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International river basin management under the EU Water Framework Directive: An assessment of cooperation and water quality in the Baltic Sea Drainage Basin

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Contents

Abstract

This report address issues connected to *international* river basin management in line with the EU Water Framework Directive. A register, in the form of a GIS data layer, of River Basin Districts established under the directive is presented. The register was created based on official maps of River Basin Districts from EU member states and candidate countries. With the register in place, the number and extent of international River Basin Districts could be determined. The results show that the number and area of international districts are significant. According to the register, 33% of the districts are international, and area-wise the international districts cover 70% of the total area of the districts. Further, a case study elucidating the connections between international cooperation and water quality in 14 international river basins in the Baltic Sea Drainage Basin is presented. The case study tries to connect indicators of cooperation with indicators influencing or describing water quality. The results show that the WFD is a push forward for international river basin management in the region. This is especially true for international river basins shared by EU member states, while the WFD in general, and the principle of river basin management in particular, may be hard to implement in river basins shared between EU member states and countries outside the EU. According to the analysis, Vistula, Pregola and Nemunas are the international river basins in the Baltic Sea Drainage Basin with least international cooperation and – at the same time – most severe water quality problems.

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International river basin management under the EU Water Framework Directive: An assessment of cooperation and water quality in the Baltic Sea Drainage Basin

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1. Introduction

During the last decades, there has been a call for more integrated management of rivers, lakes and groundwater, taking into account different social, economic, as well as environmental aspects of water issues (GWP, 2000; UN ECE, 1996). Along with these ideas, the river basin has emerged as the most appropriate spatial management unit for water, as opposed to more conventional administrative or political units (GWP, 2000). The concept of river basin management is furthermore a key-principle of the EU Water Framework Directive (WFD), adopted in 2000. According to the directive, EU member states should by 2003 have identified river basins, assigned them to River Basin Districts (RBDs) and appointed competent authorities to manage the districts. A RBD may be made up of either one single river basin (i.e. a "stand-alone" RBD) or of a combination of several small river basins (i.e. a "combined" RBD), together with associated groundwater and coastal waters. For each district, the directive requires that a characterization in terms of pressures, impacts and economics of water uses, is performed, environmental objectives are specified, and a programme of measures for achieving the objectives is elaborated in cooperation with stakeholders. All these steps will be documented and compiled into a River Basin Management Plan (RBMP), which should be ready by 2009. River basins that extend across international borders should be assigned to international RBDs. The directive specifies that member states should ensure cooperation on international RBDs lying within the territories of the EU, e.g., by producing joint RBMPs. However, somewhat confusingly, the directive at the same time indicates that if not produced, plans must then be set up for the part of the district falling within each country's own territory. If the basin extends beyond the territories of the EU, the directive encourages member states to establish cooperation with non-member states and, thus, manage the water resource on a basin level.

Although the WFD is generally regarded as an innovative and ambitious piece of environmental legislation, more critical voices have expressed a fear that the vague formulations in the directive may result in weak and ambiguous interpretations by member states in the implementation of the directive (Grimeaud, 2001), and, in fact, evidence of this has already been reported (EEB & WWF, 2005). Further, Macrory & Turner (2002) points out that although the international dimensions are more explicit in the WFD than in other EU directives, potentially forcing member states to move towards close cooperation in managing shared river basins, the strict legal requirements to actually achieve joint management are weak. Hence, there is an uncertainty regarding the implementation of the WFD in general, and the interpretations of its international aspects in particular. On the basis of this notion, an earlier study (Nilsson et al., 2004) tried to identify the number and area of international RBDs by assessing proposals of RBDs collected from member states and candidate countries. The study showed that about 1/3 of the districts are international and that international districts cover 2/3 of the total area of the districts. The study additionally showed that the plans and ambitions for cooperation on international districts vary quite considerably. These results further emphasize the need for taking *international* aspects of river basin management into account, since neglecting these may result in a failure of achieving one of the key-principles, the river basin approach, of the WFD.

The Baltic Sea Drainage Basin (BSDB) is a large heterogeneous region. The drainage basin covers an area of 1 745 000 km^2, is shared by 14 countries (Belarus, Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russia, Slovakia, Sweden and Ukraine) and home to about 85 million people (Sweitzer et al., 1996). During the last decades, the countries in the BSDB have experienced vast political changes. Following the break-up of the Soviet Union, there is today as many as ten EU member states and one EFTA state (Norway) in the basin. The southern parts are densely populated, partly heavily industrialized and dominated by arable land, while the northern parts are more sparsely populated and dominated by forest. Many of the rivers and lakes in the region are international and quite a large proportion are facing transboundary water quality problems primarily caused by excess of nutrients and pollution from hazardous substances (see e.g. Buszewski et al., 2005; IWAC, 2001; Lysiak-Pastuszak et al., 2004). The Baltic Sea itself is a sensitive ecosystem of high importance. From the late 1960's and onwards there have been numerous reports about the severe ecological status of the sea, due to human activities in the drainage basin (e.g. Elmgren, 2001; HELCOM, 2003). In order to improve the ecological state of the Baltic Sea, both politicians and scientists in the countries around the sea have taken action through, e.g., the establishment of the Helsinki Commission (HELCOM) and the initiation of a number of research projects (e.g. Gren et al., 2000; MARE, 2003; Turner et al., 1995). The efforts taken have halted the negative development and in some cases also improved the water quality; however, serious problems, such as eutrophication, still remain (HELCOM, 2003; Miljövårdsberedningen, 2005). The varying conditions – in terms of different political, socio-economic, and environmental situations – of the countries and river basins in the BSBD makes it an interesting case for exploring international river basin management under the WFD more thoroughly.

The objective of this study is threefold. The first objective is to identify the number and geographical extent of international RBDs established under the EU WFD. This will be done by creating a harmonized geographical dataset of RBDs based on the results reported by Nilsson et al. (2004), and updated with official information available as of December 2003. The second objective is to elucidate the connections between current international cooperation on water quality issues and the actual environmental conditions in international river basins. This will be accomplished through a case study on international river basins in the BSDB. The results from the case study may feed into initiatives, such as the "Workshop on Transboundary Water Management at the North-

Eastern Border of the European Union", a meeting organized by the Government of Poland, the European Commission and UN ECE in October 2005. The third and final objective is to initiate a discussion on the practical applicability of the "river basin management principle" of the WFD in international river basins.

2. Creation of RBD register

2.1 Methods

The creation of the geographical data register of RBDs was based on official maps of RBDs from countries implementing the WFD; that is, EU member states, candidate countries except Turkey[1], and Norway. The maps were collected from web pages or provided by informants well acquainted with its own country's implementation of the WFD. Italy, Greece and Croatia have, as per 30 June 2005, neither identified RBDs nor appointed competent authorities, and they were therefore excluded from the survey. In Norway and Spain there have not, as per 30 June 2005, yet been decisions concerning RBDs and competent authorities, but as proposals exist they were included in the register. Although the directive requires that also groundwater and coastal waters are identified and assigned to RBDs, this information was not incorporated in the register; the main reason being that data on this were partly lacking.

As mentioned in the introduction, the WFD requires that international river basins should be assigned to international RBDs. However, the directive does not define an international district, but instead this is up to each member state to interpret and decide. Rather than using member states' own definitions of international RBDs, which may vary due to different interpretations of the directive text, an own definition of an "international river basin district" was elaborated for the sake of this study. An "international river basin district" was thus defined as "a RBD where at least one river basin in the district covers the territory of more than one country". In general, all districts with at least one river basin where more than 500 km^2 or 3% of the basin area covered the territory of more than one country was considered as an international district. Additionally, basins/districts not fulfilling the requirements outlined above, but where the countries sharing the basin/district explicitly regard it as international were also considered as international districts.

The register, in the form of a Geographical Information Systems (GIS) data layer, was prepared following the same procedure as in Nilsson et al. (2004). A GIS data set in the scale of 1:1 million on river basins draining into the sea, provided by EU's scientific and technical research laboratory the Joint Research Centre (JRC, 2003a), combined with a GIS data set on international boundaries (ESRI, 2005), were used as digital data input. By using the collected analogue map material on RBDs as reference material, all river basins belonging to one district were selected, unified into one polygon and given a unique ID number. Thus, the borders of the RBDs were defined based upon the borders of the river

[1] Turkey was not included since the input data set on river basins did not cover Turkey. As the decision to exclude Turkey was based on the availablity of input data, the implementation of the directive in Turkey was not further investigated.

basins in the input data set. For international districts, the following delineation logic was applied: For RBDs shared between member states and/or candidate countries information from all countries was compared, matched and combined for delineating the borders of the district. This means that an international district shared by two or more countries only has been counted once, even though each country may have defined the part of the district lying within its own territory as a separate district. For districts with river basins shared with countries outside the union, the borders of the international river basin(s) were used to denote the borders of the district. Because of the restrictions and interpretations outlined above, it should be stressed that the created register does not represent an official map of RBDs; instead, it should be regarded as an output from a scientific effort of making an overview of RBDs established under the WFD.

Based on the created GIS data register, summary statistics on the number and extent of international RBDs identified under the WFD were extracted.

2.2 RBD register

Figure 1a shows a map of national and international RBDs in Europe. According to the created register, the total number of districts is 105. Thirty-five or 33% of these are classified as international districts. Area-wise, the international districts constitute 70% of the total area of the districts. Most of the larger international river basins, such as the Danube and the Rhine, have been defined as “stand-alone” RBDs, only joined with minor basins near the coasts (figure 1b). Smaller international districts are on the other hand not always “stand-alone”. Instead, they may have been joined with national river basins to form a “combined” RBD. An example of this is the RBD Bothnian Bay/Torniojoki shared between Sweden and Finland, where Sweden has combined a number of national river basins with one international river basin (Torne River) into one (international) district. The size of the districts varies considerably (table 1). The international districts are generally larger than the national ones, and the largest district is more than 2400 times the area of the smallest district. Twenty-two or 63% of the international districts are shared between member states and/or candidate countries, while 13 or 37% of the districts are shared with countries outside the EU or outside candidate countries (figure 2a). A majority of the international districts is shared by two countries, but there are also districts shared by three, four, or five or more countries (figure 2b).

Table 1. Smallest, largest and mean area of national and international RBDs.

	Smallest RBD	Largest RBD	Mean area RBD (km^2)
National RBDs	Malta (333 km^2)	Loires, cotiers vendeens et cotiers bretons, FR (156 172 km^2)	21 437
International RBDs	Neagh Bann, shared by IE and Northern IE (8 115 km^2)	Danube, shared by AL, AT, BA, BG, CH, CZ, DE, HR, HU, IT, MD, MK, PL, RO, SI, SK, UA and YU (806 238 km^2)	98 759

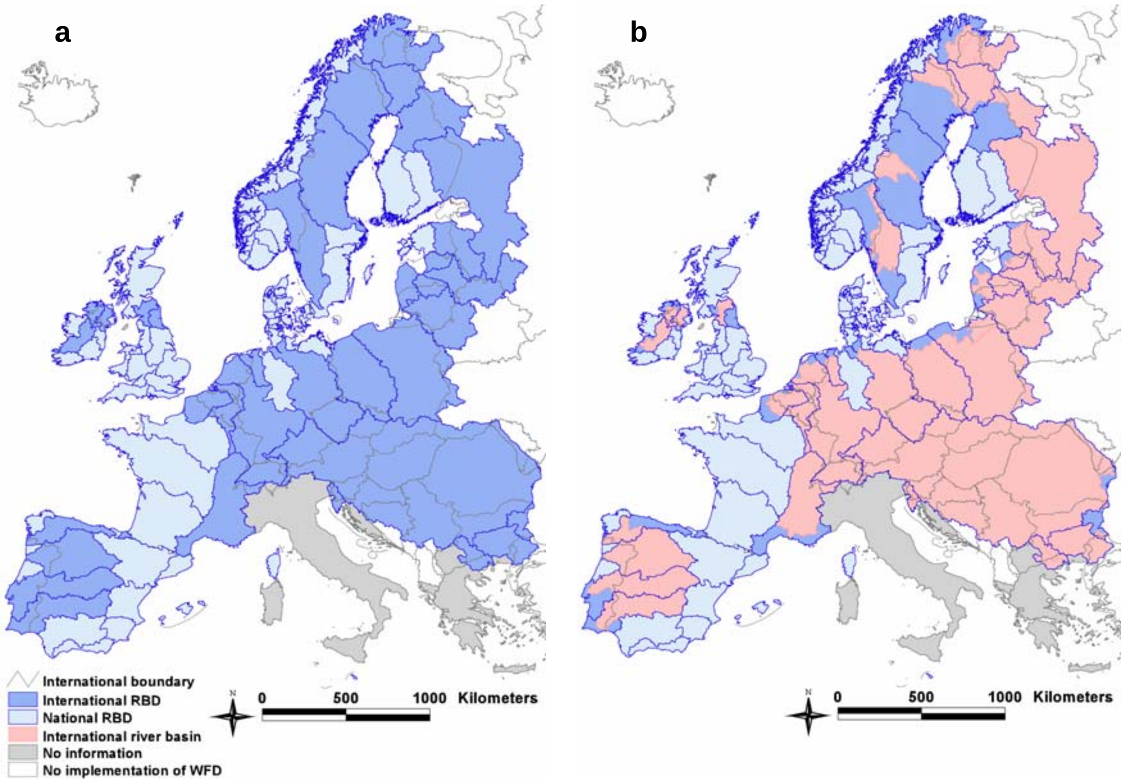

Figure 1. RDBs in Europe with: a) international RBDs highlighted (dark blue), and b) international river basins within RBDs highlighted (pink).

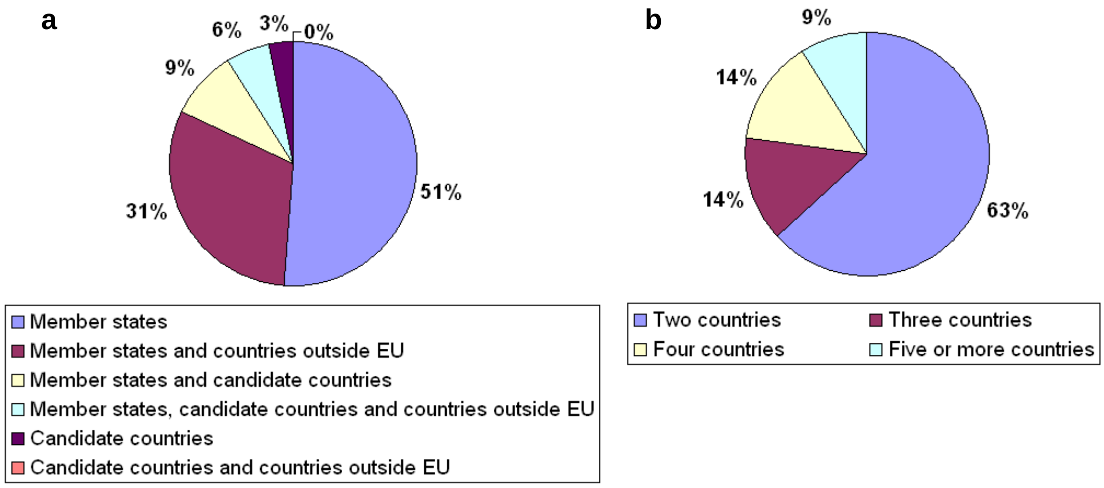

Figure 2. Characteristics of international RBDs (n=35): a) shows the different types of countries sharing RBDs, and b) shows the number of countries sharing RBDs.

3. Case study: The Baltic Sea Drainage Basin

The case study was restricted to RBDs in the BSDB with one or more international river basin. The same definition as in section 2.1 of an international river basin was used, but in addition, international river basins less than 6000 km^2 were excluded from the analysis. Having set these restrictions, 13 international RBDs and 14 international river basins could be identified from the RBD register (figure 3, table 2). As can be seen in figure 3b, approximately half of the international districts are identical with international river basins (e.g. Daugava, Nemunas, and Lielupe), i.e., these districts have been defined as "stand-alone" RBDs according to the WFD terminology. However, for the remaining districts the international river basin(s) within one district represents only a portion of the total area of the district (see e.g. Bothnian Bay/Torniojoki shared between Sweden and Finland). It is quite realistic to believe that there will be special management arrangements for the international river basin(s) in a so-called "combined district", and it would therefore be incorrect to use the whole RBD as unit of analysis. Thus, instead of using the RBDs, the 14 international river basins identified during the selection process were used as units of analysis in the case study. Considering the dynamics and the continuous developments in connection to the implementation of the WFD, 1 July 2005 was used as benchmark for the study.

3.1 Analysis

For investigating international river basin management under the WFD in the BSDB a framework of analysis was developed (figure 4). The framework tries to connect "degree of cooperation" with water quality in the international river basins included in the study. By elucidating this connection, international river basins in the BSDB deserving special attention may be highlighted.

The analysis was performed in a two-step process; focusing on one hand on indicators of relevance for international cooperation, and, on the other hand, on indicators connected to the water quality in the basins and the Baltic Sea. After selecting the indicators of cooperation, each indicator was assessed for each river basin according to a scoring system. If a river basin fulfilled all conditions of the indicator at hand, the basin received the score 1; if the river basin partly fulfilled the conditions of the indicator at hand, the basin received the score 0.5; and if the river basin did not fulfill the conditions of the indicator at hand (or in a few cases when this was not known), the basin received the score 0. Lastly, the scores for each basin was summarized to receive an overall score for each basin; thus, reflecting its degree of cooperation. For the selected indicators influencing or describing water quality, statistics for each indictor and basin were extracted using a GIS. The actual, real values for each indicator were then linearly transformed into values between 0-100. With regard to the indicator at hand, the value 0 represents the basin(s) with "best" water quality and the value 100 represents the basin(s) with "worst" water quality. The transformed values for each indicator were then summarized per basin and divided with the total number of indicators.

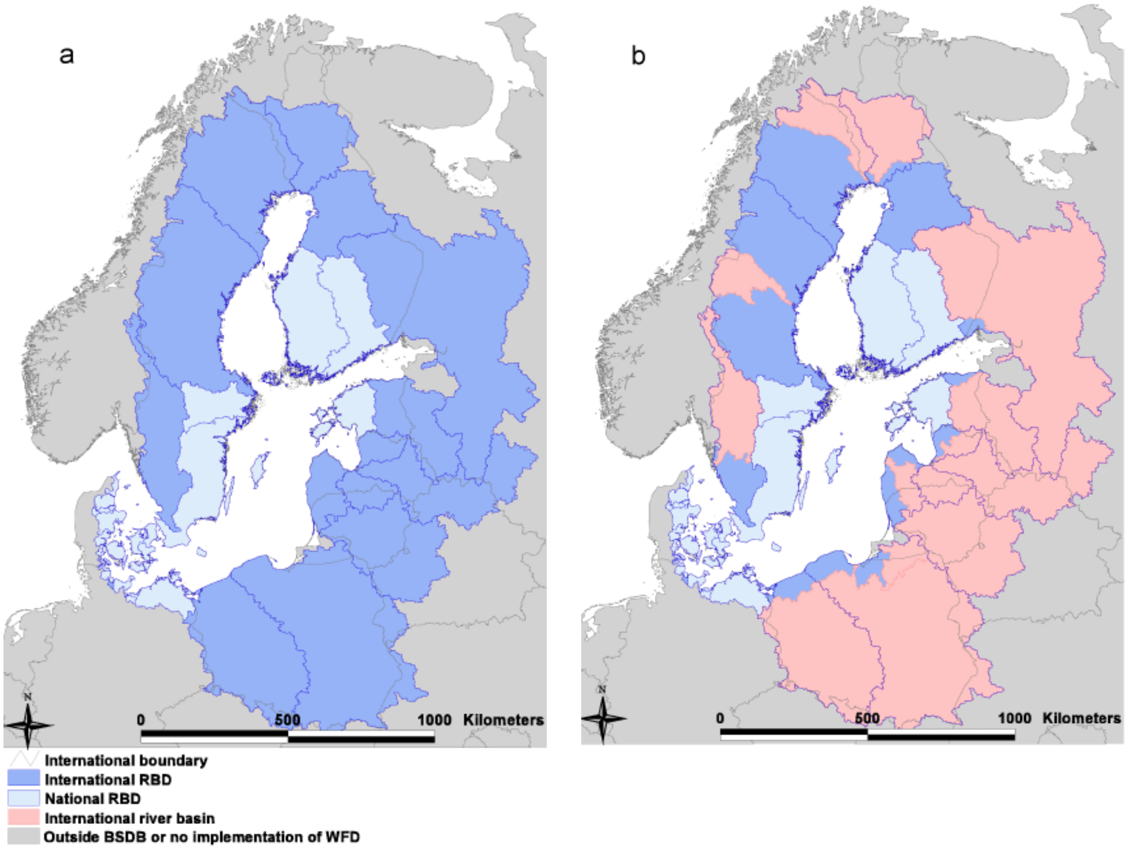

Figure 3. RBDs in the BSR with: a) the 13 international RBDs highlighted (dark blue), and b) the 14 main international river basins within the RBDs highlighted (pink).

This produced a water quality ranking score for each international river basin included in the study, where river basins with high scores are - relative to the other basins in the study - experiencing more severe water quality problems.

After completing the first two steps of the analysis, the last step was to link the indicators of cooperation with the indicators influencing or describing water quality. This was done by correlating the scores of cooperation with the water quality ranking scores.

All the indicators included in the study; the selection process, the data collection and preparation, and the analysis and assessment are described more thoroughly in section 3.2 and 3.3.

Table 2. International RBDs and international river basins in the BSBD.

International RBD	Area RBD (km^2)[2]	International river basin	Area river basin (km^2)[1]	Countries sharing river basin and area of river basin in each country (km^2)[3]
Västerhavet/Östfold, Akerhus, Hedmark, Oppland	120 559	Klarälven-Trysilelva/Göta Älv	48 326	NO, 7 749; SE, 40 577
Bothnian Sea	181 841	Indalsälven	25 518	NO, 2 021; SE, 23 497
Bothnian Bay/Torniojoki	128 190	Torne River	39 705	FI, 13 733; SE, 25 531; (NO, 441)
Kemijoki	55 545	Kemijoki	51 036	FI, 49 429; RU, 1 578; (NO, 29)
Vuoksi/Lake Ladoga-Neva River	290 682	Vuoksi/Lake Ladoga-Neva River	286 553	FI, 56 217; RU, 229 871; (BY, 465)
East Estonia	60 013	Narva River/Lake Peipsi	56 797	EE, 17 345; LV, 3 499; RU, 35 697; (BY, 256)
Koiva/Gauja	14 082	Gauja	8 652	EE, 1 113; LV, 7 539
Daugava	86 052	Daugava	86 052	BY, 33 054; LV, 23 771; RU, 27 306; (LT, 1 921)
Lielupe	17 876	Lielupe	17 876	LV, 8 872; LT, 9 004
Venta	26 517	Venta	11 624	LV, 6 423; LT, 5 201
Nemunas	92 318	Nemunas	92 318	BY, 44 654; LT, 43 285; PL, 2 628; (LV, 93); (RU, 1 658)
Vistula	226 201	Vistula	193 347	BY, 10 190; PL, 168 303; UA, 12 835; (CZ, 8); (SK, 2 012)
Vistula	226 201	Pregola	14 783	PL, 7 648; RU, 7 052; (LT, 83)
Oder	127 422	Oder	117 862	CZ, 7 418; DE, 4 557; PL, 105 877; (SK, 7)

3.2 Indicators of cooperation

Based on literature on water conflict and cooperation, the text of the WFD and guidance documents on the implementation of the directive, eight indicators - considered as giving a good estimate on the degree of cooperation - were selected. Much of the theory behind the selection is based on Savenije and van der Zaag (2000). In their paper they suggest the use of a classical temple as a model for sharing of international rivers (Figure 5).

2 Area derived from RBD register.

[3] Countries in parenthesis have less than 500 km^2 or three % of the river basin on their territory.

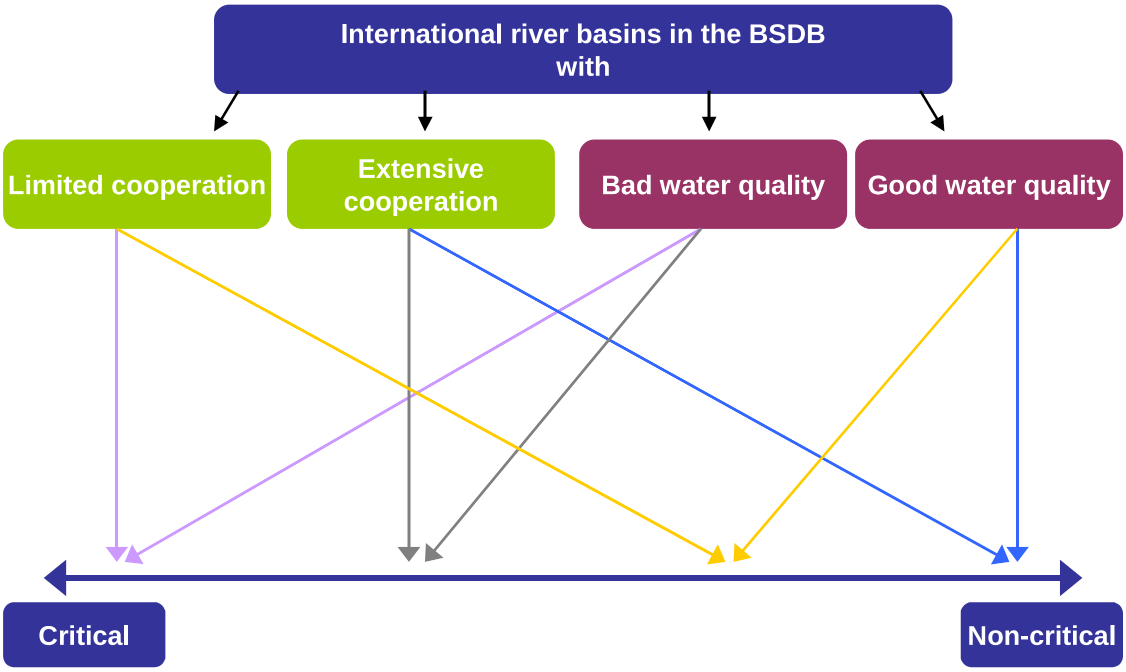

Figure 4. Framework of analysis used for examining international river basin management in the BSDB. The framework tries to connect the "degree of cooperation" (limited to extensive cooperation) with the "water quality" (bad to good water quality). This may highlight the most critical basins – with regard to cooperation and water quality – of the 14 selected international river basins in the BSDB.

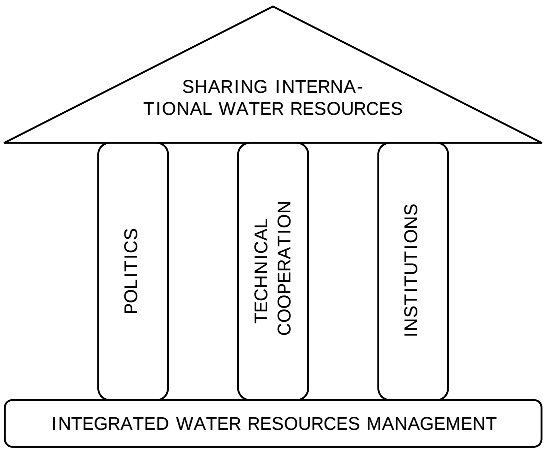

Figure 5. Integrated Water Resources Management as a basis for the sharing of international water resources (from Savenije and van der Zaag 2000).

In their model, Integrated Water Resources Management is the foundation and sharing of water resources the roof of the temple. There are three pillars, one political, one technical and one institutional, representing the necessary elements for sharing of international waters. The authors argue that there is first a need for politics to provide an enabling environment, in so that technical cooperation and proper institutions may later be established (Savenije & van der Zaag, 2000). The indicators selected for this study do not explicitly capture the political aspect, as potential indicators for this were slightly difficult to select and assess, but the other – institutional and technical aspects – are covered by the inclusion of indicators related to, e.g., water treaties and management plans.

An overview of the indicators of cooperation, the conditions of the assessment and the data sources used is presented in table 3 and below.

3.2.1 Existence of water treaties and water commissions

It is today a widely accepted consensus that institutions play a key role in promoting international cooperation and, thus, preventing and mitigating conflict (Mostert, 2003; Uitto & Duda, 2002; Wolf et al., 2003a; 2003b). For example, Savenije and van der Zaag (2000) argue that international river basin organizations are essential for joint management and Wolf et al. (2003b) found that the institutional capacity - defined as existence or absence of a water commission or treaty - within a basin appear to be a very good indicator of water conflict and cooperation. They saw that basins without treaties were significantly more prone to conflict than basins with treaties. In this study the existence of water treaties and water commissions was used as an indicator of cooperation. In fact, as water treaties and water commissions, according to literature, appear to be a prerequisite for cooperation; this indicator was given more weight than the others by dividing it into three, namely: existence of water treaty/commission, signatories/members of treaty/commission, and tasks of treaty/commission. The indicator was assessed according to the following rules:

1. If there is a water commission established and working, based on a water treaty, then the conditions of the indicator were regarded as fulfilled and the river basin received the score 1. If only one (or several) treaty exists, but no commission has been established, then the conditions of the indicator were regarded as partly fulfilled and the river basin received the score 0.5.
2. If a water treaty/commission exists and all countries sharing the basin are signatories/members, then the conditions of the indicator were regarded as fulfilled and the river basin received the score 1.
3. If a water treaty/commission exists and it has (extensive) water quality or WFD goals as specific tasks, then the conditions of the indicator were regarded as fulfilled and the river basin received the score 1.

Table 3. Indicators of cooperation.

Indicator	Conditions for fulfillment of indicator (conditions fulfilled = score 1, conditions partly fulfilled = score 0,5, conditions not fulfilled = score 0)	Data source
Water treaty / commission	- Water commission established and working, based on a water treaty (conditions fulfilled). - A treaty exists, but no commission (conditions partly fulfilled).	CTC, 2005; Kinnunen, 2005; Ministry of Environment Estonia, 2005; Oregon State University, 2002; Roll et al., 1999; Swedish EPA, 2003; 2005; Topilko et al., 2004
All countries signatories	All countries sharing the basin are signatories / members to the treaty / commission.	CTC, 2005; Kinnunen, 2005; Ministry of Environment Estonia, 2005; Oregon State University, 2002; Roll et al., 1999; Swedish EPA, 2003; 2005; Topilko et al., 2004
Water quality / WFD as specific task	Treaty / commission with (extensive) water quality or WFD goals as specific tasks.	CTC, 2005; Kinnunen, 2005; Ministry of Environment Estonia, 2005; Oregon State University, 2002; Roll et al., 1999; Swedish EPA, 2003; 2005; Topilko et al., 2004
Shared by EU member states	River basin shared only by EU member states.	
International RBD	The river basin/district has been officially appointed as an international RBD in accordance with article 3 of the WFD.	BMU, 2005; Miljöministeriet, 2005; Ministry of Environment Estonia, 2005; SFS, 2004; Topilko et al., 2004
Ambitions for joint RBMP	Officially stated plans for coordinating a joint RBMP for the river basin exist.	Kinnunen, 2005; Ministry of Environment Estonia, 2005; Nilsson et al., 2004; Swedish EPA, 2005; Topilko et al., 2004
Joint characterization	Joint report in accordance with article 5 of the WFD has been produced for the river basin.	BMU, 2005; Kinnunen, 2005; Mathisen, 2005; Swedish EPA, 2005; SYKE, 2005; Veidemane, 2005
Cooperation initiatives	Transboundary regional / basin cooperation on water management issues exist (e.g. through transboundary projects).	Haimi, 2005; Kinnunen, 2005; Swedish EPA, 2005; Topilko et al., 2004; Veidemane, 2005; Wirkkala, 2005

3.2.2 Basins shared by EU member states

Savenije and van der Zaag (2000) stress the importance of a joint legal framework for the sharing of international water resources and refer to global agreements and common law. However, they also mention that it may be important to also harmonize national water laws and regulations between riparian countries, and this is in fact what the WFD seeks to do. It is therefore argued here to use basins shared by EU member states as an indicator of cooperation, on the basis of the fact that the countries sharing these basins also share the same legislative framework for water, the WFD. In other words, if a basin is shared only by EU member states, then the conditions of the indicator were regarded as fulfilled and the basin received the score 1.

3.2.3 International RBDs

Article 3 of the WFD states that river basins extending across international borders should be assigned to international RBDs. Thus, member states should explicitly appoint all RBDs with one or more international river basins as international districts. However, as the directive text leaves quite some room for interpretations there may be variations in the definitions of international districts among member states. In this study, RBDs officially appointed as international districts according to the WFD were used as an indicator for cooperation. Thus, if the basin belonged to an officially appointed international RBD, then the conditions of the indicator were regarded as fulfilled and the basin received the score 1.

3.2.4 Ambitions for joint RBMP

The WFD encourages countries to cooperate for producing joint RBMPs for international RBDs. The first plans are to be ready in 2009, and it is thus not possible yet to know whether there actually will be any joint plans produced. However, on the basis of a questionnaire sent to member states, candidate countries, Switzerland and Norway, Nilsson et al. (2004) tried to "monitor" the ambitions of producing joint RBMPs according to the requirements of the WFD. By using the replies to the questionnaire reported in Nilsson et al. (2004), along with a brief update accomplished through the re-contacting of respondents, ambitions for producing joint RBMPs were assessed and included as an indicator of cooperation. Thus, if there are officially stated plans of producing a joint RBMP for the river basin, then the conditions of the indicator were regarded as fulfilled and the basin received the score 1.

3.2.5 Joint characterization efforts

According to article 5 of the WFD, member states should have carried out characterizations – with regard to water status, driving forces and pressures, and economic analyses – of all their RBDs. The results should have been summarized in one or more reports and sent to the European Commission in March 2005. Thus, by collecting and exploring these reports possible joint characterization efforts taken by countries may be identified and used as an indicator of cooperation. If a joint report in accordance with article 5 of the WFD has been produced for the river basin, then the conditions of the indicator were regarded as fulfilled and the basin received the score 1.

3.2.6 Cooperation initiatives for transboundary river basin management

The previous indicators reflect official opinions, decisions and actions taken at the national level. However, in practice, cooperation on international river basins may take place at other levels of society and it may be initiated and financed through other channels than official, national sources. Gooch (2004), for instance, argues that transboundary water management involves actors at different levels of society; including state actors (both central and sub-central) and institutions, as well as non-state actors such as the business sector, non-governmental organizations and civil society. For capturing this aspect of transboundary cooperation, existence of regional/basin cooperation through, e.g., various projects between local and regional authorities was therefore included as an indicator of cooperation. Thus, if there is any transboundary regional/basin cooperation on water management issues or if there has been any project in the last five years, then the conditions of the indicator were regarded as fulfilled and the basin received the score 1.

3.3 Indicators influencing or describing water quality

HELCOM and European Environmental Agency (EEA) have developed different sets of water indicators (see e.g. HELCOM, 2003; Nixon et al., 2003). The EEA, for instance, uses about 40 indicators, such as nitrogen and phosphorous concentrations in rivers, biological quality of lakes, and emissions of hazardous substances from industries, for assessing Europe's water resources. For describing the water quality in international river basins in the BSDB, it would have been desirable to use all relevant indicators proposed by HELCOM and EEA. However, to gather the data needed for such an analysis would be an enormous task and was simply beyond the scope of this study. Another alternative could be to use the data and information compiled by EU member states under article 5 of the WFD. One initial idea for the sake of this study was to collect the reports submitted to the European Commission in March 2005, and use parts of the data and information reported to derive indicators describing water quality. However, this proved to not be so easy since the characterization had been performed according to different procedures and at different scales in different countries. Thus, the figures reported could not be easily harmonized and compared. Secondly, countries outside the EU have not written any reports; and thus, basins shared by countries outside the EU are not completely covered by the characterization.

With regard to the restrictions outlined above, five indicators influencing or describing water quality were selected. The, to our knowledge, best publicly available sources of information were used to assess the selected indicators. The results derived for each indicator were compared with other sources of information when available to ensure reliability of the reported figures.

An overview of the indicators influencing or describing water quality, the assessment of the indicators and the data sources used is presented in table 4 and below.

Table 4. Indicators influencing or describing water quality.

Indicator	Description of indicator	Data source
Population	Population density (persons km^{-2}) in the river basin.	Oak Ridge National Laboratory, 2005
Cultivated land	Percentage cultivated land in the river basin.	JRC, 2003
Nitrogen concentration	Concentration of nitrogen (mg/l) in the water discharging into the Baltic Sea in year 2000.	HELCOM, 2004; Kotilainen, 2005
Phosphorus concentration	Concentration of phosphorus (mg/l) in the water discharging into the Baltic Sea in year 2000.	HELCOM, 2004; Kotilainen, 2005
Organic matter concentration	Concentration of BOD_7 (mg/l) in the water discharging into the Baltic Sea in year 2000.	HELCOM, 2004; Kotilainen, 2005

3.3.1 Population

Population is an important driving force for pollution. The number of people, along with their activities and distribution, influence the water quality within a river basin and the water quality of the recipient in which the river discharges. Smith et al. (2005) have, for instance, showed a close empirical relationship between human population and nitrogen and phosphorus loading, and in integrated assessments, such as modeling the input of pollutants from a river basin to the sea, population density is a parameter generally always taken into account (HELCOM, 2004; Scheren et al., 2004). In this study, the population density in a river basin was used as a driving-force indicator influencing water quality. LandScan 2003 is a worldwide population database developed as a part of the Oak Ridge National Laboratory Global Population Project. The database is based on census counts at sub-national level, which have been apportioned to grid cells based on likelihood coefficients. These coefficients are, in turn, based on factors such as proximity to roads, slope, land cover, and nighttime lights. The data are available at a resolution of 30 x 30 arc seconds. The LandScan 2003 data were used to, in a GIS, calculate the population density (persons km^{-2}) for all the 14 international river basins included in the case study. The actual population density figures (i.e., the number of people km^{-2}) were then normalized into values between 0-100, where the value 0 represents the basin with the lowest population density, and the value 100 represents the basin with the highest population density.

3.3.2 Cultivated areas

According to a survey carried out by the European Commission, pollution of water resources caused by agriculture is one of the main concerns of member states (European Commission, 2005). Approximately 65% of the total nitrogen load and 57% of the total phosphorus load to the Baltic Sea originate from diffuse sources, of which the main components are agriculture and managed forestry (HELCOM, 2004). Further, the report ‘Summary of River Basin District Analysis’ from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2005) notes that inputs of nitrogen, phosphorus and pesticides are high in Germany and that this mainly stem from intensively cultivated farmland (BMU, 2005). Clearly, for describing the water situation in international river basins in the BSDB, there is a need to include some indicators related to agriculture. For doing this, the percentage cultivated land in a river basin was used as a driving-force/pressure indicator influencing water quality. One global land cover mapping initiative is the Global Land Cover 2000 (GLC 2000) project, carried out in 1999-2002 and coordinated by the Global Vegetation Monitoring Unit at the JRC (JRC, 2003b). The main objective with the project was to provide a harmonized global land cover database for the year 2000. The database is based on the SPOT-4 VEGETATION VEGA2000 dataset and the FAO Land Cover Classification System was used. The data are available at a resolution of 30 x 30 arc seconds. The GLC 2000 database was used to, in a GIS, calculate the percentage cultivated land in each river basin. The actual percentage figures were then normalized into values between 0-100 according to the same logic as in 3.3.1.

3.3.3 Nitrogen and phosphorus load combined with runoff

HELCOM regularly (1987, 1990, 1995 and 2000) carries out Pollution Load Compilations, where point and non-point pollution sources in the BSDB are quantified, to determine the inputs from land-based sources into the Baltic Sea (HELCOM, 2004). HELCOM uses this information to, for instance, assess the effectiveness of measures taken to reduce pollution of the sea, and evaluate the state of the sea itself. The results confirm that one of the main problems connected to water quality in the Baltic Sea area is the loading of nutrients. According to HELCOM calculations, the total nitrogen load entering the Baltic Sea in the year 2000 amounted to 706 000 tonnes, while the corresponding figure for phosphorus was 31 800 tonnes. This load consists of discharges and losses from different sources within the drainage basin, and include discharges from industrial plants, municipal wastewater treatment plants (MWWTP), scattered dwellings, discharges from rainwater constructions not connected to MWWTPs', fish farms and losses from agriculture and managed forests, as well as natural background losses and atmospheric deposition on inland surface waters. For a detailed description of how the load compilations have been carried out; the limitations, input data, quantification methods, and reliability of results, see HELCOM (HELCOM, 1999, 2004). For this study, data provided from HELCOM for the year 2000 on total nitrogen and phosphorus loads (in tonnes) were combined with data on total runoff (in million m^3) in order to calculate the nitrogen and phosphorus concentrations of the water discharging into the Baltic Sea. Thus, the nitrogen and phosphorus concentrations at the river mouth of each international river basin included in the study were used as water quality indicators, giving a measure on the water quality of the river and the water discharging into the Baltic Sea. Having calculated the concentrations, the actual figures were then normalized into values between 0-100 according to the same logic as in 3.3.1.

3.3.4 Organic matter load combined with runoff

In the sea, the decomposition of large amounts of organic material may consume excessive quantities of oxygen, leading to oxygen depletion in deeper waters, and harming aquatic life in seabed waters. Anoxic conditions, which also may release nutrients from the sediments, have occurred frequently in the deeper basins of the Baltic Proper for quite a long time. More recently, vast areas in the Belt Sea and the Gulf of Finland have also been affected (HELCOM, 2004). Organic matter in rivers originates from a wide array of sources; municipal and industrial wastes, fish farms, scattered dwellings, agricultural land, natural leaching, and from primary production in lakes and large river. Organic matter is generally measured as BOD_5, BOD_7, COD_{Cr} or as TOC; however, HELCOM (2004) only reports BOD_7, since this parameter is the most commonly measured by the contracting parties to HELCOM. In 2000, the total BOD_7 load entering the Baltic Sea from rivers and coastal areas amounted to 1 040 000 tonnes (HELCOM, 2004). For this study, data provided from HELCOM for the year 2000 on total BOD_7 load (in tonnes) were combined with data on total runoff (in million m^3) in order to calculate the organic matter concentrations of the water discharging into the Baltic Sea. Thus, the BOD_7 concentrations at the river mouth of each international river basin included in the study were used as a water quality indicator, giving a measure on the water quality of the river and the water discharging into the Baltic Sea. Having calculated the concentrations, the actual figures were then normalized into values between 0-100 according to the same logic as in 3.3.1.

3.4 Results and discussion

Table 5 shows the results of the assessment of the indicators of cooperation in the 14 international river basins in the BSDB. In this assessment, river basins could obtain a score between 0 and 8. As can be seen from table 5, the actual overall scores obtained range from 1.5 to 7. Two river basins, Torne River and Oder, obtained the score 7. Half of the river basins obtained scores over 3, while the other half had a score of 3 or below.

Two river basins, Vistula and Pregola (both belonging to the same RBD), received the lowest score, 1.5. Looking more closely at each specific indicator, it can be seen that in all river basins a water treaty exist and in nearly half of the basins a commission has been established. Comparing this with the global situation, where only 117 of the world's 263 international river basins have treaties (Wolf et al., 2003b), the BSDB (and probably the rest of Europe as well) can be regarded as a region with a solid base for international cooperation. Six of the river basins are shared by two or more countries; however, only in one of these river basins (Oder) are all countries signatories to the treaty. In the rest of the cases only bilateral agreements exist. A little more than half of the treaties deal specifically with water quality or WFD issues. In the cases of Gauja (shared between EE and LV), Lielupe and Venta (shared between LV and LT), the WFD was actually the main reason for setting up treaties (Topilko et al., 2004). By the signing of the treaties, the countries have agreed upon working for joint RBMPs. The treaties not specifically devoted to water quality issues are generally quite old, and may focus on issues related to, e.g., hydropower or navigation. However, there are examples of treaties, such as the one for Torne River (shared between FI ans SE) originally set up in 1971 to deal with issues connected to civil engineering and fishing, that now are changed and updated because of, among other things, the influence of the WFD (Swedish EPA, 2005). Nine or 64% of the river basins are shared with countries outside the EU. This figure is substantially higher if compared to the figures reported in the RBD register for the whole of Europe where (only) 37% of the international RBDs are shared with countries outside the EU (cf. figure 2).

Table 5. Overall assessment of 'degree of cooperation' in the 14 international river basins included in the case study of the BSDB based on eight indicators. For each river basin, the conditions of each indicator have been assessed as being fulfilled (score 1), partly fulfilled (score 0.5) or not fulfilled (score 0). The sum of the scores, i.e. the overall score, represents the 'degree of cooperation' in each basin.

Int river basin	Water treaty /commission	All countries signatories	Water quality / WFD as specific task	Shared by EU member states	Int RBD	Ambitions for joint RBMP	Joint charcterization	Regional cooperation initiatives	**Overall score (0-8)**
Klarälven-Trysilelva/ Göta River	0.5	1	0	0	1	0[4]	0	0	**2.5**
Indalsälven	0.5	1	0	0	1	0	0	0	**2.5**
Torne River	1	1	1[5]	1	1	1	0	1	**7**
Kemijoki	1	1	0	0	0	0	0	0	**2**
Vuoksi/Lake Ladoga-Neva River	1	1	0	0	0	0	0	1	**3**
Narva River/Lake Peipsi	1	0	1	0	1	0[3]	0[3]	1	**4**
Gauja	0.5	1	1	1	1	1	0[3]	0	**5.5**
Daugava	1	0	1	0	1	0	0	1	**4**
Lielupe	0.5	1	1	1	1	1	0	1	**5.5**
Venta	0.5	1	1	1	1	1	0	1	**5.5**
Nemunas	0.5	0	1	0	0	0	0	1	**2.5**
Vistula	0.5	0	0	0	1	0	0	1	**1.5**
Pregola	0.5	0	0	0	1	0	0	1	**1.5**
Oder	1	1	1	1	1	1	1	0	**7**

It may be interesting to note that the average overall cooperation score for river basins shared between EU member states and countries outside the EU is 2.6, while the average score for basins shared by member states is 6.1 (or 5.1 if adjusting for the fact that "shared by EU member states" was included as one indicator). Quite many of the basins, in total eleven, have been officially appointed as international districts/basins according to the requirements of the WFD. Not so surprising, the three river basins (Kemijoki, Vuoksi and Nemunas) not appointed as international RBD according to the WFD are all shared by EU member states and countries outside the EU. In five river basins, all shared

[4] Not known.
[5] In fact, the agreement from 1971 does not address water quality or WFD issues. This has been recognized by the countries (SE and FI) and a new agreement, planned to be signed 2006, is under development. In the mean time, the countries have in 2003 signed a note to form a common international RBD for the Torne River. In this note is it said that the partners should cooperate to fulfill the requirements of the WFD.

by EU member states, there are officially stated plans to produce or coordinate joint RBMPs. It should though be noted that this indicator reflects the ambitions regarding joint RBMPs. However, as the plans are not to be ready until 2009, it is difficult to judge the actual fulfillment of the indicator. It is therefore interesting with an indicator monitoring actions already taken. From the results of the assessment of the indicator regarding joint characterization, it can be seen that - in practice - very few joint characterization efforts have been taken so far. Only in one case, the Oder, has joint characterization according to article 5 of the directive been carried out. The International Commission for the Protection of the Odra River against Pollution (ICPOAP) has coordinated the work and has published the characterization reports in German, Polish and Czech on their homepage (BMU, 2005; ICPOAP, 2005). Concerning the indicator describing more informal transboundary cooperation initiatives, it can be seen that such initiatives are present in at least nine of the river basins. One may speculate if such initiatives play a more important role in river basins shared by EU member states and countries outside the EU, where a formal, legal basis for cooperation, along with financial resources, may be lacking. For instance, in the Narva River/Lake Peipsi basin there is a number of projects, funded by e.g. EU LIFE, EU TASCIS and UNDP/GEF (see e.g. (http://www.peipsi.org/gef/, 2005)), that have been launched with the aim of supporting the development of water management plans or programs for Estonian and Russian authorities and the Estonian-Russian water commission.

The relative water quality ranking scores for the 14 international river basins in the BSDB is presented in table 6 (for a table of actual figures, see appendix). According to this ranking score, Oder is the river basin with the relatively "worst" water quality, followed by Vistula and Pregola. These ranking results appear not to be very controversial, and they are supported by more detailed studies addressing water quality problems in these specific basins (e.g. Buszewski et al., 2005; Humborg et al., 2000; Ochocki et al., 1999). Thus, the rather unsophisticated ranking approach appears to be acceptable. In total, there are five river basins (Oder, Vistula, Pregola, Lielupe and Nemunas) that received scores over 50, while six of the basins (Narva, Neva, Göta River, Torne River, Kemijoki and Indalsälven) had scores of 20 or below. These latter basins have, thus, relatively small water problems with regard to water quality.

The results from the correlation between cooperation scores and the water quality ranking scores are presented in figure 6. For facilitating the interpretation of the figure nearby points, i.e. river basins, have been lumped together into three groups. According to this suggested grouping, Vistula, Pregola and Nemunas are the three most "critical" international river basins in the BSDB. They all have a water quality ranking score over 50 and at the same time a cooperation score of 2.5 or below. Characteristic for these three basins is that there is no water commission established and no multi-lateral agreement on cooperation existing. Further, and maybe most important, the basins are all shared by EU member states and countries outside the EU, which thus complicates WFD implementation. Although the European Commission, UNECE and other important institutions have directed attention towards these regions, e.g. through the "Workshop on Transboundary Water Management at the North-Eastern Border of the European Union" (UN ECE, 2005), the results further emphasize the need for focusing upon and strengthening these regions.

Table 6. Relative water quality ranking scores for the 14 international river basins in the BSDB.

Int river basin	Population density (0-100)	Cultivated land (0-100)	N concentration (0-100)	P concentration (0-100)	BOD_7 concentration (0-100)	**Relative water quality ranking score (0-100)**
Klarälven-Trysilelva/Göta River	14	12	13	2	10	**10**
Indalsälven	2	1	0	0	0	**1**
Torne River	0	0	3	7	18	**6**
Kemijoki	0	0	0	3	6	**2**
Vuoksi/Lake Ladoga-Neva River	14	2	11	10	34	**14**
Narva River/Lake Peipsi	11	35	6	17	31	**20**
Gauja	12	42	27	15	25	**24**
Daugava	22	29	39	25	24	**28**
Lielupe	26	92	100	39	41	**60**
Venta	21	80	48	14	37	**40**
Nemunas	38	71	49	36	100	**59**
Vistula	89	79	63	75	73	**76**
Pregola	63	100	77	91	40	**74**
Oder	100	83	74	100	78	**87**

Moving on to the second group of river basins, this group (consisting of Indalsälven, Göta River, Kemijoki and Neva) have relatively low cooperation scores (<3), and at the same time very low relative water quality ranking scores. Thus, these basins may not have very well developed cooperation, but on the other hand, there may not have been a need for such cooperation to develop since the water related problems, at least with regard to water quality, are relatively small. The third marked circle is quite large, encompassing river basins (Narva, Daugava, Gauja, Venta and Lielupe) which are somewhere in the middle of the both scales. The relative water quality ranking scores for those basins actually varies quite a lot (between 20-60), while the cooperation scores lie between 4 and 5.5. In fact, the cooperation score only varies between 4 (Daugava and Narva) and 4.5 (Venta, Lielupe and Gauja) if excluding the indicator “shared by EU member states”. An explanation to the fact that Venta, Lielupe and Gauja have the same cooperation score may be that the countries sharing the basins (EE, LT and LV) appear to have started up more formal cooperation in connection to the implementation of the WFD (Topilko et al., 2004).

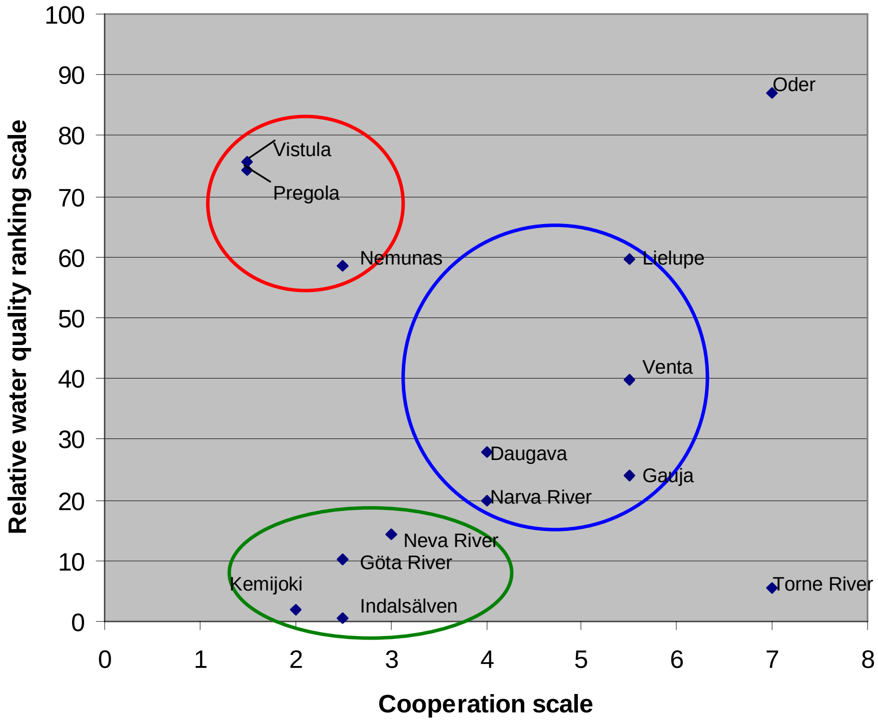

Figure 6. Correlation between cooperation scores and water quality ranking scores for the 14 international river basins in the BSDB.

Having gone through these three groups there are two river basins left; the two extremes, Oder and Torne River. Both of these river basins have received the cooperation score 7, but at the same time Oder has the highest, and Torne River the third lowest, relative water quality ranking score. Regarding relative water quality ranking, Oder has – roughly – the same magnitude of problems as Vistula and Pregola. However, in terms of cooperation score, there is a huge difference between the basins. Compared to Vistula and Pregola, Oder has a well-developed cooperation. Because of the general difficulty in evaluating cause-effect relationships, the fact that this study does not capture trends over time and the fact that the international commission for Oder was not established until 1997, it is extremely difficult to judge whether the well-developed cooperation in Oder has resulted or will result in improved water quality. However, there are studies that have reported a considerable improvement of the water quality in the basin between the years 1990-2000, although nitrogen and phosphorus concentrations are still high (IWAC, 2001). It should though be pointed out that the positive development is similar for Vistula, where the water quality also has improved since the beginning of the 1990's (Buszewski et al., 2005). Thus, these improvements are probably more linked to HELCOM activities, and measures, such as building of waste water treatment plants, taken by Poland (which is the country with the largest part of the basins). For explaining the fact that Torne River does not place itself among the other basins with both low cooperation scores and low relative water quality ranking scores there is probably a need to place the river basin in a cultural and historical context, something which is missed in this overall assessment. Additionally, the trigger for cooperation in Torne River may have been related to other water issues (e.g. fishing) than water quality, but which may have facilitated also cooperation around the implementation of the WFD.

There is a need for a small discussion on the relevance of the chosen indicators and the value of doing such an overall assessment, trying to link international cooperation and implementation of the WFD with water quality. The choice and assessment of indicators of cooperation are site-specific; thus, the indicators are relevant to the BSDB, and - to quite a large degree – to the whole of Europe. However, as many of the indicators are related to the implementation of the WFD, the value of this study for international river basins outside Europe may not be so high. At the same time, although the indicators have been developed to specifically “fit” the BSDB, there may be a criticism that the indicators are too general in the sense that they do not capture, e.g., specific cultural aspects of cooperation. The indicators describing or influencing water quality may also be discussed. Firstly, as only a few indicators were selected and included in the analysis it may be questioned whether they were the most appropriate ones. Secondly, the approach for ranking the international river basins based on the indicators influencing or describing water quality may be criticized on the grounds that it is too simple and too rough. Another remark that may be made is that the results from the assessment give a static picture of the situation. The selected indicators, especially those related to international cooperation, may change rapidly along with the proceeding of the implementation of the WFD. Hence, the value of the assessment would increase if the development over time could be included in the analysis.

Despite the weaknesses outlined above, it is still argued that the results from the correlation of cooperation scores and relative water quality ranking scores provides an interesting and clarifying overview of international river basins in the BSDB. The results point out areas, which – at least today - may need special attention and support for developing forms for international river basin management in line with the intentions of the WFD, and - ultimately - for improving water quality.

4. Conclusions

This study confirmed the findings of Nilsson et al. (2004) that the number and area of international RBDs established under the WFD are significant. According to the created RBD register, 33% of the RBDs are international, and area-wise the international districts cover 70% of the total area of the districts.

The case study on cooperation and water quality in the 14 international river basins in the BSDB showed that, also in this respect, the Baltic Sea Region is a heterogeneous area. The WFD is a push forward for international river basin management in the region. This appears to be especially true for international river basins shared by EU member states, where there are several concrete examples of how the WFD has triggered cooperation. However, the WFD in general and the principle of river basin management in particular may be hard to implement in river basins shared between EU member states and countries outside the EU, although the environmental situation with regard to water quality in these basins would gain of joint action. If the European Commission is serious in its ambitions of implementing the WFD also in international river basins, support should be given to basins shared by EU member states and countries outside the EU with relatively large water quality problems. According to the results from the case study, these river basins are Vistula, Pregola and Nemunas.

If repeated within certain intervals, the applied approach could be used to investigate or monitor trends in cooperation and water quality over time. Additionally if further developed, updated and refined, the assessment could be extended to encompass all international river basins/districts in Europe. In addition to water quality, other urgent water related issues, such as water availability - an important issue in other parts of Europe - could be addressed.

Appendix

Table 1. Figures used for calculating the relative water quality ranking scores for the 14 international river basins included in the case study of the BSDB.

Int river basin	Popul-ation density (pers km^{-2})	Cultivated land (%)	N concentration (mg/l)	P concentration (mg/l)	BOD_7 concentration (mg/l)
Klarälven-Trysilelva/ Göta River	21	8.6	0.88	0.018	1.2[6]
Indals-älven	4.3	1.1	0.35	0.013	0.74[5]
Torne River	2.0	0.46	0.46	0.028	1.5
Kemijoki	2.1	0.23	0.37	0.020	1.0
Vuoksi/Lake Ladoga-Neva River	21	1.7	0.79	0.036	2.2
Narva River/Lake Peipsi	17	24	0.61	0.050	2.0
Gauja	18	29	1.5	0.046	1.8
Daugava	32	20	2.0	0.068	1.7
Lielupe	37	64	4.4	0.098	2.5
Venta	30	56	2.3	0.042	2.3
Nemunas	53	49	2.3	0.092	5.0
Vistula	120	55	2.9	0.18	3.8
Pregola	87	69	3.5[7]	0.21[6]	2.5
Oder	140	57	3.4	0.23	4.1

[6] Data on BOD_7 are lacking. Figures have been calculated based on data from Torne River, Kemijoki and Vuoksi.
[7] Data on nitrogen and phosphorus are lacking. Figures have been calculated based on data from Vistula.

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