



**Convention on the Protection and Use of Transboundary Watercourses and International  
Lakes**

**Working Group on Monitoring and Assessment**

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**Working paper on  
guidelines on monitoring and assessment of  
transboundary estuaries**

An Inventory of Transboundary Estuaries and their Current Monitoring  
Practises



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## List of Abbreviations

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BOD	Biochemical Oxygen Demand
BSEP	Black Sea Environmental Programme
CEP	Caspian Environmental Programme
COD	Chemical Oxygen Demand
DDT	Dichlorodiphenyltrichloroethane
EEA	European Environment Agency
EU	European Union
HCH	Hexachlorocyclohexane
HELCOM	Helsinki Commission
ICES	International Council for the Exploration of the Seas
MAP	Mediterranean Action Plan
OSPAR	Oslo and Paris Commission
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
P. E.	Population Equivalent
TBT	Tributyltin
TOC	Total Organic Carbon
UN/ECE	United Nations Economic Commission for Europe
WFD	Water Framework Directive

## Summary

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The report was drawn to provide an inventory of transboundary estuaries in the European region and an overview of their current monitoring practises for the use the UN/ECE Water Convention Working Group on Monitoring and Assessment. The information was obtained via a questionnaire and personal communication with appropriate authorities. Thirteen transboundary estuaries, varying greatly in size and type, were identified in the area covered by the Water Convention in the European region. The inventory is, however, not complete due to the poor response from some of the countries.

The most important uses reported in the estuaries consist of conservation and wildlife, fishing, shipping and recreation. In some estuaries industrial use for cooling water and extraction of water for drinking and irrigation were also seen as important uses. The main anthropogenic threat to the estuaries is the discharge of wastewater, both municipal and industrial, followed closely by diffuse pollution from agricultural runoff and other sources. Other threats that were mentioned include shipping and harbour activities, mariculture, heat pollution and atmospheric deposition.

Monitoring of the estuaries is based mainly on national water laws and EU Directives and to some extent also on various international agreements. Estuaries are generally included as a part of a wider monitoring programme covering fresh waters, coastal waters or surface waters in general. Monitoring is ordinarily overseen at a national level and carried out at local or regional levels. The data produced in monitoring programmes is stored on all levels, with at least a summary of the data held nationally. Public reporting is usually done in the form of a national annual report. All of the countries perform at least basic hydrological and physical monitoring and some level of chemical monitoring. Biological monitoring is carried out in six out of the ten countries and is mainly concentrated on phytoplankton. Chemical factors are most often measured in the water phase; only three countries out of the nine also monitor the concentrations of contaminants in sediments and biota.

Most of the estuaries are covered by some international or bilateral agreement advocating joint or co-ordinated monitoring initiatives, although no agreements have been specifically drafted for an estuary. Estuaries are most commonly included in river agreements and often also in coastal marine agreements as well as being encompassed in general bilateral agreements concerning all transboundary waters. However, in reality the implementation of the bilateral agreements is often lacking and the actual level of co-operation may be much lower than aimed for in the agreement. Many of the countries that reported poor co-operation on the governmental level however also reported good co-operation and information exchange on the level of the scientific research community. The future implementation of the EU Water Framework Directive will have direct implications on both the monitored variables and the level of co-ordination and co-operation between countries sharing water bodies.

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## 1. Introduction

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In recent decades the transboundary nature of water pollution has become a commonly acknowledged problem and joint monitoring initiatives, increased information exchange and the co-ordinated management of water resources have been recognised as important tools in the assessment and reduction of the transboundary effects of pollution. Particularly in the last decade the United Nations Economic Commission for Europe (UN/ECE) and the United Nations Environment Programme (UNEP) with several other organisations have advocated a co-ordinated regional approach to resolving water related problems and prevention of conflicts over water through the reasonable and equitable use of transboundary waters (ECE/UNEP, 2000).

### ***The UN/ECE Water Convention***

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (from here on referred to as the Water Convention) was drawn up under the auspices of UN/ECE and adopted at Helsinki in March 1992. The Water Convention was intended to serve to strengthen national measures for the protection and management of transboundary surface and ground waters. The Convention Parties are required to prevent, control and reduce pollution of all waters likely to cause a transboundary impact, and to ensure waters are used in an ecologically sound, reasonable and equitable way taking into particular account their transboundary nature. The measures to control and reduce pollution should, where possible, be taken at the source of the pollution taking into consideration both point and diffuse sources, and should include the developing, adopting, and as far as possible, rendering compatible, of relevant legal, administrative, economic, financial and technical measures such as:

- Licensing, monitoring and control of waste water
- Environmental Impact Assessment (EIA)
- Precautionary Principle
- Polluter Pays Principle
- Best Environmental Practice (BEP)
- Best Available Technology (BAT)

All Convention Parties are also obliged to establish programmes for monitoring the condition of transboundary waters. The Riparian Parties, the Parties bordering the same transboundary waters, should enter into bilateral or multilateral agreements, or adapt existing agreements, in order to increase their co-operation in the field of prevention, control and reduction of transboundary impact. They should also form joint bodies to collect and evaluate data in order to identify pollution sources as well as to elaborate emission limits and joint water-quality objectives and to develop concerted action programmes for the reduction of pollution loads from point and diffuse sources. In the above framework the Riparian Parties should also establish and implement joint programmes for monitoring the conditions of

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transboundary waters and the effectiveness of measures taken. The monitoring should be based on pollution parameters and factors, which have been agreed upon and executed using harmonised measurement systems and devices. The analytical techniques as well as data processing and evaluation procedures used should be compatible. The results of these assessments should be made available to the public in all of the countries.

The Water Convention entered into force on the 6<sup>th</sup> October 1996 and by the 30<sup>th</sup> January 2002 it had been signed, ratified or accessed by 32 countries from the European region, as well as the European Community.

### ***The Working Group on Monitoring and Assessment***

The Working Group on Monitoring and Assessment is responsible for helping the Convention Parties bordering the same transboundary waters to initiate and put into practice joint monitoring programmes aiming both to determine the condition of the water body and to evaluate transboundary impacts. The working group has so far produced guidelines on the monitoring and assessment of transboundary groundwaters and transboundary rivers and are currently in the process of preparing similar guidelines for the monitoring and assessment of international lakes and transboundary estuaries. In addition to preparing the published guidelines the Working Group is running a number of pilot programmes on monitoring transboundary rivers and groundwaters as well as international lakes. The pilot programmes aim to assist countries in the implementation of the guidelines whilst at the same time providing the opportunity of making adjustments and improvements to the guidelines based on the experiences gained in the programmes.

### ***Transboundary Estuaries and their Monitoring Practises***

**Aims and Objectives.** The present report was compiled in order to produce relevant background information for the use of the UN/ECE Working Group on Monitoring and Assessment, which has been assigned the task of preparing draft guidelines on monitoring and assessment of transboundary estuaries. The report aims to provide an inventory of the transboundary estuaries found within the remit of the ECE Water Convention in the European region, together with an overview of their current monitoring practises including the reporting of results as well as the present extent of international co-operation in monitoring. In the context of this report an estuary is defined as "a partially enclosed body of water open to saline water from the sea and receiving fresh water from rivers, land runoff or seepage" according to Day *et al* (1989); a *transboundary estuary* has been defined as "an estuary, which lies on the border of and is thus shared by two or more countries", although many more transboundary rivers have estuaries, these were not included, as the estuary in itself was not considered transboundary according to the above definition.

**Method.** Possible transboundary estuaries were initially identified by pinpointing rivers in the European region on World Atlas maps, which seemed to debouch into the sea on a border between two countries. This was to give a rough idea on the number of possible locations, however more detailed information and a confirmation on the existence and transboundary nature of the estuaries was needed in order for them to be deemed as transboundary

estuaries. The main part of the investigation was based on gathering information by the means of a questionnaire, which requested some basic information on the estuary followed by more detailed questions on monitoring practises, reporting of results and international co-operation. The questionnaire also enquired about any gaps that could be identified in any of the above categories and how the future implementation of the EU Water Framework Directive was going to influence monitoring practises.

The questionnaire was sent to the Focal Points of each of the countries in the European region, which are party to the Water Convention and have a marine coastline. Each Focal Point was sent a paper copy of the questionnaire, and where possible also an electronic copy through email, to be forwarded to the relevant person in their country. Where the focal point could not be contacted for any reason, such as the contact details being out of date, other possible contacts were identified and used. Some literature sources were used regarding international agreements, which were of relevance to monitoring of transboundary estuaries, and the regional marine conventions.

## 2. Assessment of Method

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Fifteen rivers that on the map seemed to debouch into the sea along a border between two countries, thus possibly constituting a transboundary estuary, were identified from the initial search on general world atlas maps. Without closer inspection it was, however, impossible to say whether the river actually formed an estuary or whether this estuary was truly transboundary instead of lying in its entirety inside the territory of one of the bordering countries. There may also be smaller rivers forming transboundary estuaries, which would not be depicted on the larger scale atlas maps. Thus the final inventory of transboundary estuaries presented in this report is based solely on the estuaries for which questionnaire replies, or other confirmation of their transboundary status, were received.

Response to the questionnaires was varied and only 11 of the 30 countries the questionnaire had originally been sent to replied (Appendix 1.). The bulk of replies came from countries in the European Union (EU) or countries preparing for accession into the EU. Many of the focal points did not respond at all, and it was assumed the questionnaire had not reached them, possibly due to the contact details being out of date. Where possible other contacts were identified and approached but, regardless of this, 14 countries did not even acknowledge receipt of the questionnaire as requested. Two of the eleven countries that replied confirmed that they had no transboundary estuaries. Actual questionnaire replies were received from nine countries amounting to monitoring information on ten estuaries. Other information was received to confirm the transboundary status of three estuaries, for which no monitoring information was received.

There were only two cases where both of an estuary's riparian countries replied. There were also differences in the completeness and thoroughness of the questionnaire replies, which forced the investigation to be made at the level of the more incomplete answers. There were also some discrepancies in the basic information, such as the size of the total catchment, reported by the two different riparian countries in the cases where both replied. In the case of the Oder estuary, although Poland also provided information on the Lower Oder Valley and the Pomeranian Bay, only the information on Szczecinski Lagoon (Stettiner Haff) was used as Germany only provided information on this area and the Pomeranian Bay can be seen as coastal water instead of being a part of the estuary.

The room for interpretation allowed by the information received via the questionnaires was limited due to the small number of replies and their varying level of completeness and thus detailed analysis of the results was not possible. However, the questionnaire replies received gave an overall view into the state of monitoring and reporting, as well as the extent of international

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co-operation in monitoring and information exchange regarding transboundary estuaries among riparian countries.

### 3. Inventory of Transboundary Estuaries

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#### *Estuaries*

Thirteen transboundary estuaries were identified in the area covered by the UN/ECE Water Convention in the European region (Map. 1.), ten of which were identified through replies to the questionnaire sent out to countries party to the Water Convention. The other three, namely the Guadiana, Idefjorden and Volga estuaries were recognized as transboundary estuaries through personal communication (M. Varela, K. Petterson and H. Ghaffarzadeh, respectively) and have been included on the map of estuaries but they do not contribute to the overview of the current state of monitoring in the estuaries as no information on their monitoring practises was received. The ten transboundary estuaries in Europe for which information was provided via the questionnaires cover a wide range of different sizes and types of estuary with varying degrees of enclosure and different mixing regimes (Table 1.).

**Map 1. Transboundary estuaries in the European Region. Estuaries identified from the questionnaires include: 1 Virolahti, 2 Narva, 3 Curonian Lagoon, 4 Gdanski Basin, 5 Szczecinski Lagoon, 6 Ems-Dollard, 7 Scheldt, 8 Miño, 9 Neretva and 10 Meriç/Evros. Estuaries identified via personal communication include: 11 Guadiana, 12 Volga and 13 Idefjorden.**



The level of the basic information on the estuaries that the questionnaire replies provided was highly varied. Some presented very detailed information whereas in other replies the information was limited or lacking entirely. The estuaries cover a wide range of sizes from the small Virolahti estuary which encompasses a mere 32.6 km<sup>2</sup> to the largest estuarine complex of the Gdanski Basin covering an estimated 25,600 square kilometres. These two are, however, extremes and the other estuaries fall into the size range between 200 and 2000 km<sup>2</sup>. The Virolahti estuary also has the smallest catchment area at 375km<sup>2</sup> whereas the catchment of the Gdanski Basin spreads over 323,200 square kilometres. The average depths of the estuaries also vary widely ranging from around 1.5 to 57 metres. The estuaries situated on the Atlantic coast have tidal ranges of approximately 3 to 4 metres, whereas the estuaries located on the Baltic and Mediterranean Seas do not experience actual tides, although they may undergo more irregular changes of water height due to changes in weather conditions (Table 1.).

**Table 1. Basic information on the estuaries. Where the information given by the two riparian countries differed the larger value given was used for the estuary and catchment sizes whereas both values are given for depths and mixing regime. Lack of information is indicated by a line.**

<i>Estuary</i>	<i>Size (km<sup>2</sup>)</i>	<i>Catchment (km<sup>2</sup>)</i>	<i>Average depth (m)</i>	<i>Degree of enclosure</i>	<i>Mixing regime</i>	<i>Tidal regime (m)</i>
<b>Curonian Lagoon</b>	1584	100,500	3.8	semi-enclosed	mixed	n/a
<b>Ems-Dollard</b>	500	15,421	3-5	open	stratified/ mixed	3
<b>Gdanski Basin</b>	25,600	323,200	57	-	-	n/a
<i>Vistula Lagoon</i>	838	23,871	2.7-3.1	enclosed	-	n/a
<i>Gdanska Bay</i>	4581	220.3	62	open	-	n/a
<i>Pucka Bay</i>	359.2	908.8	15.6	semi-enclosed	-	n/a
<b>Meriç</b>	200	53,000	1.5-5	semi-enclosed	partially mixed	n/a
<b>Miño</b>	-	-	-	-	-	-
<b>Narva</b>	-	56,225	15	open	mixed	n/a
<b>Neretva</b>	-	12,000	4,05	semi-enclosed	partially mixed	n/a
<b>Szczecinski Lagoon</b>	687	130,621	3.5-3.8	semi-enclosed	mixed	n/a
<b>Scheldt</b>	390	-	10-20	open	mixed	4
<b>Virolahti</b>	32,6	357	4.4	enclosed	mixed	n/a

## ***Uses, Impacts and threats***

The main uses of the estuaries vary depending on their size, type and location. Overall, fishing and shipping as well as conservation and wildlife, were reported as the most important uses closely followed by recreation. All of the questionnaire replies implied that conservation and wildlife were thought of as being of a very high or quite high importance. Shipping was reported as the most important use in the larger and more open estuaries, whereas others were mainly used for fishing and recreation. Although the industrial use of water and the extraction of water for the purposes of drinking water and irrigation were reported in approximately half of the estuaries they were considered to be of lower importance. Use of estuarine water as industrial cooling water was reported as an important use in two cases whereas the extraction of water was considered an important use in the more southern estuaries (Table 2).

**Table 2. Uses, impacts and threats of the transboundary estuaries as reported in the questionnaires. Abbreviations used for Uses: CR = Conservation/Wildlife, F = Fishing, EoW = Extraction of Water, I = Industry, R = Recreation, S = Shipping. Abbreviations used for Impacts and Threats: WW = Wastewater, A = Agriculture, H/S = Harbours and Shipping, CW = Cooling Waters, M = Mariculture**

<b><i>Estuary</i></b>	<b><i>Uses</i></b>	<b><i>Impacts and Threats</i></b>
<b>Curonian Lagoon</b>	F, CR, S, R	WW, H/S, A
<b>Ems-Dollard</b>	S, CR, I, F, EoW, R	WW, H/S, A
<b>Gdanski Basin</b>	I, R, F, S, CR	WW, A
<b>Meriç</b>	F, CR	WW, A
<b>Miño</b>	F, EoW	WW, A
<b>Narva</b>	R,F,CR, EoW, S, I	WW, CW
<b>Neretva</b>	CR, EoW, F, S, R	WW
<b>Szczecinski Lagoon</b>	S, F, R, CR, I, EoW	WW, H/S, A, CW, M
<b>Scheldt</b>	S, I, CR, EoW, F, R	WW, A
<b>Virolahti</b>	F, R	M, A

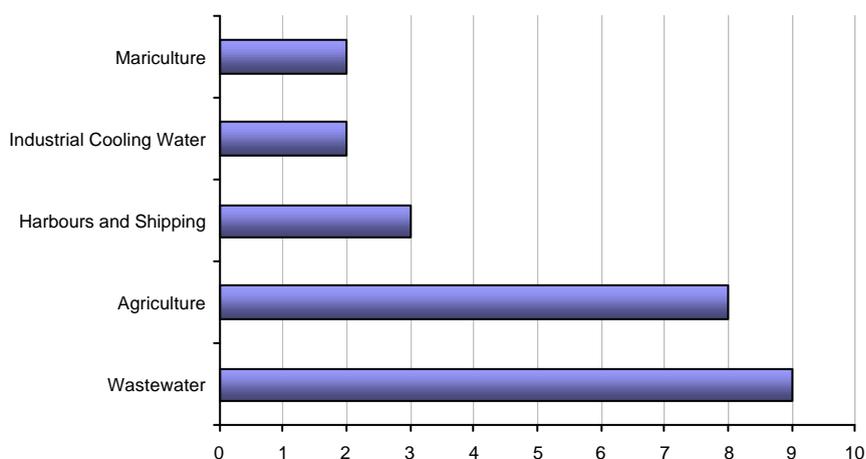
The main anthropogenic impact on the estuaries is caused by wastewater, which was reported as a threat in all but one of the estuaries (Table 2, Fig.1). All of the estuaries receive either direct discharges of wastewater or the influx of wastewater discharged into the rivers, or both. The wastewater released into the estuaries and rivers consists mainly of municipal and industrial wastewaters that receive at least a biological level of treatment, however, a small percentage only receives mechanical treatment and in some countries untreated municipal wastewater is also released into the watercourses. In the European Union member countries the council directive 91/271/EEC on the

Treatment of Urban Waste Waters sets the standard of treatment for municipal wastewaters. The directive also applies to some industrial sectors, such as the food processing industry.

According to the Waste Water Directive all wastewater from municipalities with a population equivalent (p.e.) of 15,000 (10,000 if the receiving waters are considered sensitive) or more must be treated at least to secondary level of treatment, i.e. be biologically treated, before being discharged into a water body. By the year 2005 this will include all municipalities with a p.e. of 2000 or over. Although the directive may not be fully implemented in all countries due to restrictions on time and resources, it is an important move towards better treatment of wastewaters and has also been included in the legislation of some of the European Union Candidate Countries. However, even if all of the facilities to provide adequate treatment of wastewater at least to the secondary level, and in some cases also tertiary level of treatment, are present, the treatment facilities may in some cases be overwhelmed during strong rainfall or the tourist season, when there is a massive increase in the local population (OSPAR, 2000a; OSPAR, 2000b). In more rural areas the treatment of wastewater is lacking due to the absence of the required infrastructure for the collection and treatment of wastewater.

The other major environmental impact on the estuaries is caused by diffuse pollution originating from agriculture and the sparsely populated areas with no wastewater treatment facilities, situated around the estuary and the river catchment. In those particular estuaries where there are large harbours and a lot of shipping traffic, the harbour industries surrounding the estuary and their related shipping traffic were considered an important source of both point and diffuse pollution. Other threats mentioned in the questionnaire replies included mariculture and the heat pollution caused by discharge of industrial cooling waters, which can cause more localised adverse effects on the ecosystem as well as the more general impact of atmospheric deposition of contaminants (Table 2, Fig.1).

**Figure 1. Threats reported in estuaries. Figure shows the number of estuaries where a particular impact or threat was reported.**



## 4. Current Monitoring Practises

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A water quality monitoring programme covers the whole process from the acquisition of quantitative information on the physical, chemical and biological characteristics of the water body using statistical sampling methods to the interpretation and reporting of the results. The type of information required depends on the aims and objectives of the monitoring programme, which can range from maintaining the quality of drinking water to assessing the current ecological state of the aquatic environment and detection of spatial and temporal trends in the physical, chemical and biological characteristics of water quality. (Kristensen & Bøgestrand, 1996).

The objectives of the monitoring programmes in the estuaries, are largely based on the requirements of national water laws and regulations and, in the EU Member and Candidate countries, EU directives. Monitoring programmes are also influenced by the requirements of international agreements, such as the regional seas conventions and in some cases the bilateral agreements between riparian countries. There are twelve EU directives, which have monitoring requirements that apply to estuaries. There are differences between the monitoring requirements of directives, ranging from preliminary investigations to routine monitoring and the extent to which these overlap each other depends on the national implementation of the directive requirements. The monitoring undertaken as a result of the directives will therefore vary from country to country, with differences in sampling and analytical techniques as well as at the reporting stage (Nixon *et al*, 1996). Most of these directives have now been integrated into the Water Framework Directive (2000/60/EC), which was drafted in an attempt to unify the requirements of the directives and create a more integrated water policy. The WFD will be looked at in more detail in Chapter 7.

Estuaries are rarely monitored separately, but are most often included as a part of a national water monitoring programme covering different types of surface waters or incorporated into coastal or river monitoring programmes. In almost every case the aims of the monitoring programmes in the estuaries were reported to include investigations on temporal and spatial change in the natural environment and the detection of trends. The information gathered is used in the management of waters. Other important monitoring objectives are investigations of anthropogenic impact and the effectiveness of measures as well as checks on compliance with laws and criteria.

### **Organisations and guidelines**

National guidelines and standards make national monitoring efforts more consistent and thus easier to interpret and compare. Adhering to shared international standards and guidelines in turn makes the comparison of monitoring results from different countries easier, and thus eases the exchange of monitoring information between riparian countries. All but one of the countries reported having national guidelines on monitoring. In seven out

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of the ten estuaries monitoring is conducted according to international guidelines or standards set by a convention or an agreement.

In most cases the monitoring activities are overseen at national levels of environmental administration, however in Germany the top environmental administration stands at the state, or Länder, level. Collection and analysis of samples is mainly conducted at regional and local levels, although in four out of the nine countries at least some of the sampling is done at a national level. In the case of the Ems-Dollard and Oder estuaries parts of the monitoring is also conducted by international organisations. In most of the cases information is stored both regionally and nationally. Three out of the nine countries hold some data locally although in all of these cases data is also forwarded either to a regional or national level, or both. Data is held exclusively at a national level in two countries. One country provided no information on the handling and storage of data.

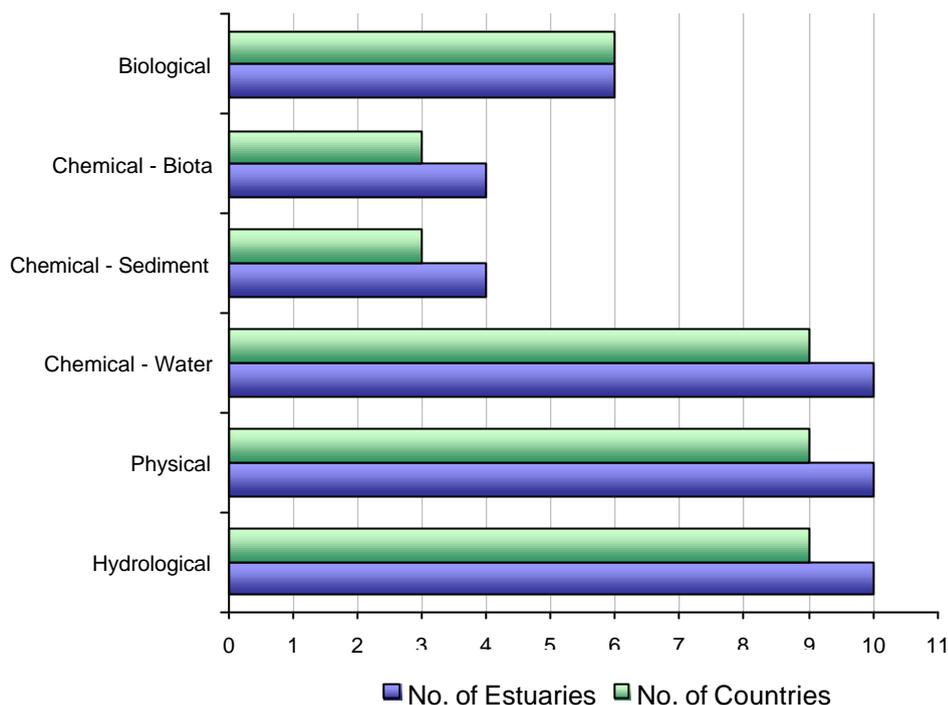
### ***Variables and media sampled***

In most of the countries that replied to the questionnaire the variables to be included in monitoring of the estuary are chosen according to the requirements of their national legislation, which is often based on EU directives, and in many cases also according to the requirements of their regional conventions (HELCOM, OSPAR and MAP) or other international agreements. Often variables are chosen to indicate signs of specific threats such as eutrophication and industrial impacts. The choice of variables as well as the number of sampling stations and frequency of sampling is often limited by the lack of available funds, equipment and human resources.

**General Factors.** All of the countries measure at least some of the basic hydrological factors such as river inflow, flow in estuary and water level and physical factors such as salinity, temperature, pH, O<sub>2</sub>, conductivity, turbidity and alkalinity (Fig. 2). Basic indicators of organic pollution such as BOD, COD and TOC are also monitored in the water phase in different combinations by eight out of the nine countries and in sediments by two countries. Eight out of the nine countries also monitor effluents discharged into the water body. The influx of pollutants from the river is also monitored by most of the countries. Two countries monitor litter.

**Nutrients and Chemical Pollutants.** All of the countries also monitor the concentrations of various different combinations of nutrients and chemical pollutants. Chemical factors are most commonly monitored in the water phase. Measuring the concentrations of contaminants in the water phase only can, however, give a distorted picture of the pollutant load, as it ignores the stores of pollutants in the sediments, which may be released back into the water column at a later stage. It would be preferable to also monitor the concentrations of nutrients and pollutants stored in the sediments in addition to the measurements made in the water phase. In order to observe the biologically relevant levels of contaminants the pollutant load of the biota should be investigated as the load in biota shows the actual bioavailable concentration of pollutants in the environment. Only three of the nine countries also investigate the concentrations of chemical pollutants in sediments and biota (Fig. 2).

**Figure 2. Types of monitoring.** The figure shows the number of estuaries and countries where different groups of variables are monitored



Eight of the nine countries monitor nutrient load in the water phase on a monthly or seasonal basis; one country provided no information on the frequency of monitoring. All of the countries monitor total Phosphorus (P) and Nitrogen (N) concentrations and eight out of nine measure phosphates, nitrates and ammonia. Six of the countries monitor silicate concentrations. Eight countries monitor heavy metals, including Cd, Hg, Pb, Cu and Zn, in the water phase. Two of the countries monitor metals once a year, four on a monthly or a seasonal basis and in one country metals are sampled every other month; one country provided no information on monitoring frequency.

The monitoring of organic pollutants, such as TBT, PCBs, DDT, PAHs and HCH, in the water column is less extensive, although six of the countries monitor different combinations of at least one or two persistent organic chemicals. The monitoring of organic pollutants is carried out annually by one country, whereas two countries monitor them seasonally, one every other month and one monthly; one country gave no information on the frequency of monitoring. The monitoring in the water phase is mainly conducted near the surface of the water column, only one country also takes measurements near the bottom, and another produces vertical profiles of total N and P concentrations.

Only one of the nine countries also measures the concentrations of nutrients in estuarine sediments. Three countries measure the concentrations of heavy metal in sediments, two annually and one once in three years. The same three countries also monitor the concentrations of varying combinations of organic pollutants in sediments, one annually, one three times a year and one once in three years. Two countries also monitor the concentration of heavy metals found in biota on an annual basis. In one country a range of organic

contaminants are monitored in biota and another country monitors the levels of DDT in biota.

**Biological Monitoring.** Six out of the nine countries execute some stage of biological monitoring (Fig. 2). The two most commonly monitored biological factors are chlorophyll concentration and phytoplankton species composition, which are monitored by five of the countries on a monthly basis or during the phytoplankton blooms. The monitoring of faecal pollution indicators is also relatively commonly. Four of the countries monitor total coliforms, three countries faecal coliforms and one country faecal streptococci. Three of the nine countries also monitor the species composition of the macrozoobenthos, their abundance being monitored by two countries. One or two countries monitor variables such as phytobenthic biomass and species composition, zooplankton abundance and species composition or fish, birds, or mammals in different combinations.

**Table 3. Groups of variables monitored (v) in different countries. For the chemical variables a distinction has been made as to the sampling media used: ? = Water ? = Sediment ? = Biota**

<i>Variables</i>	<i>Country</i> <sup>(1)</sup>									
	BA	EE	ES	FI	GE	LT	NL	PL	TU	
<b>Hydrological</b>	v	v	v	v	v	v	v	v	v	v
<b>Physical</b>	v	v	v	v	v	v	v	v	v	v
<b>Chemical</b>	v	v	v	v	v	v	v	v	v	v
<i>Nutrients</i>	?	?	?	?	??	?	?	?	?	?
<i>Heavy Metals</i>	?	?	?		??	???	???	?	?	?
<i>Organic Pollutants</i>		?	?		?	???	???	?	?	?
<b>Biological</b>	v			v	v	v	v	v		
<i>Phytoplankton</i>				v	v	v	v	v		
<i>Zooplankton</i>				v		v				
<i>Faecal Pollution</i>	v					v		v		
<i>Macrobenthos</i>					v	v	v			
<i>Vertebrates</i>							v			

<sup>(1)</sup> Country codes: BA = Bosnia-Herzegovina FI = Finland EE = Estonia ES = Spain GE = Germany LT = Lithuania NL = The Netherlands PL = Poland TU = Turkey (ISO 3166 A2)

### **Quality Assurance**

Quality Assurance (QA) procedures are important in assuring the reliability and usefulness of the data gathered in a monitoring programme. Using

standardised procedures in analysis produces data of known quality and enables the comparison of results from different studies. Only one out of the eight countries who replied to the questionnaire stated there were no QA procedures in use in the monitoring of their estuary. Most others followed the quality assurance procedures of their regional convention, or other internationally accredited procedures including interlaboratory calibrations and international reference materials. Some followed QA procedures set by their national standards.

### ***Reporting of Monitoring Results***

One of the countries gave no information on the reporting of monitoring results in their questionnaire reply. In the countries that did provide such information reporting of the results from water monitoring programmes is mainly performed at a national or regional level, although there are some locally prepared published reports. Most countries publish public reports at annual intervals. Five out of eight also publish some results on the Internet, but access to the databases is often limited. Most of the countries also forward monitoring information onto one or more international databases, such as EUROWATERNET, EUROSTAT, EEA, ICES and in most cases also to their regional convention databases, where the information will be available to other users. In all of the countries at least finished reports are available to the general public and in some cases some of the raw data is also available by request.

## 5. International Co-operation in Monitoring

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Achieving increased international co-operation in monitoring is an integral part of the Water Convention. The co-operation is to be achieved through the development of bilateral agreements enabling the setting up of joint or co-ordinated monitoring programmes between parties sharing a water body, as well as initiatives on information sharing. Joint or co-ordinated monitoring initiatives ensure the compatibility of data produced by the riparian countries thus easing the sharing of the information obtained from the common water body; therefore, forming the basis for concerted water management. Only three of the nine estuaries reported a good, working system of information exchange between the authorities. No information exchange at governmental level was reported for the remaining six estuaries, although in some cases there is extensive information exchange among research institutes

### *International agreements*

In four of the ten estuaries at least part of the monitoring is based on an international agreement. There are no treaties or agreements that have been drafted solely for estuaries; however, nearly all of the estuaries investigated in this report are included in some kind of bilateral or multilateral agreement that advocates co-operation in monitoring and sustainable water management (Table 4.). Some are general bilateral agreements between countries regarding all of their shared water resources and thus including the transboundary estuaries in question. There are also agreements covering whole rivers, which also include the estuary of that particular river. Agreements on the joint monitoring and assessment of coastal marine areas often also include the estuaries in that particular area (Box 1.).

#### **Box 1. The Trilateral Wadden Sea Co-operation**

Since the year 1978 the governments of The Netherlands, Denmark and Germany have been working together on the protection and conservation of the Wadden Sea through co-operation in management, monitoring and research. TMAP, The Trilateral Monitoring and Assessment Program of the Wadden Sea, aims to provide a scientific assessment of the status and development of the Wadden Sea ecosystem and to assess the status of implementation of the trilateral Targets of the Wadden Sea Plan. Assessment reports based on data from the existing national monitoring programmes of the member countries are produced every 3-4 years, related to the Trilateral Governmental Conferences. The reports describe and evaluate the current ecological status of the Wadden Sea, identifying issues of concern and indicating possible measures. All of the area's six estuaries, including the transboundary Ems-Dollard estuary, are included in the assessments. The assessments cover a relatively extensive range of factors, including measurements of chemical parameters such as nutrients, metals, and organic pollutants in water, sediment and biota as well as biological parameters, such as phytoplankton, zooplankton, macrobenthos and fish. TMAP also works in co-operation with OSPAR's monitoring programme JAMP, and information is shared between the two. An overview of the TMAP data is available via the Internet whilst the downloading of the actual data is restricted to selected expert groups responsible for assessing and publishing the data (Bakker *et al*, 1997; De Jong *et al*, 1999).

In reality the state of implementation of the treaties and agreements has a significant effect on whether they are actually working or not. The actual level of co-operation may often be much lower than that aimed for through the signing of an agreement. Very little information was offered on the state of implementation on the different treaties and agreements, but some countries are still working on new legislation and regulations in order to implement different treaties and conventions. Some countries that reported agreements including provisions for joint or co-ordinated monitoring initiatives, also stated that at the present time there are no joint or co-ordinated monitoring programmes in operation. In some countries the financing of the environmental field is lacking and thus the implementation of these agreements into actions is dragging behind (Gooch et al, 2002). One country gave no information at all on co-operation in monitoring.

### ***Conventions and International Monitoring Initiatives***

The European regional seas are all covered by conventions, which all give guidelines on monitoring of the marine area they cover and obtain national results to be included in a large database to serve the whole convention area. Although none of the regional conventions directly assess the water quality of European estuaries, the data collected includes data from larger estuaries (France et al, 1996). The conventions are relatively complete and incorporate the necessary tools to achieve compatible monitoring information covering a large area, but they need to be enforced and co-ordinated in order to function properly and there are still fundamental economic and scientific constraints to achieving uniform coverage (Peronaci, 1999). Conventions also only perform large-scale assessments covering large areas over long time intervals, with several years between assessments. Due to analytical difficulties or the lack of Quality Assurance procedures some parameters are measured only on a voluntary and not on a mandatory basis contributing to a lack in consistency and regularity in many existing datasets. There is generally a lack of data on biological effect parameters and estimates of contaminant fluxes are generally scarce or lacking (Bokn & Skjoldal, 1999).

**The Helsinki Commission (HELCOM).** The Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 stipulates that the Contracting Parties, individually or jointly, are to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea Area and the preservation of its ecological balance. Data on physical, chemical and biological variables collected under the COMBINE programme are used for wide ranging Periodic Assessments of the state of the Baltic. Discharges and emissions within the Baltic Sea drainage basin are mainly monitored under HELCOM's Pollution Load Compilation Programmes (PLC). Both programmes include monitoring stations in the larger Baltic estuaries. The data is stored in the ICES databank and is easily accessible to the Helsinki Commission and the Contracting parties, and after validation to the members of the scientific community and the public (Manzella & Nair, 1998).

**Oslo and Paris Commission (OSPARCOM).** The 1992 OSPAR Convention on the Protection of the Marine Environment of the North-East Atlantic requires that Contracting Parties take all possible steps to prevent and

eliminate pollution to protect the marine environment. This includes undertaking and publishing joint assessments of the quality status of the marine environment and its development, in the form of the Joint Assessment and Monitoring Programme (JAMP). The Ems-Dollard, Scheldt and Minho estuaries as well as the Guadiana estuary are all included in JAMP (Izzo *et al*, 1998). The raw scientific data derived from JAMP is stored in the ICES databank, where all of the Contracting Parties have free access to the data. Other organisations can also have access on the basis of a formal request. In general all data are available to the public but the laboratory providing the data can limit data accessibility (Manzella & Nair, 1998).

**Mediterranean Action Plan (MAP).** The Mediterranean Action Plan was established to implement the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. The Work Programme of MAP aims to protect and manage the Mediterranean marine resources. The Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL) was set up to produce information required for the implementation of the Barcelona Convention and its protocols. MED POL aims to formulate environmentally sound national and multilateral management decisions and to analyse the sources, levels, trends and effects of pollutants and the effectiveness of antipollution measures and to produce periodic assessments of the state of the Mediterranean (Izzo *et al*, 1998). All of the Contracting Parties have access to the data. Raw data are not accessible to the general public however published assessment documents are available (Manzella & Nair, 1998). No information was available as to the estuaries included in the MED POL monitoring programme.

**The Black Sea Environmental Programme (BSEP) and The Caspian Environmental Programme (CEP).** The Strategic Action Plan for the Rehabilitation and protection of the Black Sea (BS-SAP), 1996, which was created following the Odessa Declaration, 1993 and the Bucharest Convention, 1994 includes provisions for co-ordinated monitoring programmes in the Black Sea, including the measurement of the load carried by rivers, but does not specify monitoring of estuaries. The Caspian Environment Programme (CEP) is a regional programme aiming to protect the environment of the Caspian Sea and to promote sustainable development in the area. The CEP addresses multiple environmental and bioresource issues, including effective regional intersectoral co-ordination and environmental management, public awareness and involvement in the CEP, including the National Caspian Action Plans (NCAP) and the regional Strategic Action Programme (SAP). The aims of the CEP include establishment of regional data and information management systems and a regional assessment of contaminant levels as well as integrated transboundary coastal area planning and management and regional emergency response actions. CEP does not, however, have an estuarine monitoring programme. The monitoring of estuaries if ever attempted is the responsibility of the national governments (pers. comm. H. Ghaffarzadeh, CEP).

**Table 4. Bilateral and multilateral agreements between the riparian countries and the regional marine conventions relevant to the monitoring of European transboundary estuaries.**

<i>Estuary (Riparian Countries)</i>	<i>Bilateral and multilateral agreements/treaties</i>	<i>Regional Convention</i>
<b>Curonian Lagoon</b> (Lithuania/Russian Federation)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Agreement between governments of Russian Federation and Republic of Lithuania on Cooperation in the Field of Environmental Protection, 29<sup>th</sup> June 1999</li> </ul>	HELCOM
<b>Ems-Dollard</b> (Germany/Netherlands)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Permanent Dutch-German Transboundary Waters Commission</li> <li><input type="checkbox"/> The Wadden Sea Trilateral Co-operation, 1997</li> </ul>	OSPAR
<b>Gdanski Basin</b> (Poland/ Russian Federation)	<ul style="list-style-type: none"> <li><input type="checkbox"/> The Agreement between the Government of the Republic of Poland and the Government of the Russian Federation on Co-operation in the Field of Environmental Protection 25.08.1993</li> <li><input type="checkbox"/> The Agreement between the Government of the Republic of Poland and the Government of the Russian Federation on Co-operation of North-Eastern Voivodeships of the Republic of Poland and the Kaliningradzki District of the Russian Federation 22.05.1992</li> <li><input type="checkbox"/> The Agreement between the Government of the Republic of Poland and the Government of the Russian Federation on Co-operation of the Regions of the Republic of Poland with the Region of Sankt-Petersburg of the Russian Federation 2.10.1992</li> <li><input type="checkbox"/> The Agreement between the Government of the Polish People's Republic and the Union of Soviet Socialist Republics on Co-operation on the Transboundary Water 17.07.1964</li> </ul>	HELCOM
<b>Meriç</b> (Greece/Turkey)	<ul style="list-style-type: none"> <li><input type="checkbox"/> None reported</li> </ul>	MAP
<b>Miño</b> (Portugal/Spain)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Convention on Co-operation for Portugese-Spanish River Basins, 17<sup>th</sup> January 2000</li> </ul>	OSPAR
<b>Narva</b> (Estonia/Russian Federation)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Agreement between the Government of the Estonian Republic and the Government of the Russian Federation in Cooperation in Protection and Sustainable Use of Transboundary Waters, 20<sup>th</sup> August 1997</li> </ul>	HELCOM

**Table 4 (Continued). Bilateral and multilateral agreements between the riparian countries and the regional marine conventions relevant to the monitoring of European transboundary estuaries.**

<i><b>Estuary (Riparian Countries)</b></i>	<i><b>Bilateral and multilateral agreements/treaties</b></i>	<i><b>Regional Convention</b></i>
<b>Neretva</b> (Bosnia-Herzegovina/Croatia)	<ul style="list-style-type: none"> <li><input type="checkbox"/> (Agreement on water management under revision)</li> </ul>	MAP
<b>Szczecinski Lagoon</b> (Germany/Poland)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Convention on the international Commission for the Protection of the Oder, 11<sup>th</sup> April 1996</li> <li><input type="checkbox"/> Agreement between the Republic of Poland and Federal Republic of Germany on Co-operation in the Area of Transboundary Waters, 19 May 1992</li> <li><input type="checkbox"/> Agreement on Co-operation in the Fields of Environmental and Nature Protection between the Mecklenburg-Vorpommern and Szczecin Voivodeship, 1991</li> </ul>	HELCOM
<b>Scheldt</b> (Belgium/Netherlands)	<ul style="list-style-type: none"> <li><input type="checkbox"/> ICBS (Verdrag inzake de bescherming van de Schelde) Charleville-Meziere, 26 April 1994</li> </ul>	OSPAR
<b>Violahti</b> (Finland/Russian Federation)	<ul style="list-style-type: none"> <li><input type="checkbox"/> None</li> </ul>	HELCOM

## 7. The EU Water Framework Directive

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The future implementation of the European Union Water Framework Directive (WFD) 2000/60/EC will change the focus of European water policy and thus routine water quality monitoring more towards a whole catchment based approach. The directive attempts to co-ordinate the practises of water management in all of the EU member states to be based on management plans made for River Basin Districts (RBD), which are to be identified and designated by the member states. River Basin Districts are defined as the area of land and sea made up of one or more river basins together with their associated groundwaters and coastal waters. International River Basin Districts are formed where a river basin covers the territory of more than one member country.

Co-ordinated surface water monitoring programmes are to be established for the whole River Basin District according to the detailed guidelines and standards set out in the directive in order to provide a coherent and comprehensive overview of the ecological and chemical status of the water bodies. The monitoring is to be established in the form of surveillance and operational monitoring programmes. The surveillance monitoring programme is aimed at providing information on long term changes in natural conditions and resulting from anthropogenic activity and is carried out at set intervals. The operational monitoring should be carried out to establish, and assess any changes in, the status of water that have been identified as being at risk of failing to meet their environmental objectives. Additional to these investigative monitoring must be carried out when water quality standards have not been met and the reason for this is unknown, or to ascertain the magnitude and impacts of accidental pollution. Monitoring must also include an estimate of the pollution load which is transferred over Member State boundaries and which is transferred to the marine environment.

In the case of international River Basin Districts the member states concerned should work together to ensure co-ordination. Existing structures stemming from international agreements can be used to achieve the needed co-operation and help from the European Commission is available in organising co-ordination. The effects of the WFD are likely to reach further than the EU Member States, as where a River Basin District extends outside the EU, the Member States are to make an effort to establish appropriate co-ordination with the non-member states with the aim of achieving the objectives of the directive throughout the River Basin District. This will also include the EU countries sharing their expertise and technology to help the countries with less well developed monitoring systems and equipment.

The initial operational monitoring programmes are to be in force by the end of 2006 and River Basin Management plans with their inclusive monitoring programmes and are to be published by 2009. In the meantime work is done to ensure inter-calibration of monitoring systems among Member States and create useful guidelines to ease implementation.

## 8. Conclusions

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Due to the small number of replies to the questionnaire, the actual number of transboundary estuaries in the whole ECE area was left unclear and the inventory presented in this report is therefore incomplete. Difficulties were experienced especially in attempting to gain information from the countries bordering the Black Sea and the Caspian Sea. It was very difficult to get through to the focal points in these countries and none of them, with the exception of Bulgaria and Romania, replied to the questionnaire. In many cases it was assumed the request never reached the appropriate person. However there were also countries in Western Europe who failed to respond to the questionnaire. Eventually thirteen estuaries were identified either through the questionnaire replies or other communication. Monitoring information was received for nine out of these thirteen estuaries. The limited amount of information received, and the large variation in the standard of the obtained information made the analysis of results quite difficult, and the results can only be taken as indicative.

In most countries the monitoring of estuaries is executed as a part of their national surface water monitoring programmes, which aim to produce relevant information for the management of waters. The monitoring programmes and the variables measured are largely based on the requirements stated in national legislation, which in the EU Member and Candidate Countries are often based on a multitude of EU directives. International conventions, such as HELCOM, OSPAR and MAP, also impose their own requirements of information to be included in their databases and assessments to the monitoring programmes of their member countries. The monitoring programmes are in all cases but one overseen and the data stored at national levels of environmental administration. Germany is an exception as there the highest environmental authorities are at the regional level of the separate States. The actual sampling and analysis of samples is most often done locally or regionally. This places great importance on ensuring the accuracy and compatibility of the data gathered and analysed by the different institutions and laboratories and calls for advanced Quality Assurance procedures.

The ability to compare results produced in different countries, and thus share the results of monitoring programmes requires the co-ordination of the methods used in sampling and analysis. Most countries that replied reported using international standards and accredited methods as well as interlaboratory calibrations and international reference materials. Most of the countries have use of an internationally accredited laboratory. In many cases the sampling and analytical techniques are chosen following the instructions given by the regional conventions. In some cases, such as the Oder estuary, monitoring is also jointly planned, although actual sampling and analysis is conducted by the relevant institutions in each country. Joint planning and harmonisation of methods is what should be aimed for, as it is necessary to ensure the usefulness of information gained in the monitoring programmes for both parties and forms the basis of co-operation in the management of waters.

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The estuarine monitoring programmes are relatively comprehensive in the water phase, with good coverage of nutrients and chemical pollutants, but there are still gaps in the monitoring of contaminants in sediments and biota and in the extent of the use of biological monitoring. The biological monitoring practises are currently often limited to the measurement of phytoplankton during the blooms of the growing season, as an indicator of eutrophication. The issue of biological monitoring and the use of bioindicators to study the contaminant load will be addressed, at least in the European Union Member Countries and in many of the Candidate Countries by the future implementation of the Water Framework Directive, which includes an assessment system, based on a more biological outlook on monitoring. Water quality will be derived from both the ecological quality and the chemical quality of the water body.

All of the estuaries are covered by some kind of agreement promoting co-operation in monitoring and the sharing of monitoring information among riparian parties. Some information is shared as a result of the regional seas conventions through the data forwarded to their databases, which is freely available to all convention parties. Bilateral agreements stating provisions for co-ordinated or joint monitoring initiatives are also in force but the agreed co-operation in monitoring has actually been achieved only in a few cases. The lack of appropriate legislation, economic constraints and political differences often stand in the way of putting agreements into practise. However information sharing at the level of research institutes was reported as being good also in the countries where the governmental co-operation and information sharing was deficient.

The implementation of the EU Water Framework Directive will increase the co-ordination and co-operation in monitoring activities at least inside the European Union but also aims to include the nations sharing transboundary waters with Member Countries. The use of catchment-based management requires co-operation among the countries sharing the catchment and a harmonised monitoring and management plan will be created for each River Basin District. However, the implementation of the WFD, especially concerning the International River Basin Districts reaching outside the European Union, will face the same economic and political restraints as with the other agreements and treaties.

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## Appendix 1: Countries and Main Contact Persons

<i>Country</i>	<i>Contact Person(s)</i>	<i>Reply</i>
ALBANIA	Mrs. T. Hema	
AZERBAIJAN	Mrs. M. Adigezalova	
BELGIUM	Dr. J. Pauwels	X <sup>1)</sup>
BOSNIA AND HERZEGOVINA	Ms. E. Kupusovic	√ <sup>2)</sup>
BULGARIA	Mr. Stetoslav Cheshmedjiev	v
CROATIA	Mr. Z. Ostojic	
DENMARK	Mr. Leo Bjørnskov	
ESTONIA	Mr. H. Liiv	v
FINLAND	Ms. P. Kauppila	v
FRANCE	Mr. Jean Paul Rivaud	
GEORGIA	Mrs. Mariam Makarova	
GERMANY	Mr. T. Stratenwerth, Mr. R. Gade, Mr, M. von Weber	v
GREECE	Mrs. Phani Daskalopoulou-Livada	
ITALY	Mrs. Viviana Bianco	
KAZAKHSTAN	Ms. Yelena Kochenova	
LATVIA	Mr. R. Bebris	
LITHUANIA	Mrs. V. Vinceviciene	v
NETHERLANDS	Ms. M. Dirkson	v
NORWAY	Mr. Ole.T. Nyvoll	X
POLAND	Mrs. M. Landsberg-Uczciwek, Ms. H. Sozska	v
PORTUGAL	Mr. L. Veiga de Cunha	X
ROMANIA	Ms. A. Drapa	v
RUSSIAN FEDERATION	Mr. Valery Kukosh	X
SLOVENIA	Mr. Marko Slokar	
SPAIN	Mr. M. Varela	v
SWEDEN	Ms. K. Pettersson	X
TURKEY	S. Erdogan, S. Bagci	v
TURKMENISTAN	Mr. Durdymurat Bayarammuradov	
UKRAINE	Mr. Yaroslav Movchan	
YUGOSLAVIA	Dr. Andjelka Mihajlov	

<sup>1)</sup> Country acknowledged the receipt of the questionnaire but did not send a reply

<sup>2)</sup> Country replied to the questionnaire