general, the portion of point sources to the total nutrient emissions is higher for phosphorus than for nitrogen. The share of background contributions is higher for phosphorus than for nitrogen. That means that the total human influence on the nutrient pollution of the Danube is much higher for phosphorus than for nitrogen.

The relation between different human sources/activities to the total emissions is important to understand. For the Danube basin the share of the different human sources compared to the total nutrient pollution is shown in Figure 5.

5.4.3.1. Historical development of the diffuse source nutrient pollution into the Danube River system

A historical look at the development of the Danube nutrient emissions from point and diffuse sources over the last 50 years has been prepared based on the results of the present situation, and a reconstruction by means of the model MONERIS. Figure 11 and Figure 12 show the results.

The MONERIS Model

The nutrient emission Model **MONERIS** (**MO**delling **N**utrient **E**mission in **RI**ver **S**ystems) was developed and applied to estimate nutrient inputs into river basins of Germany by point sources and various diffuse pathways. MONERIS estimates the different pathways using existing approaches as well as new conceptual approaches developed especially for modelling at medium and large spatial scales. It also considers retention of nutrients in rivers basins. Due to the limited and often inconsistent data available for large-scale modelling, MONERIS was designed to work with information collated from standard monitoring programs or available from federal bureaus. MONERIS has been applied extensively to river basins in the Baltic catchment and in all of Germany, and the Danube River Basin
The model is **based on**:

[12] Underlying and immediate causes
[13] In GEF terminology

- data of river flow (from gauging stations)
- water quality (nutrient concentrations from monitoring stations)
- statistical data about nutrient inputs into the catchment
- geographical data (stored and analysed in a Geographic Information System (GIS)

The model is composed of a series of equations that allow the estimation of point sources and diffuse sources into the stream.
For the catchment defined for a particular application of the model, MONERIS will estimate the loads emitted through each of the **point sources** (direct discharges, waste water treatment plant effluents), and through a series of **diffuse pathways** (see Fig. 1: MONERIS diagram), including:

- atmospheric deposition
- erosion
- surface runoff
- groundwater
- tile drainage
- paved urban areas

Along each of these pathways from the source of the emission to the river, substances experience processes of transport, transformation, retention and loss. Knowledge of these processes is necessary to quantify and predict nutrient emissions into the river. MONERIS encapsulate knowledge of those processes.

MONERIS produces estimates of annual load through each of the defined point and diffuse pathways. It estimates nutrient retention and loss within the river system itself (i.e., the stream's self-purification processes). The **final output** is an estimate of annual nutrient load in the river at the outlet of the study catchment, which is equal to the emissions into the river via point and diffuse sources *minus* the estimated nutrient retention and loss within the river system.

MONERIS can help managers identify pathways that contribute significantly to nutrient loads and should be targeted for **management** practices aimed at nutrient emission reduction. Combined with geographic information in a GIS, it can help identify **hot spots** within the catchment -- particular areas that, due to a combination of high potential emission and a susceptibility to efficient transport, contribute nutrients significantly more that other areas. Once MONERIS has been calibrated for a particular catchment, it can be used to develop management **scenarios**. For example, a manager can ask by how much nutrient emissions into the river would be reduced under a scenario of erosion control.

According to Figure 11 the diffuse source pollution of nitrogen is about doubled in the period in the 1950s to the mid of 1980s. In the 1990s this pollution is reduced by about 23 % mainly due to the reduction of the land use intensities as represented by the N-surplus on agricultural areas. The reduction of the nitrogen surplus is much larger, especially for the countries in the middle and lower part of the Danube, than the reduction of the diffuse nitrogen sources. This is due to the differences in the residence time in the groundwater and the different retention rates for nitrogen in the unsaturated zone and in the groundwater. The large residence times in the groundwater are responsible for the fact that a further reduction of the diffuse nitrogen emissions can be assumed in the next years if the N-surplus will remain on the present level.

The present level of the diffuse nitrogen emissions into the Danube river system is about 1.8 times higher than in the 1950s. One reason for the change of the total nitrogen emissions is the change of the point source discharges. The increase from the 1950s to the end of the 1980s is approximately a factor 5 and the decrease within the 1990s is about 20 %. This is due to a decrease in the number of industrial discharges in the lower Danube countries after the political changes and substantial improvement of wastewater treatment especially in Germany and Austria.

For total N-emissions, it was found that the present state is a factor of 1.8 higher than in the 1950s but about 23 % lower than in the late 1980s.

For phosphorus the changes in the amount of diffuse source pollution is much lower than for nitrogen. This is because, other pathways (erosion and surface runoff) are more responsible for the diffuse P-emissions into the river system. In addition, the main indicators for the diffuse P emissions as a portion of arable land were changed in the past to a lesser extent than the N-surplus.

Further it should be noted that important parameters for changes of diffuse P-emissions by erosion over time, such as the change of the field size in the different regions of the Danube basin, are not available up to now.

If these uncertainties in the database and for the modelling are taken into account, the present level of diffuse P emissions into the Danube river system is probably more than 20 % above the level of the 1950s.

Changes in the amount of point source discharges of phosphorus are much higher than for the diffuse sources. For P, an increase by a factor of 4.6 was estimated from the 1950s to 1990.

This development in the amounts of P from point sources is the result of two overlapping effects - increase of the use of P in detergents and an increase in connection of population to sewers and WWTPs. The decrease of the point P emissions is due to the replacement of P in detergents to a high proportion and the increase of P elimination in WWTPs. The consequence is that the reduction of point P emissions is more than 50 %. The present level in the upper Danube is already in the range of the 1950s. The change of the total P emissions is larger than for nitrogen. A reduction of about 40 % during the 1990s was estimated and the present level of the total P emissions is a factor 1.6 higher than in the 1950s. The reconstruction of the historical changes of the sources of nutrient pollution in the Danube shows that in the last decade a substantial reduction of nutrient pollution was reached in the Danube.

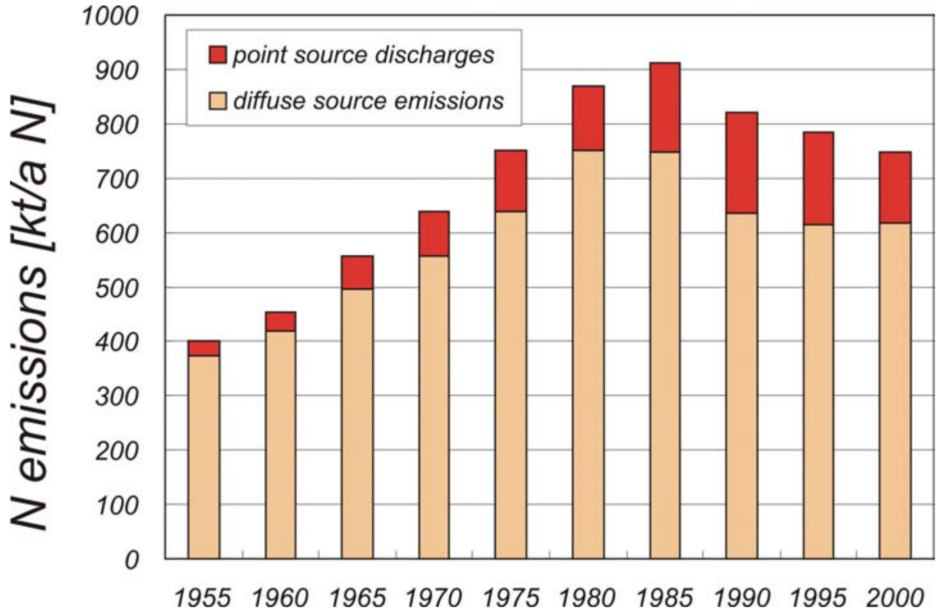


Figure 11: Temporal changes of the nitrogen emissions into the total Danube river system for the years 1955 to 2000 (MONERIS)

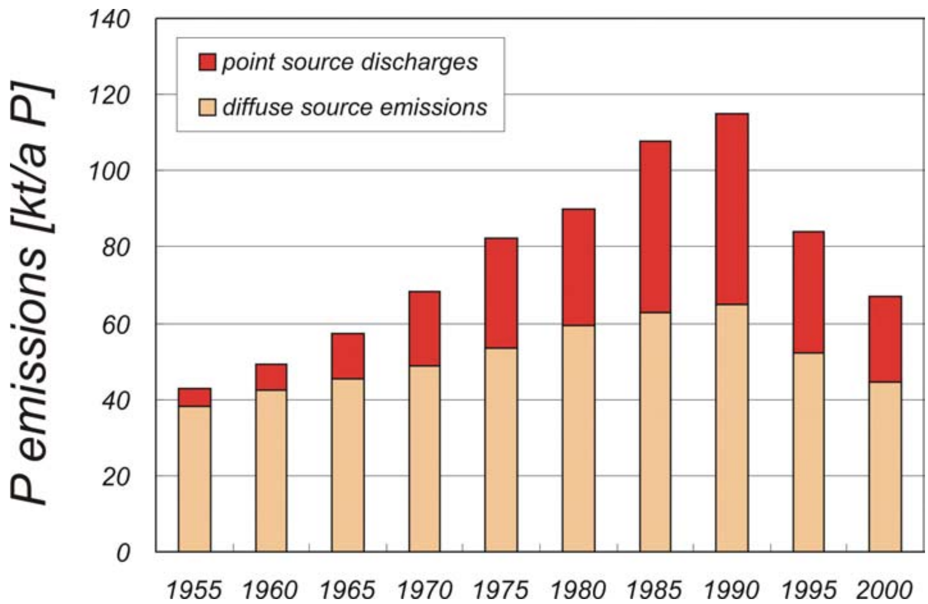


Figure 12: Temporal changes of the phosphorus emissions into the total Danube river system for the years 1955 to 2000 (MONERIS)

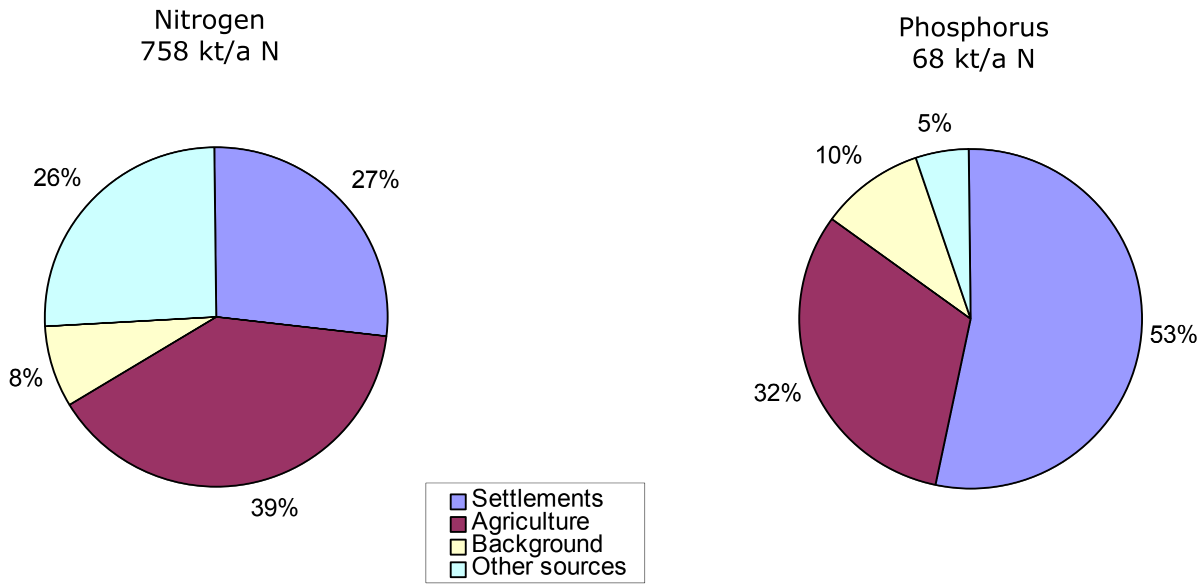


Figure 13: Total estimated nutrient emissions for the Danube river basin in the period 1998-2000; result of the MONERIS application for the WFD Danube River Basin Analysis Report

5.4.3.2. Point Source Pressures

The ICPDR Emission Inventory is the key database for the assessment of emissions from point sources on the basin-wide level. It includes the major municipal, industrial and agricultural point sources and identifies the total population equivalents of the municipal wastewater treatment plants, the industrial sectors of the industrial wastewater treatment plants, and the types of animal farms for the agricultural point sources. In addition, it includes information on the receiving water and data on some key parameters of the effluent such as BOD, COD, P and N.

The analysis of the point source pollution in the Danube River Basin district requires the availability of complete inventories of point sources with data of high and homogenous quality covering the whole catchment area. This analysis is based on the ICPDR Emission Inventory.

From the MONERIS model the main sources of nitrogen and phosphorus are show in Figure 13. For Nitrogen, the main source is agriculture and settlements are the main source for phosphorus. A summary of the main point sources of pollution in the Danube River Basin is presented in Table 3.

5.4.3.3. Diffuse source pressures

The main sources of diffuse pollution originate from agriculture. A detailed assessment of the land-use within the Danube Basin was undertaken in the Danube Basin Analysis report. Whilst intensive agriculture declined significantly after the collapse of the Eastern European economies in 1989 this sector is still considered to be the main contributor of nutrients (in particular nitrogen) to the Danube River. In addition the threat from increasing agriculture as the economies recover together with the EU CAP and its impact on the environment is a concern.

The model MONERIS was utilised to quantify the pathways of nutrients from diffuse sources. For each pathway of diffuse sources, the model takes into account the special natural conditions, which determine the retention and losses from the origin to the point of input into the river systems. As shown in Figure 6 the total diffuse nutrient pollution into the Danube river system was estimated to be 624 kt/a nitrogen and 45 kt/a phosphorus.

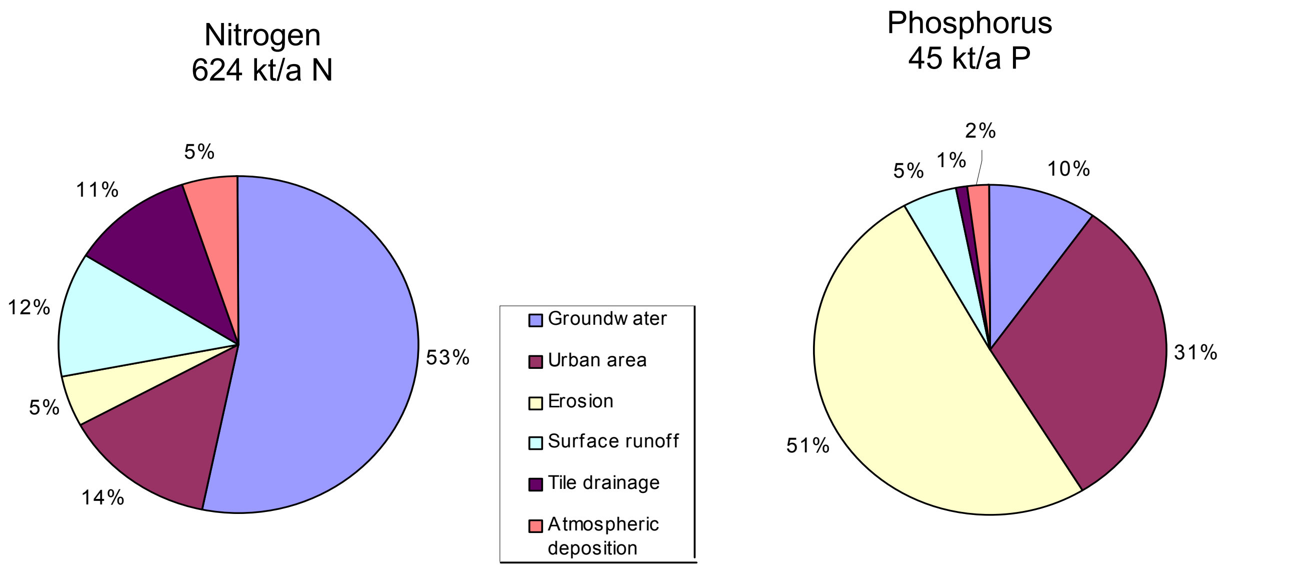


Figure 14: Estimated diffuse nutrient pollution by pathways for the total Danube river systems for the period 1998 to 2000 from the MONERIS model for the WFD Danube River Basin Analysis Report

Under the DRP the MONERIS model was updated to collect more recent information on nutrients and to utilise the same catchment boundaries as the countries used for WFD reporting. Preliminary data on total P and total N emissions within the DRB are shown on Figure 15 and Figure 16. This data could assist with the future prioritisation of actions within the basin to mitigate emissions of N and P.

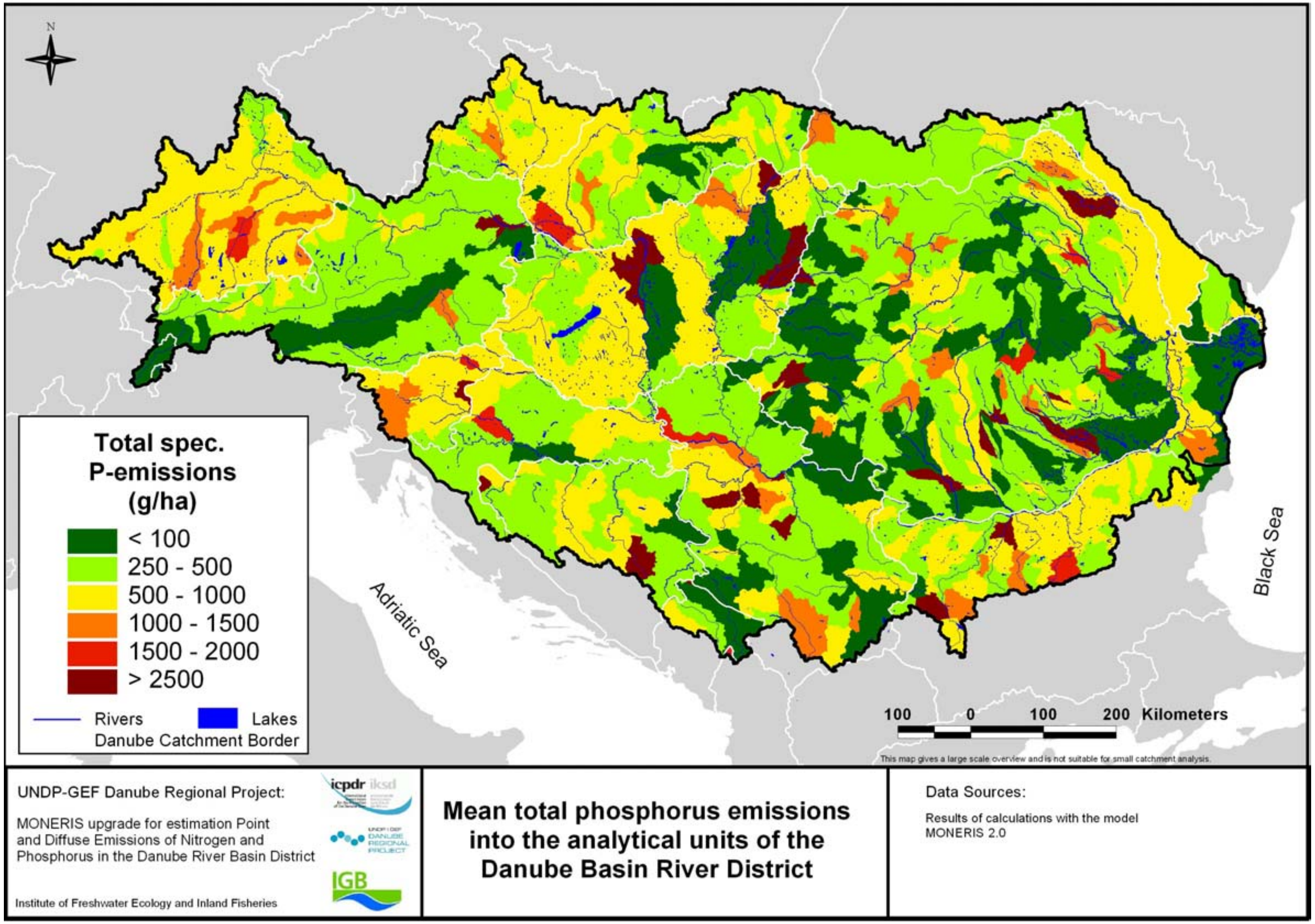


Figure 15: Mean total Phosphorus emissions into the analytical units of the Danube Basin River District

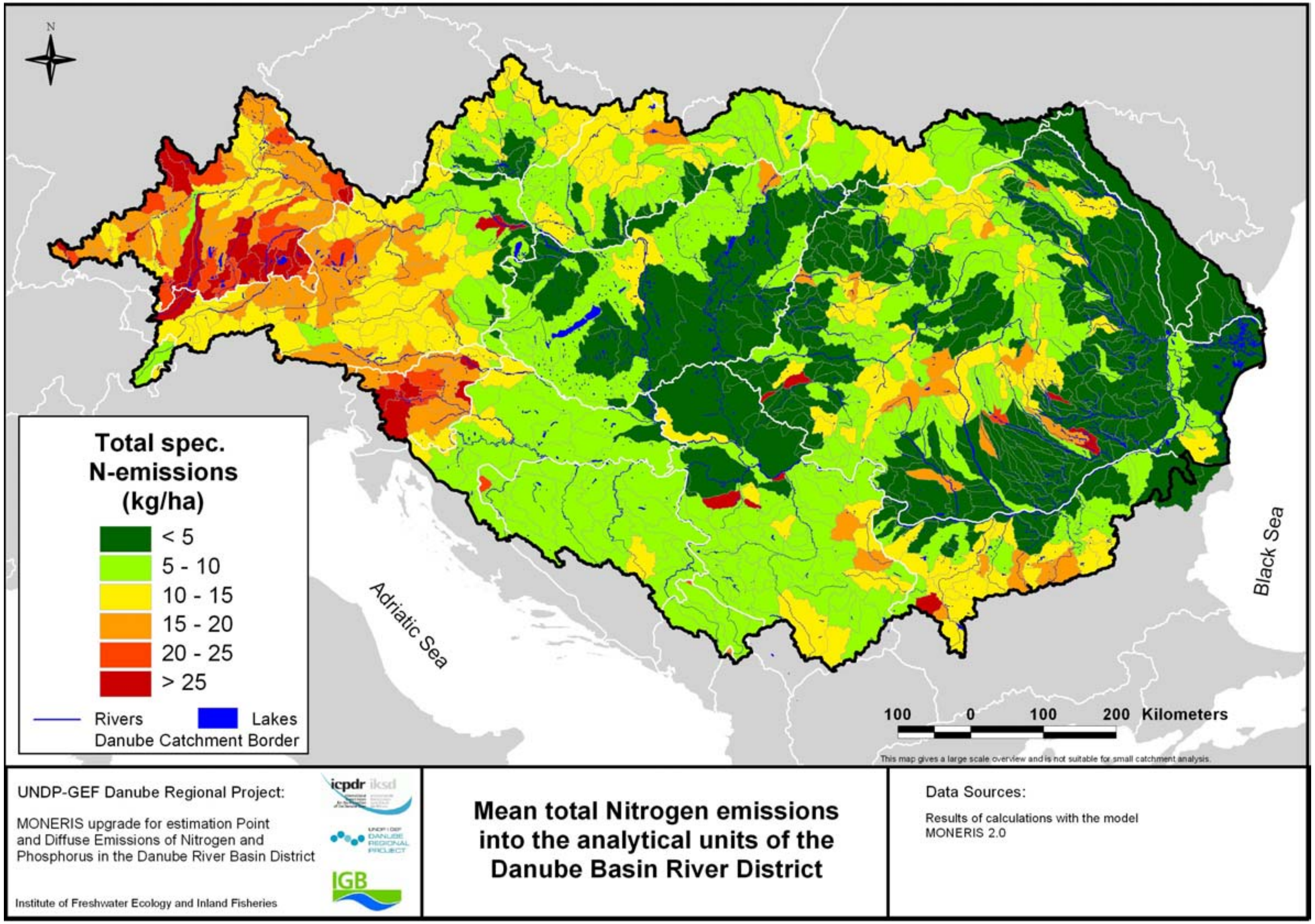


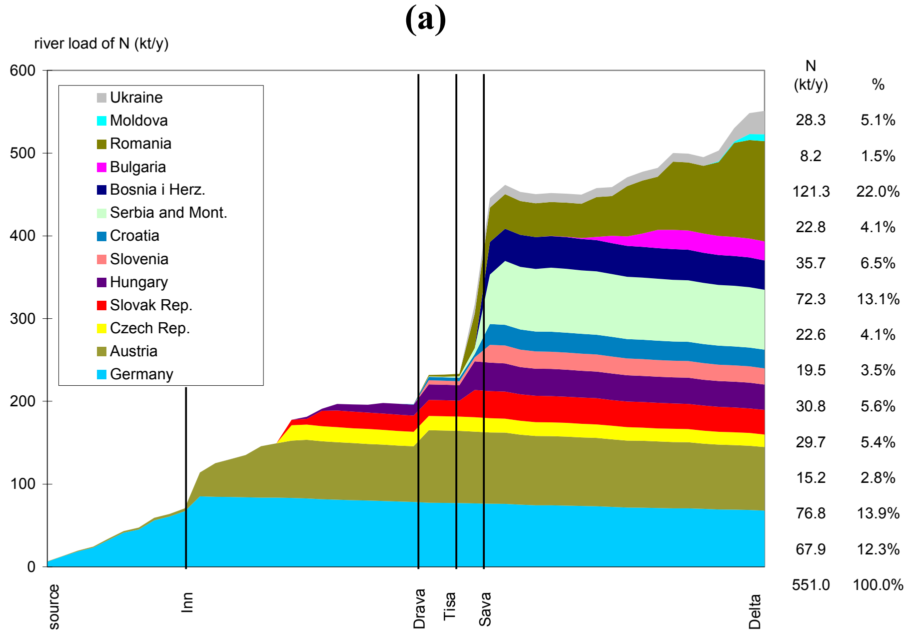
Figure 16: Mean total Nitrogen emissions into the analytical units of the Danube Basin River District

5.4.4. Environmental Impacts of Nutrient Pollution in the Danube River Basin

The main impact of nutrients from the Danube River Basin is on the northwest shelf of the Black Sea (see section 5.8). Within the basin the environmental impacts are evaluated through the use of environmental indicators or surrogates that are measured (e.g. nitrogen, phosphorus, chlorophyll a etc.) and these are used to provide an analysis of the status and an estimation of likely impacts on the Black Sea.

The initial Danube TDA (prepared by the UNDP/GEF Danube Pollution Reduction Programme, 1999) on nitrogen and phosphorus loads provided longitudinal profile along the River Danube of the in-stream load of N and P. The results (Figure 7) show that certain countries contribute relatively strongly to the annual water volume: as a result of the basin morphology and of the climatic conditions, the area specific run-off is high in those countries (e.g. Austria, Germany, Slovenia and Bosnia i Herzegovina). Other countries have a low area specific run-off (e.g. Hungary). These natural variations are reflected in the river load profiles for N and P. The areas with a high specific run-off have a relatively high contribution, while the areas with a low specific run-off have a relatively low contribution. The load profile for P shows a strong decrease in the Iron Gates area as the sediment-associated P is deposited at this location.

(a)



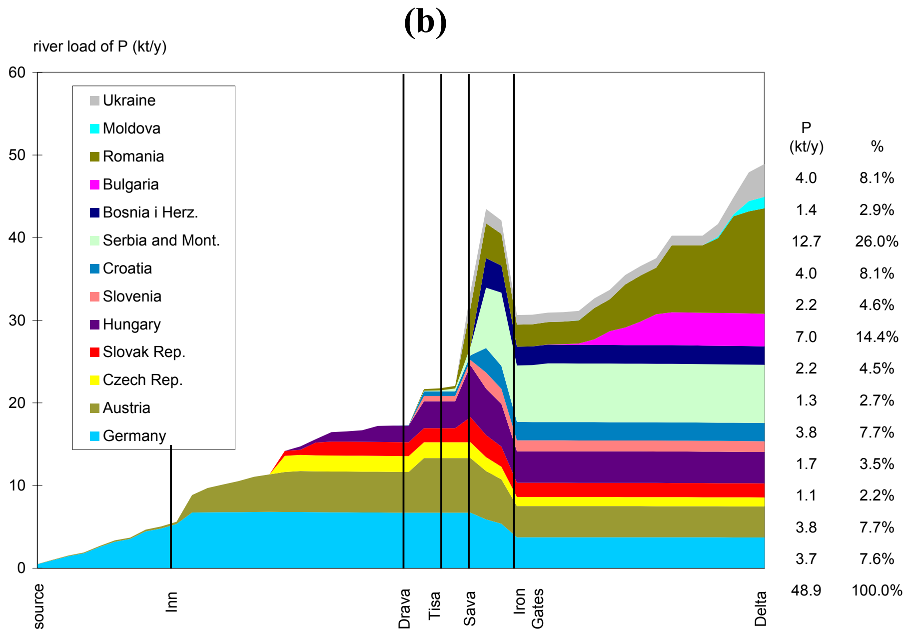


Figure 17: River load profiles of nitrogen (a) and phosphorus (b), subdivided over countries of origin – derived from simulations with the Danube Water Quality Model (DWQM) during the GEF-UNDP Danube Pollution Reduction Programme, 1999 UNDP/GEF (1999a)

The 2003 TNMN Yearbook assesses the concentrations of chlorophyll-ɑ. This parameter represents the amount of live phytoplankton in the surface water and is generally considered to be an indicator for eutrophication. The Yearbook presents the most recent information on impacts (2003) in an aggregated form, indicating the classification of the observed concentrations of chlorophyll-ɑ in 5 classes. Class I represents the lowest concentrations and Class V represents the highest values. The summary chart is presented in Figure 18. This graph indicates that there is a large data availability problem: more than 60 % of the stations are classified as "no data". The available data indicate eutrophication problems in the slow-flowing and relatively shallow reaches of the Middle Danube (in Hungary). The Joint Danube Survey results also point in this direction (see Figure 19). This survey in August-September 2001 indicated a strong algae bloom in the Hungarian part of the Danube and to a lesser extent in the upper part (DE-AT) of the basin.

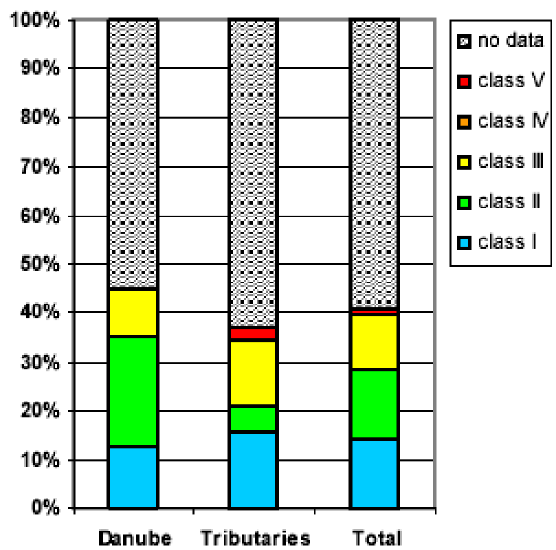


Figure 18: Information related to the concentrations of chlorophyll-ɑ in the Danube and its large tributaries, on the basis of TNMN field data from 2003

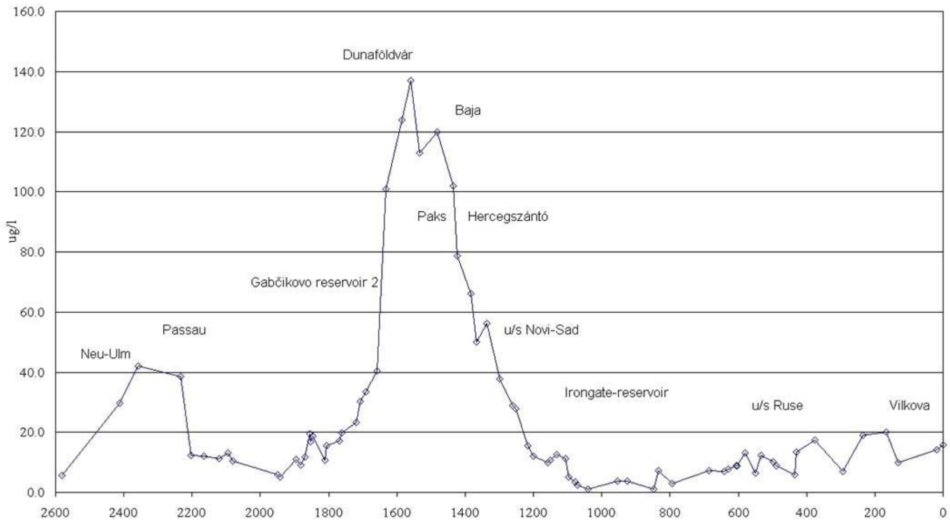


Figure 19: Concentrations of chlorophyll-α [µg/l] in the Danube River on the basis of field data collected during the JDS

5.4.5. Knowledge gaps

The key issues that should be addressed in the future include:

- Improved monitoring of concentrations and loads of nutrients (including the routine measurement of all forms of nitrogen and chlorophyll a);
- Enhancing the performance of the MONERIS model;
- Providing estimates on the timescales for recovery of the basin – in particular associated with nitrogen in groundwaters;

5.5. Organic Pollution

5.5.1. Introduction

Organic pollution refers to species that create a demand on oxygen to degrade these species. Typically, these arise from human and animal waste, and industrial processes such as food industry. The main impact of 'organic pollution' is the consequential depletion of the dissolved oxygen concentration in water and the impact this has on biological species.

The absence of wastewater treatment plants or the failure of these to operate effectively is the main reason for 'organic pollution' being identified as one of the four key issues within the Danube Basin Analysis. The reduction of this pollution is mainly an issue of investments and the construction or upgrading of wastewater treatment plants. Under the EC DABLAS programme the ICPDR has developed a list of priority needs for investments throughout the basin.

In surface waters, the loads of organic pollution are still unacceptably high in most of the Danube tributaries and in some parts of the Danube River. The discharge of untreated or insufficiently treated wastewater from municipal, industrial and agricultural sources are widespread, in particular in the middle and lower part of the basin. The indicators for impact from organic pollution show that the water quality is significantly affected, the major cause being insufficient treatment of wastewater from municipalities.

The Danube shows an increase in organic pollution (expressed as BOD5 and COD-Cr) from upstream to downstream, reaching its maximum between Danube-Dunafoldvar (rkm 1560, below Budapest) and Danube-Pristol/Novo Selo (rkm 834, just below the border of Serbia and Montenegro, and Bulgaria). Here the target values are frequently exceeded. In parallel, the dissolved oxygen concentrations show a decrease from the upper to the lower Danube, showing also clearly the influence of the two major reservoirs, Gabcikovo and the Iron Gates. The biological impact assessment is mainly based on the Saprobic System to detect biodegradable organic pollution. According to the Saprobic System, the Danube is classified as "moderately polluted" (Class II) to "critically polluted" (Class II-III).

The tributaries are in part highly polluted. This can be seen from highly elevated values for degradable organic matter (expressed as BOD5) and for organic matter with low degradability (expressed by COD-Cr). In some tributaries also the oxygen content is significantly lower than in the main course of the Danube, e.g. in the Arges River (see Figure 5: Risk of Failure to Reach Environment Objectives – Organic Pollution).

5.5.2. Drivers and Pressures of Organic Pollution[14]

Drivers of Organic Pollution

The main drivers for organic pollution are:

> Municipalities;
> Agriculture;
> Industry (predominately food processing)

Pressures from Organic Pollution

The main sources of organic pollution are inadequate municipal and industrial wastewater treatment and poor agriculture practices (for example, manure handling and storage for diffuse sources, and no treatment for intensive animal farms as point sources).

5.5.3. Environmental impact

The impact of organic pollution is to cause depletion in the dissolved oxygen concentration with consequential impact on biological species. In the absence of routine measurements on biological species it is common to monitor key indicator species that provide an estimation of organic pollution. The main indicators of the impact of organic pollution are:

> Dissolved oxygen concentrations (and percent saturation)
> BOD_5 and COD measurements;
> A measure of biological quality parameters or impact assessment (e.g. Saprobic index).

The implementation of the WFD monitoring requirements (2007 onwards) will result in a better understanding of the ecological quality of water bodies providing a more direct estimation of the impact of organic (and other) pollution.

[14] Underlying and immediate causes

5.5.3.1. Dissolved Oxygen

Summarizing the spatial distribution of the mean values of DO the following observations are presented:

- A decreasing tendency of the dissolved oxygen content downstream the Danube River was recorded.
- In the upper Danube section, the dissolved oxygen values increase from Danube-Neu Ulm (rkm 2581) to Danube-Wien-Nussdorf (rkm 1935). In this stretch, all concentrations are above 8.5 mg/l and no value is below the target limit which indicates a positive situation;
- In the middle stretch, the oxygen concentrations are slightly lowers then those in the upper part. A uniform pattern is present along this stretch, with no value below the target limit;
- Decreased concentrations appeared in the areas influenced by the two major reservoirs (Gabcikovo – slight decrease at rkm 1806 and Iron Gates – a significant decrease downstream of rkm 1071);
- In the lower part only three values were below the target value at rkm 834;
- In the tributaries, the dissolved oxygen content generally decreases from those located in the upper area to those located in the lower part;

5.5.3.2. Biochemical Oxygen Demand (BOD_5)

BOD5 characterizes the oxygen demand arising from biological activities. High BOD5 values are usually a result of organic pollution caused by discharges of untreated wastewaters from treatment plants, industrial effluents and agricultural run-off. Generally, it can be said that BOD concentrations less than 2 mg/l O2 are indicative of relatively clean rivers and concentrations higher than 5 mg/l O2 are signs of relatively polluted rivers.

According to TNMN data, BOD5 values varied during 1996 – 2000 in a range of 1.4 – 8.2 mg/l O2 in the Danube River and 1.8 – 60.5 mg/l O2 in the major tributaries. This means that 13.3% of values were above the target value (5 mg/l O2) in the Danube River (mainly in the middle and in the lower sections) and 35.9% in the major tributaries.

The spatial distribution of the mean values of BOD5 in the Danube River shows that the profile is relatively scattered, with a concentration maximum located in the middle stretch of the Danube. In the tributaries, the BOD5 values indicate a higher content of biodegradable organic matter occurring in the Morava, Dyje and Sio in the upper and middle Danube section and in the Yantra, Russenski Lom, Arges and Siret in the lower Danube.

5.5.3.3. Impact assessment (Saprobic index)

As the benthic invertebrates are sensitive to the presence of the organic compounds in water, the analysis of macrozoobenthos in the aquatic ecosystem provides useful information on the impacts of organic pollution.

The results of the macrozoobenthos analysis presented in this chapter are based on the biomonitoring procedures agreed within the ICPDR. The Saprobic index system is based on a classification of water quality using seven biological quality classes. Similar to the chemical water classes, water quality class II (moderately polluted) indicates the general quality objective.

Macrozoobenthos was analysed also during the Joint Danube Survey (2001) and the results obtained showed that:

> The saprobity of the Danube varied between water quality class II (moderately polluted) and II/III (critically polluted). Taking into account that the saprobic index is also influenced by the habitat structure (for example, comparison of free-flowing stretches to impounded areas), the Danube showed good water quality (class II) all the way to Budapest.

> Downstream of Budapest, where the Danube passes through the Hungarian Lowlands, water quality often decreased to class II-III, indicating significant organic pollution. Taking into account the high chlorophyll-a values as well as the extreme over-saturation with oxygen in this reach, secondary pollution caused by an elevated phytoplankton biomass, which usually leads to an increase in saprobity, was clearly recognisable.

> Downstream of Belgrade to the Iron Gate reservoir, water quality varied between class II and II-III. Signs of pollution began to appear, and there were significant differences in the saprobity of the samples collected from the left and right banks of the Danube, which seemed to be due to the pollution effects of the discharging tributaries. Only the impounded reach upstream of the Iron Gate Dam showed saprobity values below the limit for water quality class II.

> In the Lower Danube reach, especially down-stream of big cities, discharges seemed to result in an increase in the level of bacteria and detritus feeders. Comparing the Upper and Lower Danube in terms of the sum of abundances, the lower section of the Danube was clearly marked by a significant decrease in biodiversity. Arms and tributaries of the Danube were found to be more polluted than the River itself and even reached water quality class III (strongly polluted) or higher.

Almost the same pattern of water quality assessment is provided by the Joint Danube Survey data. Thus, the results obtained show that the saprobity of the Danube varied between water quality class II (moderated polluted) or II/III (critically polluted).

5.5.4. Knowledge gaps

There are relatively few gaps in information from organic sources within the basin. It is clear that organic pollution originating via point sources (and diffuse sources) from human settlements and intensive farms are a problem.

Additional steps should focus on the improvement of the Analytical Quality Control System and the development of ecological classification systems.

At present the methods for biological assessment are not sufficient to provide a detailed assessment of the ecological quality of water bodies.

5.6. Contamination with hazardous substances

5.6.1. Introduction

The EU Water Framework Directive defines the term ‘hazardous substances’ as substances or groups of substances that are toxic, persistent and liable to bio-accumulate; and other substances or groups of substances that give rise to an equivalent level of concern. Exposure to excessive loads of hazardous substances can result in a series of undesirable effects to the riverine ecology and to the health of the human population. Hazardous substances may affect organisms by inhibition of vital physiological processes (acute toxicity), or they may cause effects threatening population on a long-term basis (chronic toxicity).

Hundreds of hazardous substances are being used and released into the Danube River Basin. Pollution from hazardous substances is significant although the full extent cannot be evaluated to date. There are only few data available for some hazardous substances such as heavy metals and pesticides, which indicate the transboundary scale of the problem. Cadmium and lead can be considered as the most serious heavy metals exceeding the target values considerably in many locations on the lower Danube. Also, pesticides show alarming concentrations in some tributaries and in the lower Danube. It will be necessary to improve the data base on pressures and impacts from hazardous substances, e.g. through further development of the existing inventories such as the European Pollutant Emission Register to a comprehensive European Pollutant Release and Transfer Register. Despite the "knowledge gap" it is essential that measures for the introduction of "best available techniques" and "best environmental practices" are being developed without delay, otherwise it will be impossible to achieve "good ecological" and "good chemical status". Altogether 33 priority substances are listed by the WFD, which has been accepted by the ICPDR as a basis for establishing the Danube List of Priority Substances.

5.6.2. Drivers and Pressures[15] of Hazardous Substance pollution

Drivers of Hazardous Substance Pollution

The main drivers resulting in hazardous substance pollution are:

- Industry
- Agriculture
- Transport.

Pressures / or Stress from Hazardous Substance Pollution

The pressures/stresses from hazardous substance pollution derive from both point and diffuse sources. These can be summarised as:

- The inappropriate use or storage of agro-chemicals;
- Industrial processes with inadequate wastewater treatment;
- Accidental spills of leakages of chemicals;

The data on releases of hazardous substances in the Danube River Basin is relatively scarce, the Emission Inventories provide only very limited information. According to the Inventory of Agricultural Pesticide Use, performed in 2003 within the UNDP/GEF DRP, the use of pesticides has declined significantly in most of the countries of DRB. Data from the FAO database (Table 5) show a strong decline in pesticide use in the CEE countries to about 40% of 1989 levels compared to a relatively small decrease in EU Member States during the same period. The most applied pesticides are Atrazine, 2,4-D, Alachlor, Trifluralin, Chlorpyrifos and copper containing compounds. There are indications, however, that the use of pesticides in the CEE region increases again and that this tendency might be accelerated after the enlargement of the EU.

[15] Underlying and immediate causes

Table 5: Consumption of pesticides (in t/a) in some Danube countries and specific pesticide consumption (kg per ha agric. area and year) in 2001 according to the FAO database on agriculture

Pesticide category	DE	AT	CZ	SK	HU	SI	RO
	t/a	t/a	T/a	t/a	t/a	t/a	t/a
Fungicides and bactericides	7,912	1,336	1,050	537	1,637	921	2,802
Herbicides	14,942	1,436	2,590	2,136	3,149	362	3,960
Inorganics	1,959	99	272	0	684	504	0
Insecticides	1,255	0	157	175	298	81	1,110
Rodenticides	80	1	162	34	20	19	0
Total	26,148	2,872	4,231	2,882	5,788	1,887	7,872
Pesticide consumption	kg/ha·a	kg/ha·a	kg/ha·a	kg/ha·a	kg/ha·a	kg/ha·a	kg/ha·a
Specific pesticide consumption per ha agricultural area and year	1.53	0.82	0.99	1.18	0.94	3.77	0.53

Figure 21 and Figure 22 indicate Accident Risk Spots (based on industrial activities) and contaminated sites in flood risk areas respectively.

5.6.3. Environmental impacts of hazardous substances

The environmental impacts of hazardous substance pollution are on the aquatic life and potentially in the drinking water supply and human food chain. In the absence of effective impact assessment on biological communities environmental impacts of hazardous substances are estimated through the measurement of specific chemical species in water, sediment and biota.

5.6.3.1. Heavy metals

For most of the monitored heavy metals the general pattern of their occurrence is an increase from the upper to the lower part of the Danube. Many of the tributaries have elevated levels of heavy metals, particularly in the lower Danube.

Based on the evaluation of TNMN data from years 1996 – 2000 using the interim classification the following conclusions can be drawn on the content of the total heavy metals:

- The content of lead, copper and cadmium in the Danube mainstream is rather high having 57 % of the results for lead and copper and 47 % of the results for cadmium above the target limit; the situation in the tributaries is slightly better - 53% results exceeded the target value for lead, 22 % for copper and 32 % for cadmium (target value for total Cu is 20 µg/l, for total Pb is 5 µg/l and for total Cd is 1 µg/l).
- Due to the lack of data for mercury in the lower Danube a comprehensive picture cannot be given, however, it is worth mentioning that altogether 63 % of the results from tributaries were above the ICPDR limit of 0.1 µg/l.
- Pollution of the Danube mainstream and its tributaries by arsenic, chromium, nickel and zinc can be considered as low. However, the lack of data for these heavy metals in the lower Danube section has to be mentioned.

The overview of classification of the TNMN results from the year 2001 for cadmium and mercury is shown in Figure 20.

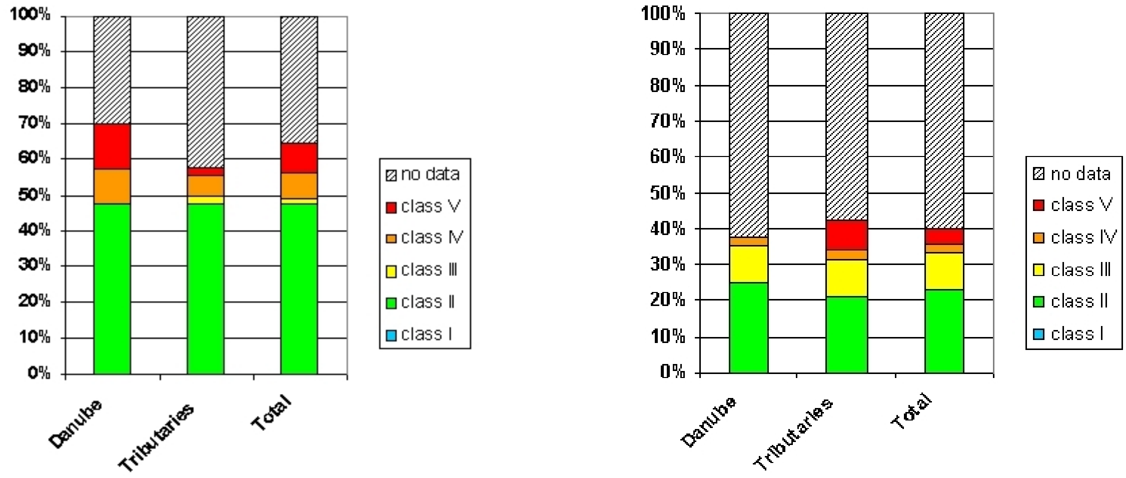


Figure 20: TNMN Water quality classes for cadmium and for mercury in 2001

Reviewing the 1996 – 2000 TNMN data the assessment of the risk separates the heavy metals into several groups.

> **Cadmium** and **lead** can be considered as the most serious inorganic micro-contaminants in the Danube River Basin. Their target values are slightly exceeded in several locations in the middle Danube and seriously exceeded in most of the sampling sites of the lower Danube. The situation in the case of cadmium is critical. The target value is substantial exceeded in many locations downstream rkm 1071 (values mostly 2-10 times higher than the target value). The pollution of the lower Danube by cadmium and lead can be regarded as a significant impact.

> For **mercury** the data is missing from more than 40 % of locations. Moreover, from almost half of monitoring sites reporting the results no quality class indication was possible because the limit of detection of the analytical method used was higher that the target limit. So, the overall picture on mercury is incomplete focusing predominantly on the upper and middle Danube. Elevated concentrations of mercury in the Danube mainstream and its tributaries in the upper and middle section are quite frequent. Mercury is the only heavy metal for which the target limit was exceeded even in the upper Danube section.

> **Copper** is a very common element naturally occurring in the environment. Its concentration increases significantly downstream the Danube. Most of the exceeding values (up to several times the target value) were detected in the lower section of the river (including tributaries). In the middle part the only significant occurrence of copper was detected in the Tisza River.

> The pollution of the Danube River and its major tributaries by **nickel**, **zinc** and **arsenic** is low with the elevated profile only in the lower section. The problem is the lack of the data from the lower Danube, where elevated concentrations were observed. In general, the risk stemming from these three elements can be looked upon as low. .

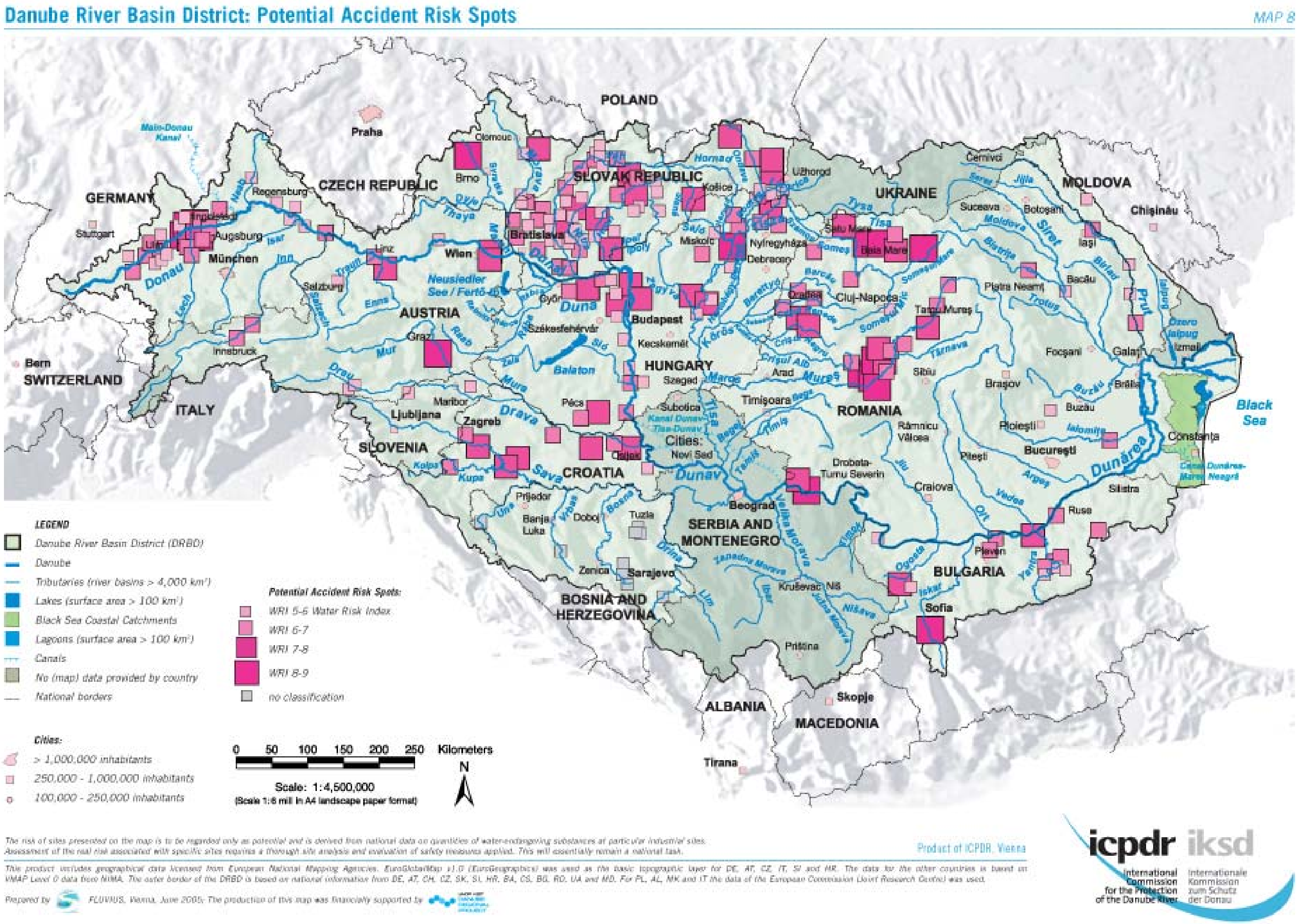


Figure 21: Potential Accident Risk Spots

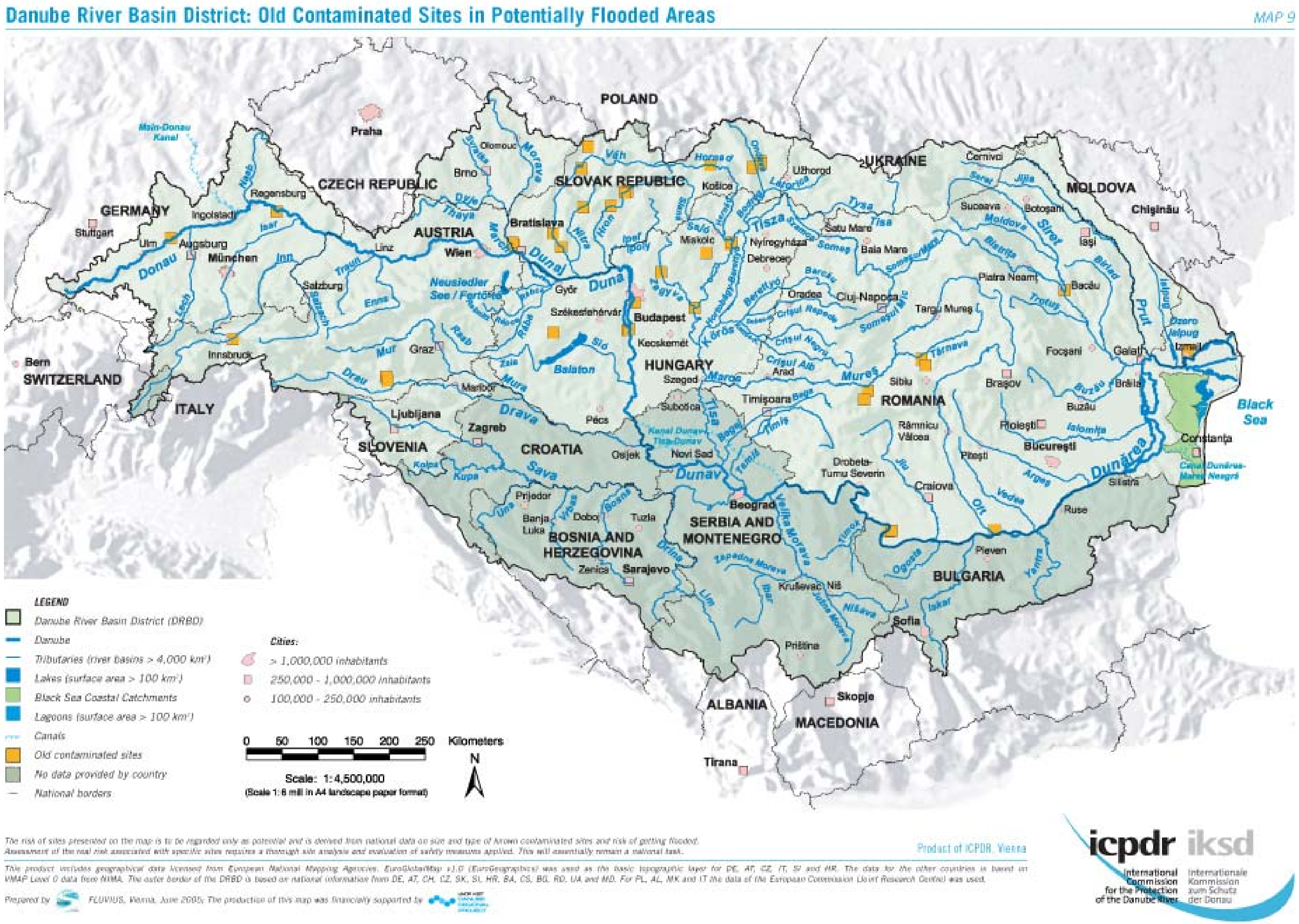


Figure 22: Old Contaminated Sites in Potentially Flooded Areas

5.6.3.2. Organic micro-pollutants

Lindane, pp'-DDT, Atrazine, chloroform, carbon tetrachloride, trichloroethylene and tetrachloroethylene are the organic micropollutants regularly monitored in water in the frame of the TNMN programme. In general, the data collected so far exhibit rather large variation due to big differences between reported limits of detection in various Danube countries. The following conclusions can be drawn:

- The organochlorine pesticides (Lindane and pp'-DDT) show an increasing profile from the upper to the lower Danube. In case of Lindane the limit value of 0.1 µg/l was exceeded in 24 % of the Danube samples and in 9 % of the samples from tributaries. Despite a high uncertainty the level of pollution by p,p'-DDT is significant and gives a strong indication of potential risk of failure to achieve a good status. An important fact in this case is that p,p'-DDT is a pesticide banned in Europe and it is likely that the contamination stems from the past loads. However, the Inventory of Agricultural Pesticide Use (UNDP/GEF DRP) reports on uncontrolled and illegal trade of pesticide products leading to the use of banned pesticides (e.g. DDT) by farmers so this pollution source should be checked if possible.
- From 1996 to 2000 the concentrations of the polar pesticide **atrazine** were found below the detection limits at most of the monitoring sites along the Danube River. Despite its banning in the upper Danube area, atrazine belongs to the most applied pesticides in the Danube River Basin.The target limit of 0.1 µg/l was exceeded in 13 % of the Danube samples. The tributaries were more contaminated with atrazine with approx. 30 % of values above the quality target. The highest concentrations of atrazine during that five-year period were found in the tributaries Sio and Sajo. The elevated concentration of atrazine in the Sava triggered the alarm in the ICPDR Accident Emergency Warning System in 2003.The overview of classification of the TNMN results for atrazine in the year 2001 is shown in Figure 23.

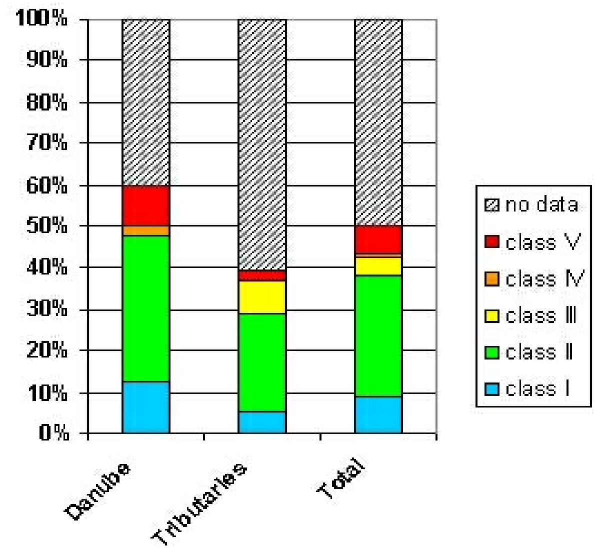


Figure 23: TNMN Water quality classes for Atrazine in 2001

For the volatile organic compounds (VOCs), data are available for the upper and middle Danube only. **Chloroform** was the most often detected VOC in the Danube River Basin during 1996-2000. It exceeded the interim target of 0.6 µg/l in about one third of the collected samples. Significantly lower contamination was recorded for **tetrachloroethylene** – only about one tenth of the samples were above the target value of 1 µg/l. The situation was even better in the case of **tetrachloromethane** and **trichloroethylene**. Only in 2% of the samples from the tributaries the target value of 1 µg/l was exceeded. In the Danube mainstream no elevated concentrations of tetrachloromethane and trichloroethylene were observed during 1996-2000.

5.6.4. Knowledge gaps

The main gaps in knowledge are associated with the lack of data (both from the TNMN monitoring programme and on emissions of hazardous substances) and the quality of the analytical data.

Specifically for heavy metals and organic micro-pollutants the issues are:

- Heavy Metals: A necessary issue still to be clarified in the future is the determination of natural background concentrations to be used for setting of region-specific quality standards. Due to the geomorphologic conditions the natural occurrence of heavy metals in the Danube River Basin varies.
- The major problems in assessing the results on organic micro-pollutants are the lack of the data (especially from the lower section), high detection limits not matching with the environmental quality standards and a high uncertainty of analytical results. These all factors must be taken into account when formulating any statements on existing risk.

5.7. Hydromorphological alterations

5.7.1. Introduction

Hydromorphological alterations have a significant impact on the ecosystems of a river. These can include, the disruption of fish migration due to the construction of dams, the prevention of floods reaching natural wetlands or the creation of artificial channels with the loss of natural bank habitats.

The extent of the hydromorphological alterations in the Danube basin has been significant over the past centuries. Such alterations include, *inter alia*, the building of dams, weirs and sluices, the canalisation of rivers and subsequent disconnection of their floodplains and old arms, erosion (incision) of the river bed and lowering of water tables with consequently higher flood risks. Some of these changes are irreversible, however, there is a potential for rehabilitation, which should be explored to the fullest extent. This is particularly the case, where floodplains could be reconnected with the main river thereby improving natural flood retention and enhancing fish migration to their natural habitats. In addition, migration path-ways would be needed on barriers on the Danube and most of its tributaries.

The most important hydromorphological pressures are related to hydropower use, navigation and flood defence measures. In the upper parts of the Danube chains of hydropower plants and navigation sluices interrupt the continuity of the river with the effect that only few free-flowing sections on the Danube remain, e.g. in the Austrian Wachau, a World Cultural Heritage Site. Also on the tributaries many dams and weirs have been constructed. Resulting impacts especially affect the migratory fish species that cannot reach their spawning grounds, feeding or refuge grounds in other parts of the river-floodplain system.

Iron Gates I and II on the middle Danube shared by Serbia and Romania have dams 60 and 30 m high and backwaters reaching 310 km upstream on the Danube. Also the tributaries are strongly affected by backwaters reaching 100 km upstream on the Sava and 60 km upstream on the Tisza River, and also on many smaller tributaries. The Iron Gates have multiple effects on the Danube ecosystem. The

Iron Gates function in particular as sinks for nutrients and sediments with subsequent impacts on the Lower Danube and the Black Sea. Also, the groundwater tables are elevated considerably in the backwater areas endangering settlements, municipal and industrial facilities and agricultural activities, particularly in the Serbian lowlands.

Navigation occurs on nearly all parts of the Danube and the lower parts of its major tributaries. Construction and maintenance of the navigation channel, sluices and harbours have significant negative effects on the aquatic environment. The Lower Danube and many tributaries are also affected by hydromorphological alterations based on flood defence measures.

Although a number of studies have been carried out on individual river stretches and special aspects of river degradation, a comprehensive assessment of the direct and indirect effects of hydromorphological alterations in the DRB countries does not yet exist. Therefore, it is not possible to give an overview of the situation for the whole Danube basin. Instead examples will be given, which highlight the kind of impacts from hydromorphological changes that have occurred and allow the assumption that similar impacts have taken place in other parts of the basin where similar pressures from hydromorphological alterations exist.

5.7.2. Drivers and Pressures of Hydromorphological Alterations[16]

Drivers of Hydromorphological Alterations

The main drivers for hydromorphological alterations are:

- Hydropower generation
- Navigation
- Flood control

Pressures from Hydromorphological Alterations

The main pressures caused by hydromorphological alterations are:

- Longitudinal continuity interruptions;
- Lateral connectivity interruptions
- Hydrological alterations.

5.7.3. Environmental impacts (stresses) from hydromorphological alterations

The most significant impacts from the pressure of hydrological alterations are on:

- Fish migration
- Disconnection of wetlands
- Sediment transport and trapping
- River regulation (changes in flow regime and impact on ecology)

The following provides specific impacts from different forms of river engineering programmes in the Danube Basin.

[16] Underlying and immediate causes

Impacts from river regulation works

The Danube regulation works of the 19th century (since 1870 in the Austrian – Hungarian Monarchy, since 1895 in districts of the present Serbia and Montenegro) together with the nearly complete loss of sediment supply from the Upper Danube catchment in the 20th century (retained by a series of dams from the Alps down to Gabcikovo Hydropower Dam), increased the sediment deficit for the entire Danube up to the Iron Gate and even beyond. The result is an ongoing channel incision for long stretches of the Danube, e.g. on the Hungarian Danube of about 1 - 3 cm/a. On the Austrian Danube downstream Vienna, the river bed is eroding at a rate of 2.0 – 3.5 cm/a. Connected water tables in the alluvial flood plain are reduced as well, sometimes in a magnitude of several meters. An example can be seen in parts of the upper Danube in Baden-Württemberg (rkm 2,670- 2,655).

The meander cut-offs carried out to improve the navigation route (e.g. the Hungarian Danube was shortened from 472 km to 417 km) have changed the water table and resulted in a progressive silting of the many cut-off side-channels and oxbows. Most important floodplain areas, such as the protected areas of Gemenc-Béda Karapancsa are slowly drying out. The local nature and water management authorities have started to halt this erosion and improve the water exchange by re-connecting the Gemenc floodplain area with the main channel and retaining more water in the side-arm system. The formerly rich fisheries can only thrive by restoring the migration routes and spawning areas in the floodplain.

During the last ten years the war and post-war impacts in former Yugoslavia inhibited the maintenance and reconstruction works in many areas of the Danube River. Between Baja (HU) and Belgrade numerous ecologically valuable bank segments and islands were therefore preserved or have even self-restored themselves over these past ten years.

Pronounced sediment accumulations occur behind the Iron Gate dams. Between 1972 and 1994, about 325 million tons of sediment were deposited, taking up 10 percent of the entire reservoir and resulting in a much reduced transport of suspended solids and soil sediments downstream of the Iron Gate. In the backwater of the Iron Gate, stretching upstream over 310 km (up to Novi Sad), the effects of the increased inner and outer colmation (clogging) have led to problems with the supply of drinking water in communities located along the impoundment.

Downstream of Bratislava from the impounded Danube 80 % of waters are diverted into the sealed Gabcikovo power side-canal. The remaining 20 % for the 40 km long section of the main river bed are too small to balance various effects: A drop of 2 - 4 m of the surface and groundwater table and resulting desiccation of bank forests; a loss of hydro-dynamics in the disconnected, artificially irrigated and impounded side-arm systems (altogether 8,000 ha on both sides of the river); absence of former morphological processes resulting in a disappearing of pioneer species, a reduced water quality and an overgrowing of former open or periodically inundated habitats.

Specific impacts from dams and weirs (disruption of river continuity)

Impoundments lead to an alteration of the hydraulic characteristics of a river. A major problem associated with the interruption of the river continuum is the decrease of velocity and retention of sediment in the impounded stretches. As a consequence of reduced slope and current velocity, fine sediments cover the natural habitats of the bottom-dwelling organisms and clog the interstices in the bed sediments. This leads to a diminished flow of oxygen into the bed sediments and to a reduced recharge of the groundwater. These changes in flow and substrate composition affect the benthic invertebrates and the spawning grounds for fish. Typical rheophilic fish species, dependent on gravel and cobble as spawning habitats, such as *Thymallus thymallus, Chondrostoma nasus*, *Barbus barbus*, or *Hucho hucho* are especially affected during their spawning and larval phase. Another impact of reduced current velocity and changes in sediment composition in mountain streams is the loss of habitat for algae. *Hydrurus foetidus,* a typical winter species, is one of the most densely colonised habitats for benthic invertebrates. Bottom-dwelling, rheophilic species feeding on algal and bacteria disappear and species typical for fine sediments can occur in masses (for example Tubificidae). As a result, typical benthic invertebrate communities are absent and the ecological integrity of such rivers is disturbed.

Due to all these effects the self-purification capacity of the river may also be reduced. As an example, monitoring results on the Bavarian Danube show a change in water quality from class II to II/III after completion of the impoundments Straubing and Geisling in 1999, although discharge of wastewater has been minimised. The impoundment changes the living conditions for all organisms – e.g. slower current velocity – and results in a change in river water quality due to intensified secondary production.

Migratory species are impacted by dams and impoundments that disrupt the longitudinal connectivity of rivers and streams. In-channel structures that exceed a certain height prevent or severely reduce the migration of certain aquatic species. Particularly some of the migratory fish species such as the sturgeon or the sterlet can no longer reach their spawning grounds, feeding and shelter areas.

One of the well-known impacts of the Iron Gate dams has been the extinction of sturgeons migrating in the middle and upper Danube basin after its construction. The construction of the Iron Gate dams has changed the distribution of fish species. The migration path was cut for anadromous species coming from the Black Sea into the Danube for spawning. Now, in Serbia and Montenegro, *Acipenser gueldenstaedti* (Danube or Russian sturgeon), *Acipenser ruthenus* (sterlet), *Acipenser stellatus* (stellate or starred sturgeon), *Huso huso* (beluga), and *Acipenser nudiventris* are present only downstream from the Iron Gate II. *Acipenser ruthenus* (sterlet) is present in all Serbian parts of the Danube, as well as its tributaries, such as the Sava, the Tisza and the Morava River.

Another example is known from the Inn River in Germany, where over 30 fish species were originally present. After the construction of the first impoundment at Jettenbach in 1921, professional fisheries on the river collapsed. Today, only two fish species are able to maintain their stocks by natural reproduction in this part of the river.

Effects of intermittent hydropower generation (hydropeaking)

Intermittent hydropower generation (hydropeaking) causes special downstream effects on the aquatic fauna. Water is released by pulses several times per day, which causes tremendous water level changes. These "artificial floods" damage the aquatic fauna, by sweeping them away during pulses and drying out in periods of retention. In the Austrian part of River Drau/Drava for example a reduction of 50 % of the fish stock, and 80 % of the benthic invertebrate community, has been attributed to peak operation in the Möll tributary and the impoundment of the Malta tributary.

Effects on riverine wetlands (disruption of the lateral connectivity)

Wetland habitats in the Danube river basin have been drastically altered in the last two centuries. The main causes of wetland destruction have been the expansion of agriculture uses and river engineering works mainly for flood control, navigation and power production. Drainage and irrigation are also responsible for the drop in water levels and the loss of wetland and floodplain forests, leaving only a few natural forests. Compared to the 19th century less than 19 % of the former floodplains (7,845 km² out of once 41,605 km²) are left in the entire Danube basin.

Since the 1950s, altogether 15-20,000 km² of the Danube floodplains were cut off from the river by engineering works. In the large plains of the middle and lower Danube (Hungary, Serbia and Montenegro, and Romania) extensive flood protection dike systems and drainage/irrigation networks were built up since the 16th century, but especially in the 19th and 20th century, and have caused a huge loss. For instance, in Hungary, 3.7 million ha were diked in and in Romania 435,000 ha.

In the Danube section between Romania and Bulgaria, dikes are usually only 200 to 300 m away from the main stream. Through this process, starting in the 16th century, the formerly extended floodplains along the Danube have been reduced drastically. Outside the dikes, natural succession processes from reed and marsh vegetation towards dry meadows but also forestation measures alter the habitat structure of the dynamic floodplain. These habitats, which are disconnected and partly far away from the Danube, are lost as spawning grounds for fish (pike, carp, etc.). Their loss contributed to the decline of fisheries in the lower Danube.

The complex system of riverine flood plains with its typical aquatic communities is dependent on constant changes in the duration, frequency and amount of floods. Elimination of these fluctuations inhibits regeneration of these habitats and siltation of backwaters cannot be reversed. Impacts on fauna and flora are significant. Typical fish fauna dependent on different habitat types during their life cycle (i.e. areas of refuge during floods and specific spawning and larval habitats) suffer from loss of habitats. Studies on the Middle Danube have shown that following the construction of flood control measures commercial fisheries have lost their importance. This factor is also apparently responsible for the decrease of fish catches in the Rajka and Budapest section of the Danube during the last two decades from over 300 tons in 1976 to approximately 50 tons in 1996. In the lower Danube the number of fish species has declined from 28 species before 1980 to 19 species today. Dominant species like the carp have been replaced by species of value for fisheries and have resulted in a decrease of fish catch from 6,000 t/a down to 2,500 t/a presently.

Impacts from navigation

Impacts from navigation often overlap with those of hydropower generation and flood defence, and are not very well studied. Special measures for maintenance of the navigation channel such as dredging affect the vertical connectivity. Benthic invertebrates inhabiting the river bottom and fish eggs are directly affected in areas of gravel extraction. Studies in Germany have shown that after the termination of gravel extraction typical benthic invertebrate communities re-establish themselves within two to three years. From the mechanical point of view, regular ship traffic causes waves resulting in artificial changes of water level along the riparian zones. Consequences are the disturbance of reproduction habitats for fish and benthic invertebrates as well as de-rooting of aquatic plants. Fish larvae and young fish are affected by the wash of the waves. Another negative effect of ships' engines is the unnatural suspension of fine sediments that increases turbidity and reduces the incidence of light needed for plant and algae growth. Construction of harbours especially those with steep, artificial banks have adverse effects on the aquatic fauna and cannot be used as habitats. German studies have shown that only half of the original species numbers and only 1/10 of the expected abundance can be demonstrated in such artificial surfaces.

Exploitation of sand and gravel and other activities leading to changes of gravel-dominated river bed can significantly affect the sturgeon population, which requires deep gravel-dominated habitats with a high water velocity during the spawning period. In addition, water pollution can impact negatively the functionality of spawning sites, the development of embryos and reduce the abundance of benthic invertebrates found in the diet of most sturgeons. And the increase of waves disturbs the biota on the riverbanks.

5.7.4. Knowledge gaps

Follow-up should be initiated regarding the following points:

> Methods for the assessment of significant hydromorphological alterations need to be harmonised. A type-specific approach would be advisable.

> Further research is needed on the link between hydromorphological pressures and the response of the biota. Ecological classification systems should be developed in a way to also assess hydromorphological degradation. Common methods would be needed (e.g. common sampling method, common approach for the analysis and interpretation of results, stressor specific multi-metric classification systems).

> Future monitoring networks need to include sites that are “at risk” of failing to reach the environmental objectives due to impacts from hydromorphological pressures.

> Migration pathways are needed on many barriers along the Danube and its tributaries. Species concerned are e.g. *Vimba vimba, Chondrostoma nasus, Lota lota*, *Alosa pontica* and *A. caspia normanni* as well as the sturgeons.

> Restoration of fish habitats should be carried out making best use of experience gained from previous restoration projects with similar measures in other parts of the Danube basin.

5.8. Transboundary impacts on the Black Sea

5.8.1. Introduction

During the 1970s and 1980s, the trophic status of the Black Sea, and particularly the northwest Shelf increased dramatically, resulting in extended and extensive periods of hypoxia, with severely damaged pelagic (water column) and benthic (sediment) ecosystems. The following short- and long-term nutrient-related targets have been agreed upon for the recovery of the Sea:

Short-term: to avoid exceeding loads of nutrients discharged into the Sea beyond those that existed in 1997.

Long-term: to reduce the loads of nutrients discharged to levels allowing Black Sea ecosystems to recover to conditions similar to those of the 1960s.

Trophic status is determined by nutrient and organic loads/concentrations. Organic matter in the Sea can be derived from external sources (River flows and discharges from land) or can be generated within the sea itself via photosynthesis, predominantly by phytoplankton, the growth of which are stimulated by elevated nutrient concentrations. Thus, both nutrient and organic loads/concentrations need to be considered in assessing the recovery of Black Sea ecosystems.

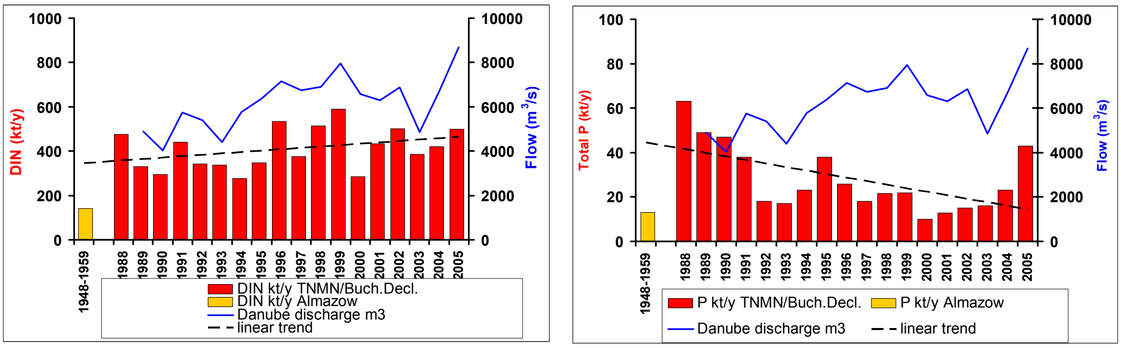
A detailed assessment of the impact of the Danube on the Black Sea prepared by the UNDP/GEF DRP and the BSERP is included in the DRP’s final DVD. A summary of the key issues and observations is presented below.

> While the emphasis of the DRP and BSERP projects has been (and remains) on nutrient source reduction, some of the best indicators of the trophic status of the receiving waterbody (the Black Sea and, more specifically, the North West Shelf) are at least as closely allied to organic enrichment as they are to nutrient enrichment. Further emphasis on reducing organic loading to the Danube and the Black Sea could, therefore, contribute to improvements in the

ecological status of the Black Sea. However, no studies are known to have been undertaken comparing the importance of riverine and coastal anthropogenic organic carbon discharges with organic loads produced by primary production in shallow, coastal waters.

- River loads of nitrogen and phosphorus increase with the river discharge. The large variability in annual flow rates makes it difficult to undertake statistics on short time-series of loads. The increasing trend of the annual water volume during the past 15 years may (partly) obscure any river load trends as a result of anthropogenic emissions. Also, even after excluding statistical "fliers" the error margin in measured nutrient concentrations is in the region of 10-20%, a fact which may obscure (weak) trends.
- Short-term nutrient concentration data (2000-2003) show an improving trend (i.e. concentrations are decreasing) in the upper and middle reaches of the Danube. More recent (2003-2005) data suggests that this improvement is now being reflected in reducing nitrate loads to the Black Sea.
- In absolute terms, there appears to have been a trend of decreasing total phosphorus and increasing inorganic nitrogen loads between 1988 and 2005. However, when the trend of increasing river flow over the same period is accounted for, there is actually a marginal decrease in inorganic nitrogen loads and a more substantial decrease in total phosphorus loads, albeit that flow-corrected data over the period 1996-2001 suggest no real improvement . The large increase in annual total phosphorus load during 2005 can be explained in full by the high flows during that year.
- To date, the emphasis on nutrient control has focused primarily on point source reduction. The benefits of capital investment in nutrient-stripping technology to date have been rather small, and there is an apparent need to re-focus attention on diffuse sources. However, the benefits of major reductions in livestock numbers and inorganic fertilizer usage since 1988 almost certainly have not yet been fully realized. When they are (and agriculture-derived nutrient loads fall substantially), capital investment in wastewater treatment plants will become progressively more important.
- The longer-term trends in inorganic nitrogen loads, while initially appearing to be disappointing, should be taken in context, since recent (2003-2005) data suggest that real improvements are beginning to occur. There is a widely acknowledged lag phase for nutrient source reduction being reflected in reduced water level concentrations and loads. There are two main reasons for this: (i) for diffuse sources-derived nutrients, the time taken to flush historically accumulated nutrients from soils and groundwaters to surface waters (ii) internal loading in water bodies (in this case referring to both the Danube and the Black Sea) from historically-enriched sediments until new sediment-water equilibria can be established.
- The reducing nutrient concentrations (2000-2003) in upper and middle reaches of the Danube suggest that this lag period may be nearing an end, a hypothesis supported by 2003-2005 nitrate data from Reni (see Figure 24). The pattern of improvements being shown first in upstream sections of the river is fully consistent with what would be expected as the lag phase begins to end.
- Nutrient data for a coastal water site near to Constanta showed a decrease in nitrate levels during the late 1970s, which has been maintained since (albeit with 2005 being a year of unexpectedly high concentrations, corresponding to relatively high flows in the Danube River). Phosphate levels at the same site showed a substantial fall during the early-mid 1990s, with a lower level being maintained since the late 1990s .
- The situation and trends (since 1990) in nutrient levels throughout the NW Shelf as a whole remains unclear because of the paucity of available data, perhaps the fairest interpretation of which is either an increase or no change in nutrient concentrations (data not shown).

Amalgamated marine average annual nutrient concentrations show wide variability, so timescale is critical when assessing trends. The inclusion or exclusion of a couple of years of annual average values could dramatically change this assessment. However, for the Romanian part of the NW Shelf, while nitrate concentrations show an increasing trend (1990-2004), phosphate levels have shown a decreasing trend.



Data source: Trans-National Monitoring Network database; Romanian Waters National Administration

Figure 24: Danube River annual nutrient loads and flows to the Black Sea (1988-2005)

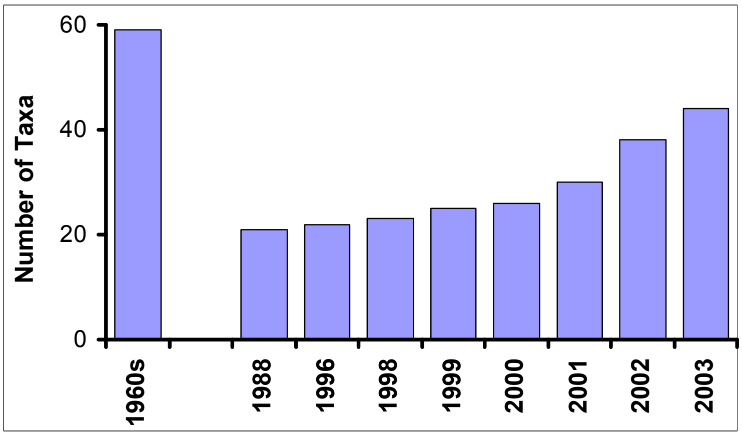
> Despite data suggesting that the nutrient status of the NW Shelf has not yet improved substantially, and may even have worsened at some sites during the last 15 years, there is clear and compelling evidence of improving biological status. Causes underlying this biological recovery are not fully understood, but the most likely influencing factors are: (i) climate change; (ii) over-fishing; and (iii) the invasive combjelly *Mnemiopsis leydyi,* a planktonic organism that first appeared in the Black Sea in the early 1980s. *Mnemiopsis* feeds "actively" on zooplankton and fish larvae, but only "passively" on phytoplankton.

> Over-fishing may have resulted in decreased grazing pressure on zooplankton and, therefore, increased grazing pressure on phytoplankton. However, available historical commercial fishing data for the Black Sea Region are (in general terms) sparse and incomparable. BSERP has funded a number of workshops and studies on fish stock assessment methodologies to promote regional harmonization in the future, but these will not help re-build historical datasets.

> Phytoplankton results strongly suggest an improving situation throughout the 1990s, and continuing improvements since then. This conclusion is supported by remote sensing data of chlorophyll-like substances, available since the late 1990s.

> The Danube continues to have an impact on zoobenthos populations just offshore of the delta, but further north the Dniester River is almost certainly an additional cause of disturbance to zoobenthos communities. However, zoobenthos biodiversity nears to Constanta has increased greatly since the late 1980s, suggesting that the impact of the Danube has reduced substantially since then. (see Figure 25)

> Dissolved oxygen concentrations in the 1970s showed a huge deterioration in environmental conditions / trophic status of the NW shelf in the 1970s and early 1980s. However, by the mid 1990s substantial improvements had been recorded. The overall situation appears to have improved further since then, albeit with a temporary return to eutrophic conditions in 2001. A further return of hypoxic conditions was also reported off the coast of Constanta (Romania) and in the Ukrainian part of the NW Shelf during 2005, but the extent and severity of this event remains unclear.



Data source: Dr C. Dumitrache, National Institute for Marine Research and Development, Constanta, Romania

Figure 25: Number of macrozoobenthos species near Constanta, Romania (1960s-2003)

As evident from the long-term estimate during the recent period (1998-2005) the trend of falling phytoplankton levels observed during the 1990s (both abundance and biomass) has been maintained during the first half of the 2000s. However, the two parameters (particularly biomass – the more important indicator of productivity) still remain at substantially higher levels than those observed during the early 1960s (Figure 26 A). Inter-annual variability in average biomass levels has continued to remain at a high level (Figure 26 B).

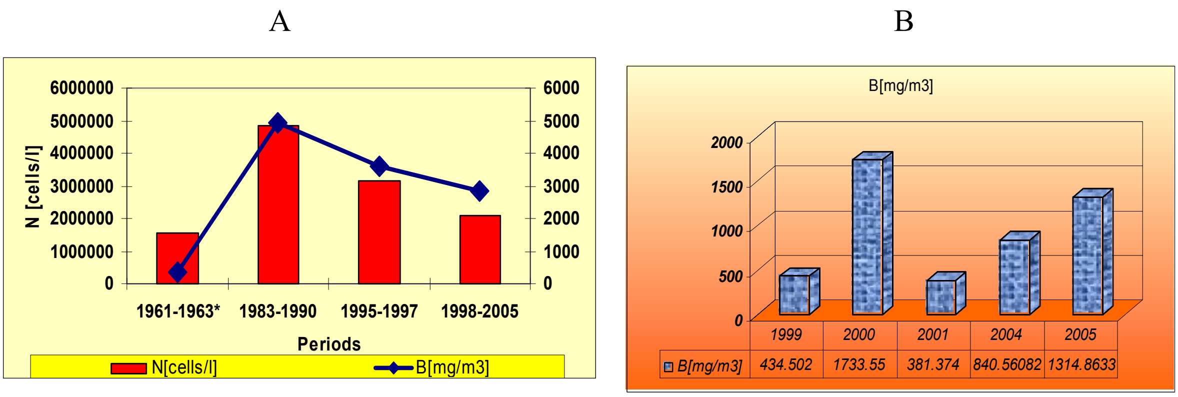


Figure 26: Long-term dynamic of phytoplankton abundance and biomass in the western Black Sea coastal area (Galata transect): A) Average phytoplankton abundance [cells/l] and biomass [mg/m^3] by periods (1961-2005); B) Average biomass [mg/m^3] in September [1999-2005].

In the context of long-term investigations, zooplankton community dynamics and structure reveal significant year to year alterations. Long-term summer dynamics of the dominant Copepods and Cladocera [ind.m^{-3}] demonstrated large inter-annual fluctuations (Figure 27). Critically low zooplankton abundance was registered in the middle of 1980s after M. leidyi introduction (Kamburska et al., 2003, Kamburska et al., 2006). The combination of eutrophication (provoking an increase of primary production), top-down control by aliens (M. leidyi) and small pelagic fishes resulted in large variations in the density of the major taxonomic groups. The average abundance of both taxonomic groups sustained at a lower level during the 1980s in contrast to the period 1967-1980. This level was again reduced in the middle 1990s due to the enhanced amount of M. leidyi, before its predator Beroe appeared (Kamburska et al., 2006). The large inter-annual fluctuations still could suggest instability of the recent trend especially in summer, although of signs of relatively recovery of the zooplankton community expressed in increasing of species richness and decreasing of dominance.

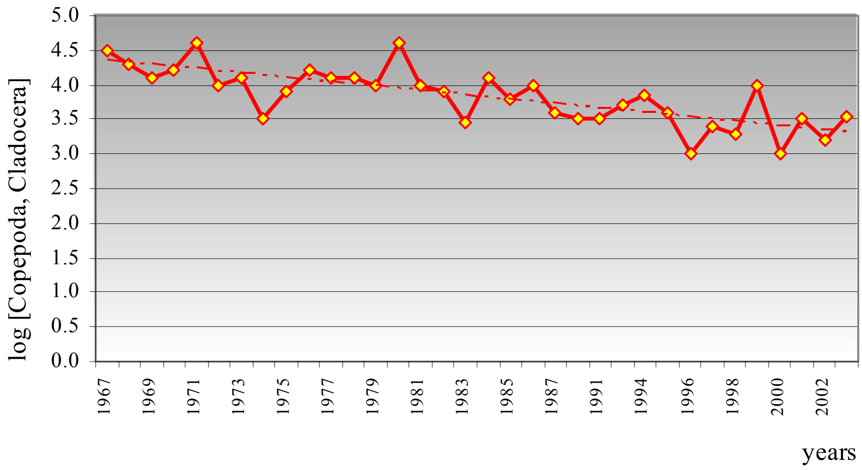


Figure 27: Long-term dynamics of Copepoda and Cladocera abundance (log transformed) at 3 miles station off cape Galata (Western Black Sea) during summer of the period 1967-2005 (the data 1967-2003 by Kamburska et al. 2006).

6. STAKEHOLDER INVOLVEMENT IN THE DANUBE RIVER BASIN

The active involvement of interested stakeholders and the broader public is a core principle of sustainable water management. This need was recognised in the establishment of the Danube River Protection Convention signed in 1994. The inclusion of organised public and stakeholders is a requirement of the DRPC and to-date 12 organisations have taken the opportunity to have 'observer status' at the ICPDR.

This approach of involving the public and stakeholder organisations has been further enhanced under the requirements of the EU WFD. Whilst this is a responsibility directed at EU Member States, the ICPDR has taken the initiative, as the co-ordinating body for the implementation of the WFD, to address public involvement on a transboundary scale. The ICPDR has an active process defining a *Danube River Basin Strategy for Public Participation in River Basin Management Planning 2003 – 2009*, which is being implemented by the countries under the guidance of a expert group within the ICPDR.

The activities in the basin are aimed at:

- Raising awareness on water management within the Danube River Basin;
- Informing the stakeholders (including the public and NGOs) on the requirements of river basin management and their possibilities to be involved;
- Involvement of the appropriate stakeholder groups;
- Developing a network for public participation experts throughout the Danube Basin;
- Developing an effective media network to ensure contact with the wider public.

Specific activities have included:

- The on-going publication of Danube Watch – a quarterly magazine on Danube actions, activities;
- Preparing brochures and other publications on river basin management in local languages;
- Providing an accessible web information system;
- Accessing a wide range of local journalists;
- Undertaking a stakeholder analysis at a basin-wide level;
- Providing guidance and assistance with a workshop on public participation;
- Initiating Danube Day (June 29 – the date of the Convention signing) to celebrate the Danube throughout the region;
- Promoting stakeholder workshops. These have included topic specific (e.g. agriculture, navigation hydropower, etc.) and more general issues;
- Supporting the development and growth of the NGO community through Danube Environmental Forum (DEF). With the support of the UNDP/GEF DRP the membership of DEF has risen from about 50 to over 160 organisations throughout the Danube Basin;
- NGO support has been provided to enable over 150 projects aimed at pollution reduction to be undertaken through a UNDP/GEF DRP small grant scheme;
- Public participation and access to information under the Aarhus convention has been supported.

The UNDP/GEF DRP has provided considerable resources (approximately 45% of its overall budget) to supporting the above and other activities to assist the ICPDR and the countries of the Danube Basin meet the needs of both the Danube River Protection Convention and the EU WFD.

7. ANALYSIS OF INSTITUTIONS, LEGISLATION AND INVESTMENT NEEDS WITHIN THE DANUBE RIVER BASIN

7.1. Analysis of Institutions and Legislation

The legal frame for cooperation of the Danube Countries to assure environmental protection of ground and surface waters and ecological resources in the Danube River Basin is the Danube River Protection Convention (DRPC), which came into force in October 1998.

The ICPDR is the institutional frame not only for pollution control and the protection of water bodies but it sets also a common platform for sustainable use of ecological resources and coherent and integrated river basin management.

Objectives of the Danube River Protection Convention:

> Ensure sustainable and equitable water management;

> Conservation, improvement and the rational use of surface waters and ground water;

> Control discharge of waste waters, inputs of nutrients and hazardous substances from point and non-point sources of emissions;

> Control floods and ice hazard;

> Control hazards originating from accidents (warning and preventive measures);

> Reduce pollution loads of the Black Sea from sources in the Danube catchment area.

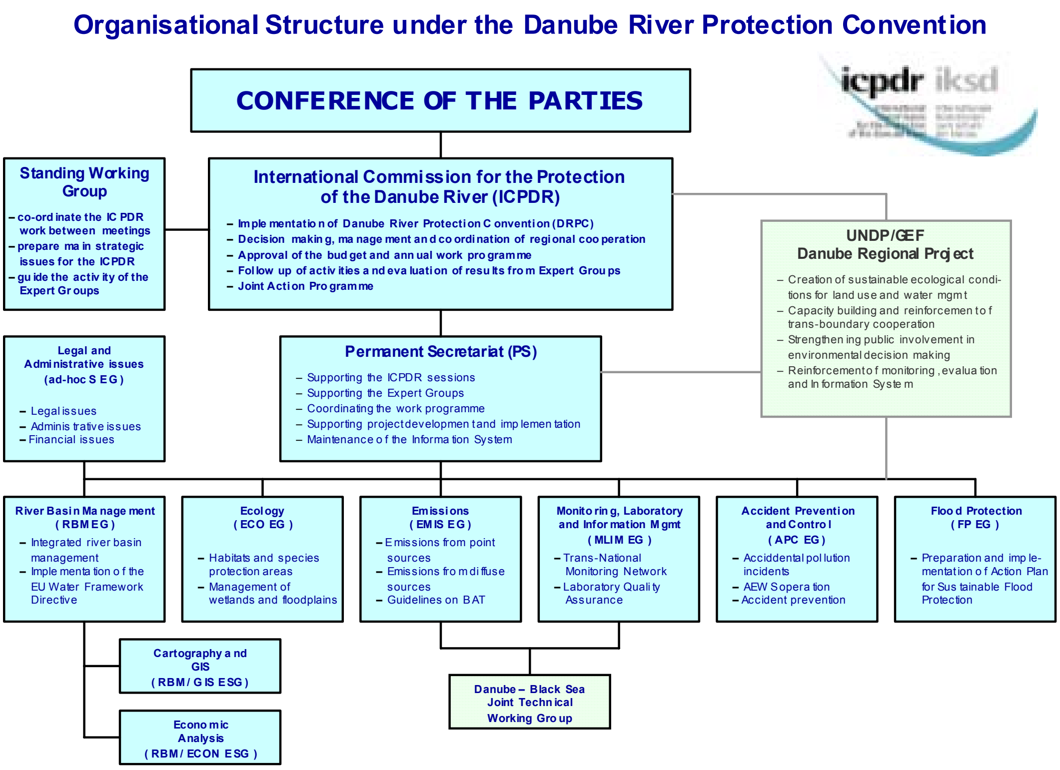


Figure 28: Organisation Structure under the Danube River Protection Convention

Since its creation, the ICPDR has been effective in reaching agreed policy among countries on priorities and strategies for improving the Danube and implementing the DRPC. This includes improving tools to manage the basin such as the Accident Emergency Warning System, the Trans-National Monitoring Network for water quality and the information system for the Danube (DANUBIS). In effect, it has done much to promote trans-boundary cooperation among numerous countries in a highly complex European region.

Danube countries face substantial challenges in establishing and strengthening the policy and institutional framework required for functioning market-based and democratic societies. Today, progress can be reported with all Danube countries in redesigning policies, programs and regulations, in establishing appropriate incentive structures, redefining partnerships with stakeholders, and strengthening financial sustainability of environmental services. Following a challenging and demanding period of transition, all DRB countries have in the last years developed a comprehensive hierarchic system of short, medium and long-term environmental policy objectives, strategies and principles which reflect the political context of each country, key country-specific environmental problems and the sector priorities on national and regional levels.

Still the key challenge Danube countries face in the policy field is to identify the most effective ways of transposing EU environmental directives. Country's choice on how to achieve compliance with EU directives will have a significant influence on compliance costs.

In all DRB countries the legal framework for environmental management of water resources and ecosystems consists of a hierarchic system of decrees, laws, directives, ordinances, regulations and standards on different administrative levels. In addition to the WFD, there has been a high level of transposition of the EU Directives into the national legislations of the DB countries. All DRB countries currently have a more or less comprehensive system of environmental and water sector-related policies and strategies, which usually reflects:

- The capability of the country to contribute to the solution of transboundary problems;
- The significance and evidence of country-specific environmental problems;
- The significance and evidence of environment-related health hazards;
- The economic development and potential of the country.

Despite the diversity of problems, interests and priorities across the basin, the Danube countries share certain values and principles relating to the environment and the conservation of natural resources.

The key principles for water management and water pollution that have formed the basis for the revision of legal and institutional arrangements adopted by Danube countries include:

- Consider water as a finite and vulnerable resource, a social and economic good
- Use of the integrated river basin management approach
- Implement precautionary principle
- Introduction and use of BAT, BAP and BEP
- Control of pollution at the source and creation of cleaner production centres
- Apply polluter pays principle and the beneficiary pays principle
- Implement principle of shared responsibilities, respectively the principle of subsidiarity
- Use market based instruments
- Implement good international practices in managing environmental expenditures
- Strengthen international partnership and transboundary cooperation
- Long-term objectives of water policies in the DRB countries mainly focus on:

- Preservation of a sound environment for the future generations;
- Protection of biological diversity;
- Protection of drinking water resources.

Countries in the DRB have increasingly recognized that developing and implementing regulation (at the national, regional and local level) is a precondition for effectively responding to a range of key challenges. Further assistance and efforts are still needed to building institutional capacity at central and local government level to address the broad challenges of legal reforms.

The water legislation was amended, or is under revision, according to the EU Directives in most of the countries. The water sector-related policies and strategies reflect:

- Country's commitment to respond to EU requirements and international agreements obligations
- The need to incorporate general principles for sustainable development, environmental, economic and social concerns into the national development strategies
- Capability of the country to contribute to the solution of transboundary problems
- The significance and evidence of country-specific environmental problems.

A fundamental objective of regulatory reforms in the Danube countries is to foster high quality regulation that will improve the efficiency of national economies and environmental actions, and will eliminate the substantial compliance costs generated by low quality regulations. By helping countries to revise their legal and institutional arrangement, the ICPDR has contributed to long-term economic prosperity and increased opportunities for investments to reduce pollution and protect natural resources.

Most of the Danube countries still need to pay attention to adequate coordination and implementation of policies, legislation and projects for nutrient reduction and pollution control through establishment or strengthening of their inter-ministerial coordinating mechanisms ("Inter-Ministerial Committees") at the national level involving all technical, administrative and financial departments. This will help them effectively address pollution prevention and control issues which require decisions and activities in more than one government ministry in order to reinforce the development and implementation of and compliance with national policies and legislation for nutrient reduction, pollution control and sustainable water management.

In general terms, the 13 DRB countries can be categorized and characterized as follows: **Germany** and **Austria** have substantially reformed their regulatory regimes to assure the functioning of their democracies and market-based economies, with all legislation in compliance with the "highest environmental standards". Significant efforts are also required for EU member states for reaching an acceptable level of implementation.

The **German** water management and protection policy is in compliance with EU water policy, aiming at achieving of good water status for all waters by 2015. With the elimination of biological and chemical pollutions from municipal and industrial sources the most important conditions for further continuous improvements of the water ecology are already met.

The core of water legislation in **Austria** is the Water Right Act, which was revised in 2003 to accommodate the EU Directives principles. Austria is currently engaged in developing an Ordinance defining water quality objectives for rivers as well as for lakes. Primary goal of water policy is to ensure sustainable water management through a prudent human interference into waters. Main principles are: (i) minimizing impacts on water quantity and quality via a stringent system of permits and control, (ii) protection of population and its living pace and goods against floods, and (iii) public awareness on the value of water and for it rational use. The WFD implementation is regarded as an important supporting tool to achieve the primary goal of water policy in Austria. In response to the disastrous floods 2002 activities for the protection against floods are intensified taking into account developments on the international level. Federal Ministry of Agriculture and Forestry Environment and Water Management is the competent authorities responsible for preparation and implementation of the Flood Action Plans.

The experience of the new Member States having joined EU in May 2004 is important information for other Danube countries.

In March 2004, the Ministry of Environment of **Czech Republic** prepared the updated State Environmental Policy for 2004 – 2010. Considerable attention is paid to wetland ecosystems, to rehabilitation of aquatic biotopes, to effective and sustainable protection of surface and ground water bodies, to harmful contaminants, to integrated water protection and management. Through river basin management plans, measures to protect wetlands and floodplains shall be implemented. The use of wetlands and water resources should be sustainable in view of economic pressures and global changes, and this includes principles referring to landscape and environmentally sound agricultural practice, wetland and floodplain uniqueness, restoration, remediation and rehabilitation of damaged wetlands areas. The Water Act considers the whole water policy such as protection of water, water use, management of water and protection of water depending ecosystems.

The National Environmental Programme of **Hungary** includes substantial provisions and measures for the conservation and management of surface and groundwater resources. Some of the key targets and approved policy directions are: regulation development to encourage sustainable and economical water use; improvement of water quality for the main water bodies; gradual increase (to a level of 65%) of the number of settlements with sewers; at least biological treatment of wastewater from sewers; nitrate and phosphorus load reductions for highly protected and sensitive waters. By 2003 the Hungarian legislation on water quality protection was fully harmonized with the EU regulations, including the appropriate institutional set-up.

The implementation of the water management and protection policy of **Slovakia** is in compliance with EU water policy, i.e. the WFD, aiming at achieving of good water status for all waters by 2015. The legislative tools for achieving policy objectives have been prepared. All EC directives have been transposed into the national law system. The transposition was finished in 2004 through an updated version of the Water Act. Main priority in relevant sectors (urban wastewater, industrial wastewater, land use, wetlands) is the implementation of EC directives' requirements (urban and industrial wastewater during the transition periods), namely reduction of nutrients and priority substances and creation of effective water management that will be able to promote sustainable water use based on long - term protection of available resources.

The need to implement a unified policy on the environment and the use of natural resources, which integrates environmental requirements into the process of national economic reform, along with the political desire for European integration, has resulted in the review of the existing environmental legislation in **Moldova**. The current priorities for water management include the strengthening of institutional and management capability through improvement of economic mechanisms for environmental protection and the use of natural resources, setting internal environmental performance targets and controls, self-monitoring, review of current legislation in line with European Union legislation, and the adjustment or elaboration on a case-by-case basis.

Bosnia and Herzegovina is faced with major challenges in the environmental and water management area. Among specific objectives for environment is the development of an environmental framework in Bosnia and Herzegovina based on the Acquis. The most important issues in the environment sector will be identified in the Environmental Action Plan, which is being developed with World Bank support. The EU is supporting a Water Institutional Strengthening Programme, which is complemented by two Memoranda of Understanding (2000, 2004) between both Entities and the EC. Since the WFD was adopted, numerous and diverse activities were initiated to further implement the Directive.

The water management in **Serbia and Montenegro**[17] is faced with serious tasks that require, above all: (i) the creation of a system of stable financing for water management, (ii) the reorganization of water management sector, and (iii) the revision of water legislation and related regulations, in compliance with requirements of European legislation.

The remaining accession countries Romania, Bulgaria, Croatia as well as those non-accession countries are experiencing the historic opportunity of European integration, which is the most important driver of reforms but brings great challenges at the same time:

The adoption in 1999 of the Strategy for the Integrated Water Management marked the beginning of the reforms in the water sector in **Bulgaria** in line with the WFD and assumed obligations under international instruments. Several other programs such as Environmental Strategy to implement the ISPA objectives, the Program for the UWWT Directive implementation or the National Strategy for Management and Development of the Water Sector until 2015 complete the picture of on going efforts in Bulgaria towards complying with EU legislation.

In **Croatia**, the current basic environmental and water legislation and regulations (such as the Water Act, Water Management Financing Act, State Water Protection Plan) will be revised to meet the EU directives requirements within the frame of two EC CARDS projects expected to start at the end of 2004.

In **Romania** basic water legislation (Water Law) and implementing regulations, standards and ordinances regulations have already been fully harmonized with the EU directives.

Ukraine has not yet updated the environmental policy act (the Principal Direction, 1998). The update version of the Sustainable Development Strategy, however, has been recently submitted for approval by the Parliament. The Program of the Development of Water Economy is in force but still specific legislation on water management is missing. The current Governmental Action Plan is a comprehensive document, which integrates economic, social and environmental concerns. The Water Code of Ukraine harmonized with EU Directives is submitted as well for approval.

The high cost of achieving EU environmental compliance is a formidable challenge for the new member states, **Bulgaria** and **Romania**, and several Balkan countries that have negotiated Stabilisation and Association Agreements (SAAs) with the EU to bring their countries closer to EU standards.

Since the beginning of accession negotiations, the EU has stressed that at least 90% of the cost of environmental compliance must be borne from countries' own sources, representing 2-3% of GDP for many years to come.

[17] Serbia and Montenegro have recently formed two states. However an update of the internal structures has yet to be prepared

Table 6: Status of water-related policy, programmes and National Environmental Action Plans in the DRB countries

Country	Explicitly formulated policy objectives for water management and pollution control	Programmes especially dealing with water management and pollution control	Programmes dealing with WFD implementation
DE	Appropriate system of policy objectives completely in line with the requirements of the relevant EU Directives	Action Programs Environmental Statute Book	Strategy for WFD implementation
AT	Appropriate system of policy objectives completely in line with the requirements of the relevant EU Directives Austrian Water Protection Policy Water Right Act	Action Programme to control diffuse pollution Austrian Programme of Environmental Friendly Agriculture	Strategy for WFD implementation
CZ	Appropriate system of policy objectives	Program for adequate implementation of municipal WWTPs	The State Environmental Policy 2004 – 2010 Resolution 339, 2004
SK	Satisfactory system of policy objectives in the Strategy for National Environmental Action Program, 1993; National Strategy for Sustainable Development, 2000 and Water Management policy	National Environmental Action Program Codex of Good Agricultural Practices State Water Protection Plan Action Plan for the protection of biological and landscape diversity	Strategy for WFD implementation Inter sectoral Strategic Group Coordinating office Working Groups
HU	Appropriate system of policy objectives	National Environmental Program National waste water collection and treatment programs National agro-environm. protection program Other programmes (lake, oxbow lake, low land, etc.)	Strategy for WFD implementation
SI	Satisfactory system of policy objectives	National Environmental Action Plan, 1999 New Environmental Action Plan in preparation Operative program for wastewater collection and treatment	Strategy for WFD implementation
HR	Satisfactory system of policy objectives in the current legislation: National Strategy for Environmental Protection, 2002 State Water Protection Plan, 1999 Environmental protection Plan Nature Protection Act, 1999 Water Act, 1995	State Water Protection Plan Strategy and Action Plan	Strategy for WFD implementation
BA	Limited number of policy objectives	EU CARDS Program USAID, WB, GEF programmes National Environmental Action Plan, 2003	New Water Law in line with WFD, expected 2005
CS	Insufficient system of policy objectives and focussed programs	No explicit programmes	Harmonisation with EU legislation
BG	Satisfactory system of policy objectives	Environmental Strategy to implement ISPA objectives Program for UWWT Directive implementation National Strategy for Management and development of the water sector until 2015 Programme for construction of munic WWTPs	Strategy for WFD implementation
RO	Satisfactory system of policy objectives	National Environmental Action Plan Strategy for environmental protection Strategy for water resources management Series of nutrient-related programmes to be carried out during the forthcoming period Action program for reduction of pollution due to dangerous substances	Strategy for WFD implementation
MD	Reduced policy objectives. National Strategy for sustainable development, 2000 Concept of the Environmental Policy, 2001	National Water resources management Strategy, 2003 Water Supply and Sewage program, 2002 National Action Plan on Health and Environment, 1995	Strategy for WFD implementation
UA	Under the revision system of policy objectives within the frame of the update version of the Sustainable Development Strategy	Program of the Development of Water Economy Governmental Action Plan	Water Code of Ukraine harmonized with EU Directives (expecting approval)

7.2. Summary of investments identified

Under the ICPDR Joint Action Plan and the EC DABLAS programme over 4,000 M USD of required investments in municipal, agricultural, industrial and wetland restoration were identified. These needs have been incorporated into the monitoring of the performance indicators for the GEF Danube –Black Sea Strategic Partnership. A mid-term report on the activities undertaken of the Partnership has been provided to GEF Council in October 2005. The summary below represents the conditions at that date and indicates the fully-financed projects that were underway or had been completed recently.

Table 7: Summary of investments and project nutrient reductions.

Timeframe	No. of Projects	Total Investment MUSD	Nutrient Removal, t/a	
			N	P
Completed by Dec 2003	56	803	5,351	1,013
Completed in 2004 and 2005	35	475	4,552	836
Completed after 2005 (full financed)	106	1440	>10,013	>1,839
World Bank-GEF NRIF	14	576	5,936	443
TOTAL	211	3,294	>25,852	>4,131

Among the 211 fully financed projects, 128 are situated within the DRB EU member countries: Austria, Germany Czech Republic, Hungary, Slovakia, and Slovenia. Municipal sector projects account for the majority of the fully financed projects, and national co-financing provided more than 50% of total municipal investments. Most GEF-WB investments are instead concentrated on non-EU countries and in the agricultural sector.

Table 8: Overview of implementation of EU Directives

Country/ Directive	Water Framework	Dangerous Substances	Integrated Prevention and Pollution Control	Seveso	Environmental Impact Assessment	Environmental Management and Audit Schemes
Bosnia & Herzegovina	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive
Bulgaria	Partially implemented using as future framework for national legislation	Transposed and substantially implemented in National Legislation	Partially implemented using as future framework for national legislation	Partially implemented using as future framework for national legislation	Fully implemented in National Legislation	Partially implemented using as future framework for national legislation
Croatia*	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive
Czech Republic	Transposed and substantially implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation
Hungary	Transposed and substantially implemented in National Legislation	Fully implemented in National Legislation	Transposed and substantially implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation
Moldova	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive
Romania	Partially implemented using as future framework for national legislation	Partially implemented using as future framework for national legislation	Partially implemented using as future framework for national legislation	Partially implemented using as future framework for national legislation	Transposed and substantially implemented in National Legislation	Partially implemented using as future framework for national legislation
Serbia – Montenegro	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive
Slovakia	Transposed and substantially implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation
Slovenia	Transposed and substantially implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation	Fully implemented in National Legislation
Ukraine	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive	Not implemented and changes not planned to transpose the EU directive