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An Indicator-based Analysis of the River Basin Districts established under the EU Water Framework Directive

ABSTRACT

This study gives a first indicator-based assessment of the differences and similarities between the River Basin Districts (RBDs) established under the EU Water Framework Directive (WFD). The RBDs are intended to be the management units for water resources within the EU. Yet, limited harmonized or easily comparable data currently exists for this new administrative level. While there are coordinated efforts to develop a Water Information System for Europe (WISE), there is still a need for making initial and complementary assessments of the RBDs, using a set of identical indicators for all RBDs. The analysis was performed with the help of geographic information systems (GIS) and publicly available spatial databases, environmental monitoring databases and other statistics. A major goal of the study was to rank the RBDs according to the pressure on and status of their water resources. The results show a clear north-south dichotomy and that the most serious water situations occur in Western Europe, although a few regional variations appear for some indicators. The current assessment was limited in terms of the information available and more comprehensive assessments of the RBDs for comparison and policy-making purposes are needed.

KEYWORDS

Water Framework Directive; River basin districts; Freshwater resources; Pressure indicators; Status indicators; Index

1. INTRODUCTION

The Water Framework Directive (WFD) [1] is intended to be a comprehensive encapsulation of European Union (EU) water policy, providing guidelines and requirements for how Member States are to manage their water resources [2]. The overall objective of the WFD is to achieve "good ecological and chemical status" for all waters within a predetermined timescale, and the directive stipulates a number of steps that Member States are to take in order to reach this goal. The most novel of these are those pertaining to the establishment and

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management of River Basin Districts (RBDs), outlined in Articles 3, 5, 11 and 13 of the WFD.

In March 2005, Member States had to submit their first analysis of the characteristics of each RBD (Article 5 reporting) to the European Commission. These reports, along with other information and data collected during the WFD implementation will be gathered and presented in the Water Information System for Europe (WISE), currently developed by the European Commission in collaboration with the European Environment Agency (EEA), Eurostat and the Joint Research Centre (JRC) [3] (http://wise2.jrc.it/home/php/index_new.php). In the short term, WISE is intended to serve as a publicly accessible portal for WFD information. In the long term, i.e., by 2010, the aim is to develop an information system that contains most of the relevant information for water resources and management on a European scale. Currently, WISE is an ambitious prototype, where data continually is added to the system and a public user may at this moment access information on, e.g., RBDs, rivers, lakes and groundwater. However, as the information in WISE to a large extent is and will be based on WFD reporting by EU Member States, it may be questioned if the data and information in WISE will be comparable between countries. The map showing "Main river and main lakes as submitted by Member States" produced by the European Commission [4] (available at http://ec.europa.eu/environment/water/water-framework/transposition.html) clearly shows this potential problem. It is quite obvious from this map that Member States have used different criteria for selecting and reporting "main rivers and main lakes". Furthermore, taking the so-called Article 5 reports as another example, besides being voluminous (ca. 24,000 pages), the reports have been completed according to a country's particular standards and are often only available in the country's own language. This therefore makes comparison between RBDs very difficult if not impossible. Additionally, as the Article 5 reports are strictly *national* reporting obligations towards the EU, limited effort appears to have been placed upon harmonizing the characterization for international RBDs. Thus, one can imagine that, for policy and decision-makers especially, it may at this stage be very difficult to obtain a comprehensive idea of how the RBDs throughout Europe compare to one another with respect to various parameters.

Since the RBDs are intended to be the management units for water in the EU and since little harmonized and easily comparable data and information currently exist for this new administrative level (although hopefully this will soon emerge under the WISE initiative), there is an urgent need for making an initial assessment of the RBDs established under the WFD, using a set of identical parameters – indicators – for the whole region.

The EEA has pioneered work on indicators in Europe and continually uses indicators to assess the state of the environment [5, 6, 7]. However, for freshwater issues, indicators are normally presented per country, sometimes for selected major European river basins but so far not for RBDs [8, 9].

The aim of this study is to provide a broad assessment of the RBDs established under the EU WFD using a limited set of characteristics and indicators to produce statistics that identify and quantify both basic features and pressures. The major goal is to produce a relative ranking of the RBDs, illustrating which are currently experiencing more or less pressure on their water resources and which are in a "better" or "worse" condition in terms of water status.

While the WFD ambitiously aims to achieve "good ecological and chemical status" for all freshwaters, groundwater and coastal waters, this translates for most RBDs into eutrophication as the first priority among various water-related ecological and chemical issues of concern. The Water Directors of the EU and the Commission have thus jointly started a separate line of activities under the WFD Common Implementation Strategy dealing specifically with this complex issue [10]. In this study we accordingly gave a slight priority to eutrophication when selecting state and pressure indicators. Another important issue, especially for the Mediterranean region, is water availability. The EU Water Directors have, among other things, established a drafting group with the aim of investigating water scarcity management in the context of the WFD [11]. Hence, in this study we also included indicators of relevance for water availability.

Although the information provided by the indicators used herein is general and perhaps at times oversimplified, it can be used to make general assessments and policy decisions. One could view this study as a first "summary" of basic conditions related to water resources within the EU RBDs. Ultimately, studies of this kind can help to increase the effectiveness of environmental management systems through benchmarking, specifically by looking at the relationship between the status of water resources and the pressures placed on water resources.

2. RBD CHARACTERIZATION AND ASSESSMENT

At the time of this study, we did not have access to a digital copy of the European Commission's published map of RBDs. The definition of RBDs used for the characterization, assessment and ranking of the RBDs was instead based on a dataset created by Nilsson and Langaas [12]. This dataset is based on official maps of RBDs from countries implementing the WFD; that is, EU Member States, Candidate Countries and Norway. Italy, Greece and Croatia are not covered in the dataset as they, as of 30 June 2005, neither had identified RBDs nor appointed competent authorities. In Norway and Spain, as per 30 June 2005, no decisions had yet been taken concerning RBDs and competent authorities, but since proposals existed they are included. Due to lack of data, the dataset does not contain any information about coastal waters of RBDs. The RBD dataset was created by combining a dataset in the scale 1:1 million on catchments draining into the sea, provided by the EU's scientific and technical research laboratory, the JRC, with a dataset on international boundaries. By using the analogue map material on RBDs from each country as reference material, river basins belonging to one district were selected and unified into one polygon. For international RBDs shared between Member States and/or Candidate Countries, information from the concerned countries was combined for delineating the borders of the district. When an RBD contained one or more river basins extending outside the territories of the EU, the borders of the river basin(s) were used as borders for the RBD. Thus, in the creation of the RBD dataset, river basin borders - rather than country boundaries - were used as borders for the RBDs. By using this logic, a small number of RBD borders may deviate from the officially designated borders. For a more thorough description of the development of the RBD dataset, see Nilsson et al. [13] and Nilsson and Langaas [12].

In total, four characteristics and four indicators were used to characterize and assess the RBDs (Table 1). The potential list of characteristics and indicators of interest for use in this kind of study is extensive. However, ultimately, the choice of indicators was mostly influenced by the information available and accessible and by what currently appear to be some of the biggest freshwater-related problems in Europe: eutrophication as affected by agriculture and the addition of nutrients, and water quantity as affected by population and amount of runoff available. ArcGIS 9 was used to harmonize, re-project and display all digital geographic data, and extract statistics and summaries per RBD.

The selection and assessment of the indicators included in the study are described further below.

Table 1: River Basin District Characteristics and Indicators.

	Characteristic or Indicator	**Type of Indicator**	**Units**	**Data Source** **(see Map Layer and Information/Dataset Sources after references)**
Area	Characteristic	-	km²	Nilsson, KTH
Population	Characteristic	-	People	LandScan 2003
Population Density	Indicator	Pressure	People/km²	Calculated
Average Annual Discharge	Characteristic	-	m³	EEA Waterbase Datasets and others (see Map Layer and Information/Dataset Sources)
Water Availability	Indicator	Status	m³/person·year	Calculated
Nutrient (N/P) Concentrations	Indicator/ Characteristics	Status	mg/l	EEA Waterbase Datasets
Land Cover	Characteristics	-	Percent	GLC 2000
Cultivated Land	Indicator	Pressure	Percent	GLC 2000

2. 1 Pressure Indicators

It is important to get some idea of the pressures being placed on Europe's water resources. *Percentage of agricultural/cultivated land* constitutes a primary indicator for measuring pressure on water resources, and was thus chosen as one of the indicators for examination in this study. The geographic land cover layer selected, GLC 2000, provides information on how the land in Europe is used, including which areas are devoted to agriculture. The percentage of cultivated land within an RBD can give an indication of the pressure on water resources in that district, since it provides an indication of the relative amount of nutrient pollution from agriculture one might expect to find in the area.

Population is the next important factor when looking at pressures on water quantity and quality. *Population density* was therefore also selected as a key indicator for pressure placed on water resources. Population density is the average number of people per square kilometre and was obtained by dividing the population of the district by the district area. Population per district was extracted from LandScan 2003, available at a resolution of one kilometre.

2.2 State Indicators

To obtain an idea of the actual state of water resources in Europe, quality and quantity indicators were chosen.

Water availability was selected as an indicator of the available quantity of water. Average yearly runoff was considered to be the measurement that provides the best means of gauging how much water is available for use within a given RBD. This is because "the renewal rate, not the global volume of water at a given time determines how much water is available for use" [14]. In order to know how much water one can sustainably extract from a lake, one must know the replenishment rate of that lake. Groundwater also has a connection to run-off in that "groundwater eventually seeps to the surface in springs, or flows into rivers" [14]. This study thus used the mean of the largest recorded annual river runoff measured at medium to low altitude stations as an estimation of available water resources within an RBD. The mean was taken from varying number of years depending on the information available, i.e. some means were obtained from annual runoff information from the last three years, others from twenty years back. This information mostly came from the EEA Waterbase Datasets; yet it was necessary to use other data sources when runoff information for certain regions was lacking (see Map Layer and Information/Dataset Sources following the References for more information). If the RBD contained more than one river basin, the largest recorded runoff from each basin was selected and these were summarized for the RBD as a whole.

In order to assess the water availability within an RBD, the population within a district was compared to the amount of water available and the following standards were applied [14]:

Low = or < 100 people per flow unit

Medium (quality or dry season problems) = 100-600 people per flow unit

High (water stress) = 600-1000 people per flow unit

1 flow unit = 1 million cubic meters per year

These standards above were adapted to the following, as shown below:

No water stress = 10,000 m^3/person·yr or more

Risk of water stress = between 10,000 and 1,667 m^3/person·yr

Water stress = less than 1,667 m^3/person·yr.

Measurements of nutrient concentrations, specifically *phosphorous and nitrogen concentrations*, were selected as indicators of quality of European waters. The mean total nitrogen concentration, N_{Cavg}, or mean total phosphorus concentration, P_{Cavg}, are the mean total nitrogen, mg/l, or mean total phosphorus, mg/l, concentrations from all the quality monitoring stations in an RBD at which total nitrogen or phosphorus measurements were taken. Measurements from the most recent available six or seven years per station were used. Where total nitrogen and/or phosphorus data were missing, total ammonium and/or orthophosphate were used. All information on nutrient concentrations was provided by the EEA Waterbase Datasets.

While a normative standard could be used to measure and compare water availability, finding an appropriate measure for comparison of water quality proved more difficult. As a part of the on-going WFD implementation, quality standards are currently being developed and decided upon through activities under the Common Implementation Strategy for the WFD. However, these quality standards are not yet ready and cannot be used here.

There are a number of other EU directives that specify acceptable concentration levels of nitrate (NO_3), such as [5]:

- Drinking Water Directive: maximum allowable nitrate concentration = 50 mg/l;
- Surface Water Directive : guideline nitrate concentration = 25 mg/l;
- Nitrates Directive: must identify waters with annual average nitrate concentrations of 50 mg/l or higher.

However, these levels are, it seems, representative of a “worst case scenario”; that is, they indicate that the state of the water is so poor that action must be taken and that the water cannot, for the time being, be used as it normally would. These limits are thus not applicable for the study at hand, where ideally a range of quality levels should be apparent. Due to the lack of an appropriate normative standard, water quality was only assessed on a relative scale, comparing RBDs to each other.

3. RBD RANKING

For the ranking of RBDs, two basic relative rankings were carried out: one in terms of *pressure* placed on the water resources and one based on the current *status* of the waters within the RBDs. The pressure ranking is composed of the two pressure indicators: percentage of agricultural/cultivated land and population density. The status ranking is composed of the two state indicators: concentrations of nutrients and water availability.

Table 2: Definitions of the Indicator and Aggregated Indices.

$$\text{Population Density Index for RBDn} = \frac{\text{Population Density (pers/km}^2\text{) for RBD}_n}{\text{AVG (Population Density for all RBDs)}}$$

$$\text{Cultivated Land Index for RBDn} = \frac{\text{Cultivated Land (\%) for RBD}_n}{\text{AVG (Cultivated Land for all RBDs)}}$$

$$\text{Water Availability Index for RBDn} = \frac{\text{Water Availability (pers/m}^3\cdot\text{yr) for RBD}_n}{\text{AVG (Water Availability for all RBDs)}}$$

Nutrient concentration Index for RBD_n =

$$\frac{\left(\frac{\text{Nitrogen (mg/l) for RBD}_n}{\text{AVG (Nit. for all RBDs)}} + \frac{\text{Phosphorus (mg/l) for RBD}_n}{\text{AVG (Phos. for all RBDs)}} + \frac{\text{Orthophosphate (mg/l) for RBD}_n}{\text{AVG (Orthophos. for all RBDs)}} + \frac{\text{Ammonium (mg/l) for RBD}_n}{\text{AVG (Ammon. for all RBDs)}}\right)}{4^*}$$

*This number depends on what nutrient information is available for each RBD. For example, for several districts in Ireland, no nitrogen or phosphorus information was available, so the average of only their orthophosphate and ammonium indexes is taken.

$$\text{Aggregated Status Index for RBD}_n = \frac{\text{(Water Availability Index for RBD}_n + \text{Water Quality Index for RBD}_n\text{)}}{2}$$

$$\text{Aggregated Pressure Index for RBD}_n = \frac{\text{(Population Density Index for RBD}_n + \text{Cultivated Land Index for RBD}_n\text{)}}{2}$$

$$\text{Pressure Management Index for RBD}_n = \frac{\text{Aggregated Pressure Index for RBD}_n}{\text{Aggregated Status Index for RBD}_n}$$

The procedures for obtaining the rankings are illustrated in Table 2. For each indicator, the average of all the RBD scores was calculated and each individual RBD score was then divided by the average. This provided a number that revealed the deviation of the individual RBD score from the category average, and it is this number that gives the RBD its rank. This series of operations was performed to obtain a number of indexes, namely a population density index, a water availability index and a cultivated land index (index referring to the fact that the ranking is based on the scores' relationship to the average). Since a higher score means worse ranking in each of the categories, scores for water availability were converted from m^3 per person per year to persons per billion m^3 per year. With a few more calculations, a nutrient concentration index was also obtained. Given that there are four nutrient categories (Ammonium, Nitrogen, Phosphorus and Orthophosphate) and that a relative score could be calculated in each category for almost all RBDs, it was possible to take the average of these per district to obtain a relative overall "nutrient concentration" score for each RBD.

The same method was used to combine the water availability and nutrient concentration indexes and thereby obtain an aggregated "status" index. The scores from the water availability and nutrient concentration indexes for a given RBD were averaged to provide its score in the aggregated status index. The same applied when combining the population density index and cultivated land index in order to obtain an aggregated "pressure" index.

Dividing an RBD's score from the aggregated pressure index by its score in the aggregated status index gives an idea of how much greater or smaller the pressures within the RBD are compared to the status of its waters, and although admittedly highly speculative, thus also gives an indication of how well an RBD is managing the pressures that are being placed on its water resources. This calculation has been named the Pressure Management (PMI) index and may be considered an attempt to suggest an approach to benchmark water management effectiveness.

4. RESULTS

An example of a characterization map, produced for the Lielupe RBD, is shown in Figure 2. Such maps have been produced for all RBDs and are available (in pdf-format) upon request from the corresponding author.

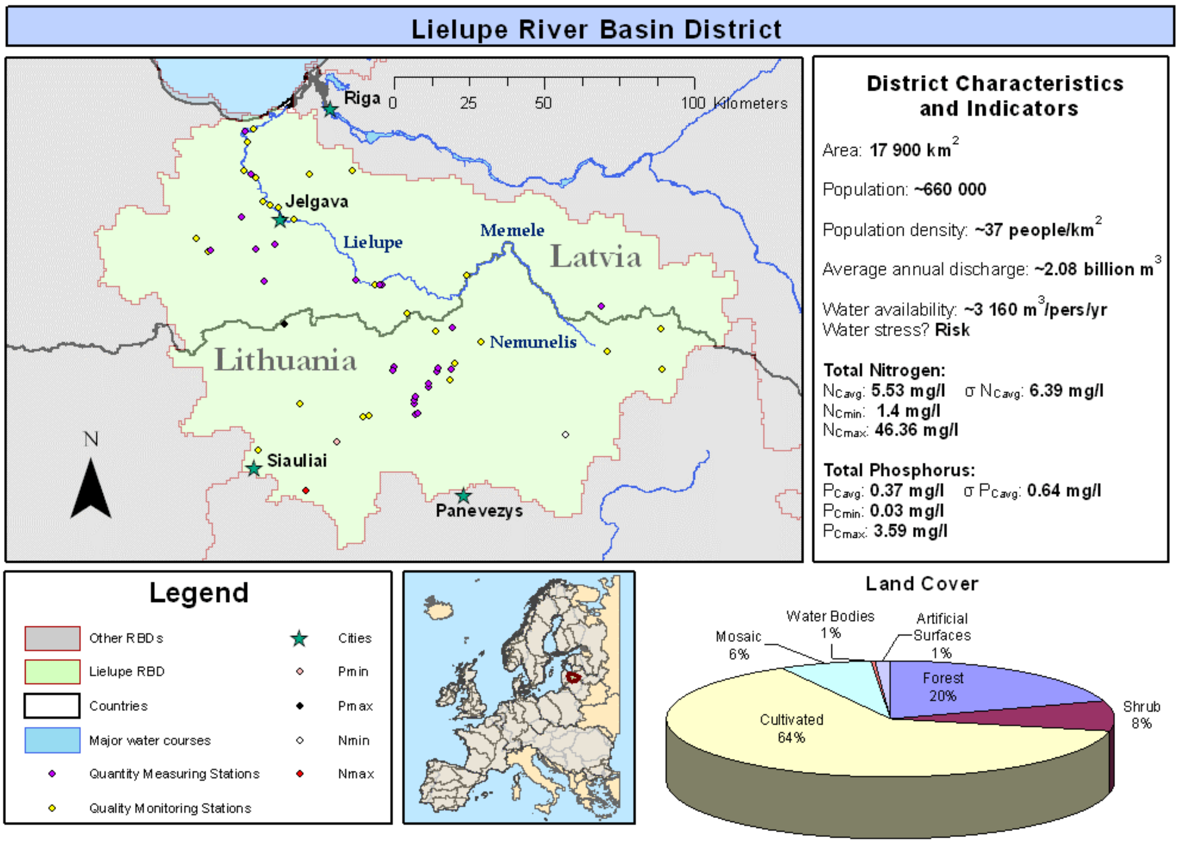
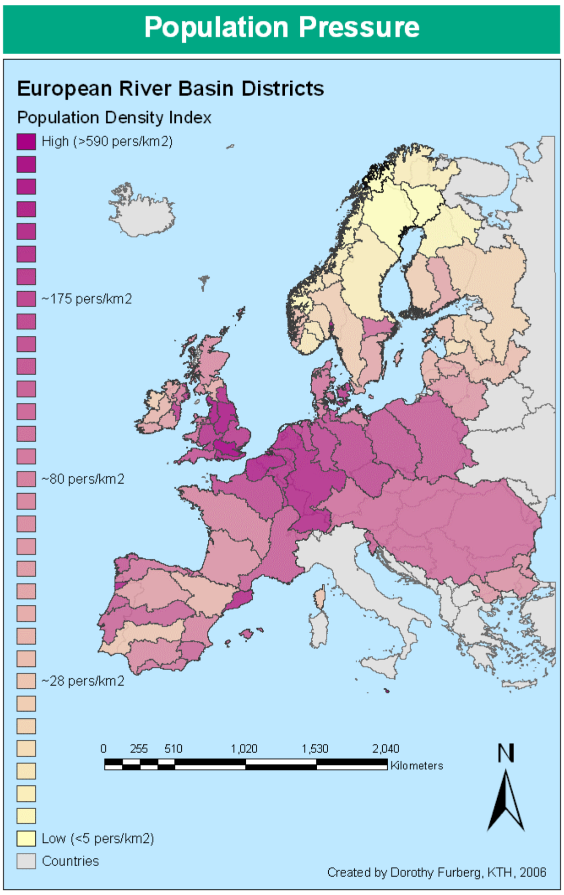
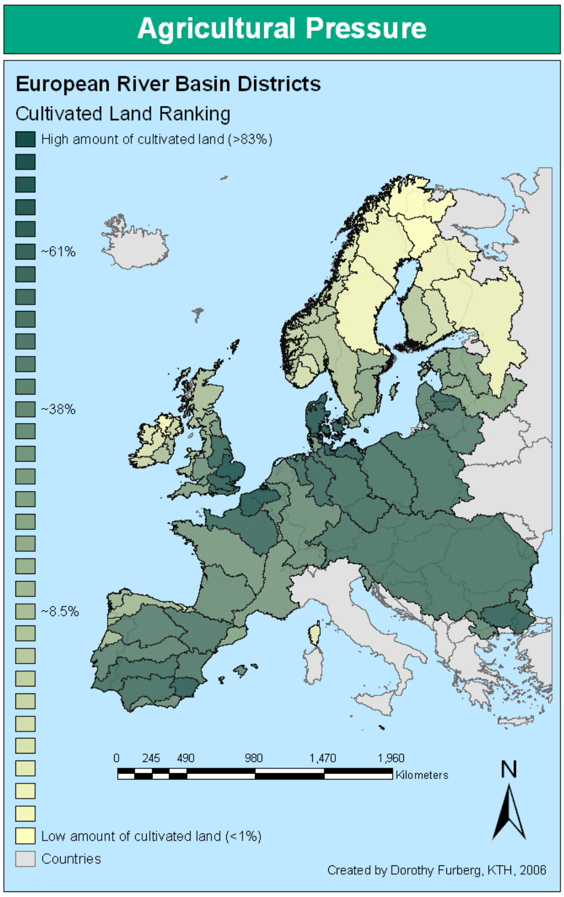


Figure 2: Characterization map for the Lielupe RBD.

The results from the RBD rankings are presented as a number of graduated colour maps (Figure 3-4).

From the individual indicator and combined pressure/status maps (Figure 3), it becomes clear that there are significant differences among Europe's RBDs when it comes to water quantity and quality and pressures on water resources, and that the RBDs with lower status and higher pressure, and the inverse, appear to be grouped geographically. These groups are listed in Table 3. The table displays those RBDs that are ranked repeatedly either among the ten highest or among the ten lowest in each of the indicator rankings. This means, for example, that the Telemark RBD in Norway was ranked somewhere in the top ten in all four indicator rankings and in both aggregated index rankings (cultivated land, population density, water quantity, water quality, pressure on water resources, state of water resources). As can be seen from the table, the RBDs in the Nordic countries (excluding Denmark) fair well when compared to the rest, while the toughest water-related challenges appear in Great Britain and Spain. As might be expected given the information contained in the maps in Figure 3, Western Europe dominates the list of RBDs with the greatest percentage of cultivated land and highest population density, which often translates into regional hotspots for high nutrient concentrations in rivers and periodic water stress.





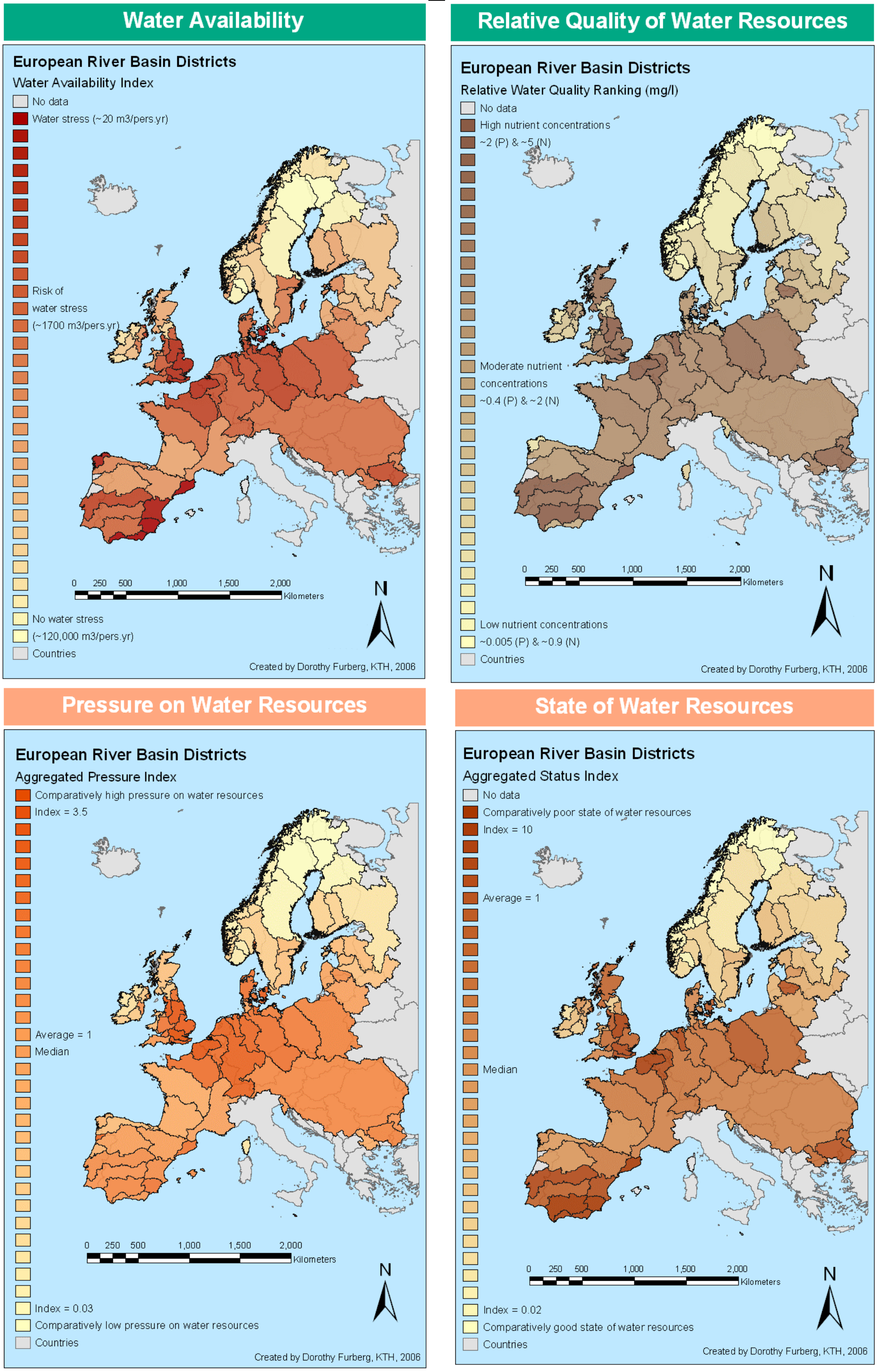


Figure 3: Pressure on and state of water resources in the European RBDs

Table 3: Repeatedly Highest and Lowest Ranked River Basin Districts.

Repeatedly highest ranked RBDs:	**River Basin District**	**Countries**
	Telemark	Norway
	Sogn og Fjordane	Norway
	Nordland	Norway
	Troms	Norway
	Bothnian Sea	Norway, Sweden
	Bothnian Bay	Finland, Sweden
	Finnmark/Tenojoki-Paatsjoki	Finland, Norway, Russia
	Oulankajoki	Finland, Russia
	Kemijoki	Finland
Repeatedly lowest ranked RBDs:	**River Basin District**	**Countries**
	Humber	Great Britain
	Anglian	Great Britain
	Thames	Great Britain
	Southeast	Great Britain
	Denmark East	Denmark
	Scheldt	Belgium, France, Netherlands
	Catalonia	Spain
	Segura	Spain

This table displays those RBDs that are repeatedly ranked either among the ten highest scoring or among the ten lowest scoring RBDs in all four indicator rankings and both aggregated index rankings (i.e., cultivated land, population density, water quantity, water quality, pressure on water resources and state of water resources). The RBDs in each category are listed according to geography and not according to rank within the top or bottom ten.

A more nuanced picture emerges if one looks at the PMI map (Figure 4). It indicates that some RBDs with high pressure on water resources are actually handling this pressure rather well. This is the case for the Rhine RBD and for some RBDs in Denmark, for example. On the other hand, the PMI map also reveals where pressure management effectiveness is either low because it is not needed or low where it is badly needed. The results suggest that several RBDs in southern Spain appear not to handle their pressures well, since these are not as extreme as elsewhere in Europe, but still lead to some of the poorest water quality and quantity conditions. In addition, it becomes clear that pressure management is minimal because pressures are low to begin with in some northern European RBDs. Thus the state of water resources there is comparatively good without the authorities having to intervene to protect them. This is the case for several districts in Sweden and Finland.

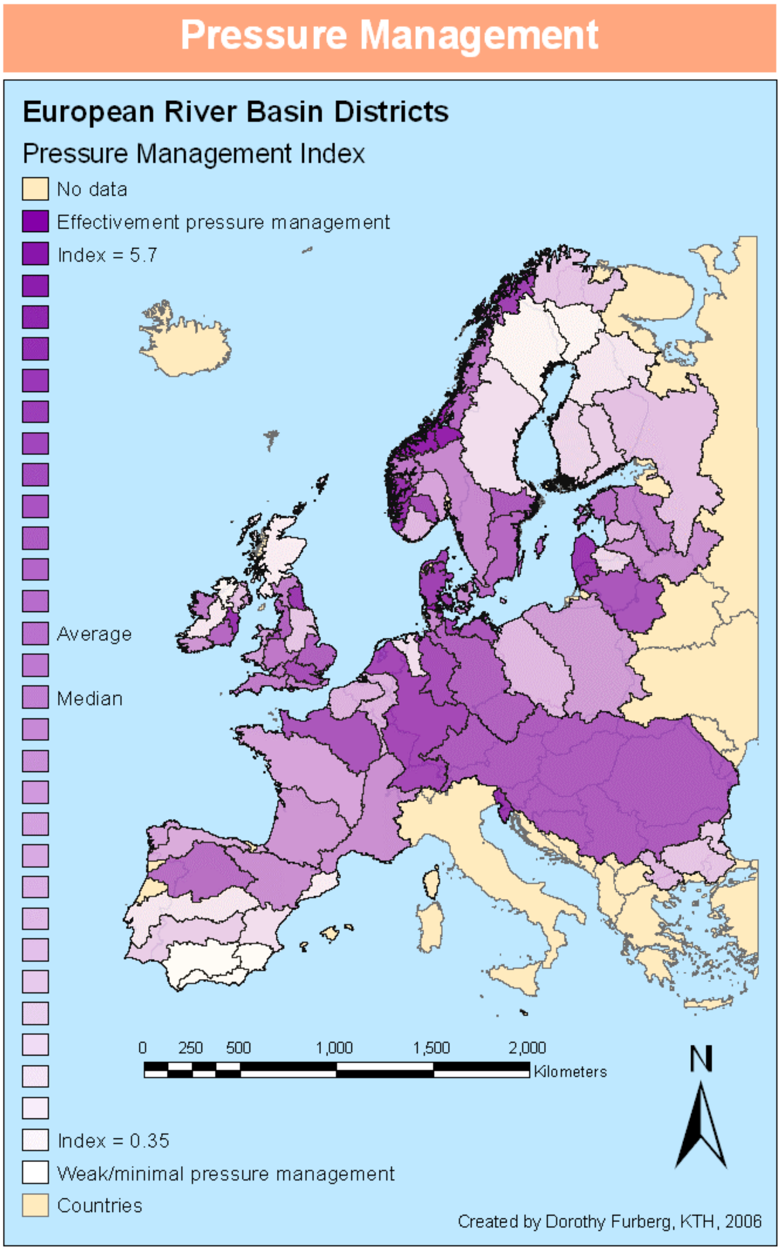


Figure 4: Pressure management per RBD.

One can also get a feel for where the RBDs lie in terms of pressure on and status of water resources through the graph in Figure 5. The central line represents the average of the PMI index. Those districts that have a relatively high pressure index and low status index, such as Sonderjyllands Amt, are doing very well in terms of pressure management. The reverse is true of those who have a low pressure index and high status index.

It could be considered reassuring that the majority of RBDs are plotted below the average line, signifying that for this majority, pressure on water resources is a more significant problem than the actual state of their water resources. The caution here is to note that the state of water resources in certain RBDs is so poor that their scores pull the average line up a bit, and thus cause more RBDs to be plotted below the line. In essence, they make the other RBDs "look better" than may actually be the case.

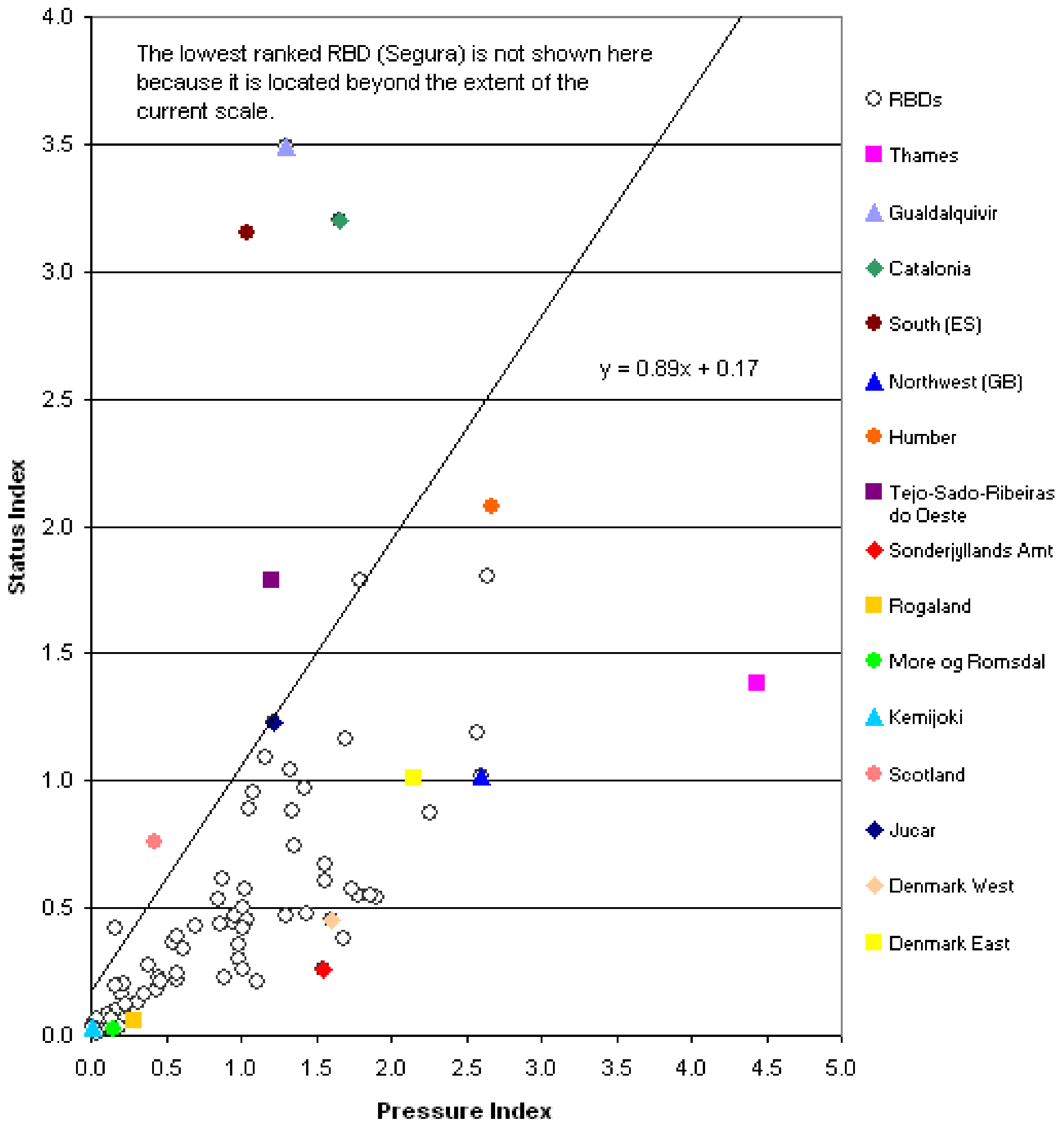


Figure 5: Pressure Management Index plot - status vs. pressure per RBD.

5. DISCUSSION

While the north-south gradient evident in the ranking of the RBDs comes as no real surprise, it is interesting to note that the repeatedly lowest ranked RBDs are located exclusively in Western Europe. One might have expected the major problem areas to appear in Eastern Europe in the new Member States due to the previous lack of environmental protection for water resources, particularly during the Soviet era. One caution in this regard, however, is that almost no quality information for Russia and Belarus was publicly available, and thus districts that share parts of these countries may not be accurately ranked. This will be addressed in more detail in the next section on data limitations and uncertainty.

What may at first glance look like a “water stressed” region could in reality be an area whose inhabitants would claim that there are no signs of water stress. This study did not take groundwater resources into account and thus some areas that may be ranked as “water stressed” are in actuality drawing heavily upon their groundwater stores to compensate for a lack of surface water. This is the case for Germany and Denmark [6]. By contrast, Norway uses almost exclusively surface water resources since they are so plentiful [6]. But regions that draw heavily upon groundwater run the risk of lowering the groundwater table, since groundwater stores take years if not decades to recharge [15] and of saltwater intrusion into coastal aquifers, which occurs particularly in the Mediterranean region [6]. In this case, the “water stress” ranking is more a signal that there exists an unsustainable situation in terms of water use, even if no immediate warning signs have yet appeared.

80% of water used in European agriculture is absorbed by crops and evaporates from fields [6]. Evaporative demand is highest in southern Europe: Spain’s, for example, is twice that of Sweden’s [14]. This condition compounds the problem of water shortages; when temperatures are highest, water quantity is at its lowest, while demand, from the agricultural and tourist industries in particular, is at its peak. Yet it is important to note that the water availability indicator (m3/pers·yr) does not account for the coping capacity of different countries to handle water shortages [16]. Almost no country uses all of its available water resources, either because it does not need to or because it is too expensive to “mobilize” the rest [14]. Spain, as an alternative to bulk transfer of water, intends to increase its desalinization capacity in order to meet water demand in particularly stressed basins [6]. Thus there are alternatives for meeting demand in Europe’s water stressed regions; it is simply a question of mobilizing resources and technology in those areas.

With regard to nutrient concentrations in particular basins, it is important to recall that this study does not provide information about trends over time. Since 1992, nitrate concentrations have fallen most markedly in Denmark, Germany and Latvia [6]. This is welcome news in light of the fact that RBDs within these countries are often ranked lowest in terms of nutrient concentrations. Not all trends are positive, however. Phosphate levels in the Duero in Spain, for example, have deteriorated over the past 25 years [6].

5. 1 Data Limitations and Uncertainty Analysis

A particular challenge in this study was the fact that different types of information had to be obtained from different sources and then combined to obtain the results. The most reliable datasets available were at times incomplete and had to be complemented with information from other sources. This was the case for the EEA water quantity dataset. As can be noted in Figure 6, measuring stations and runoff information were missing for Romania and concerned areas of Serbia and Montenegro, Bosnia and Herzegovina, Croatia, Belarus and Russia that border the EU. What is surprising, however, is that data for the Czech Republic, Ireland, Belgium, Poland, Portugal and Sweden (all EU Member States) are lacking, which constitute large gaps of information in the dataset. It was therefore necessary to seek quantity (runoff) information for these regions from other sources (Figure 6). Combining different datasets for the same indicator is not ideal, as the degree of harmonization and standardization is not assured, and the results may thus not be as accurate as they otherwise could have been due to these conditions. But the results are still a useful indication of the state of water resources in each of the districts, which can be investigated and complemented with more in-depth and rigorous studies in the future.

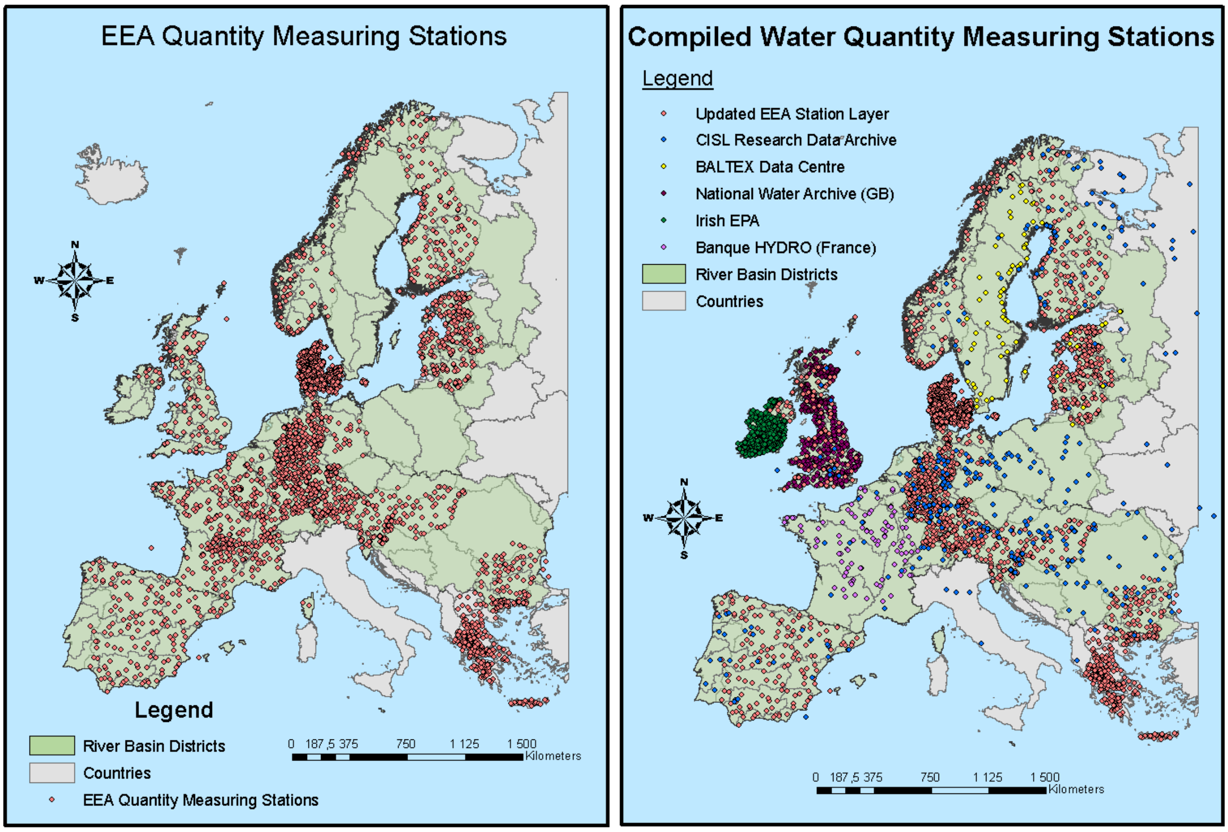


Figure 6: EEA quantity measuring stations (left) and compiled water quantity measuring stations (right).

Turning our attention to quality issues, the EEA water quality dataset lacks information for Portugal and areas of Belarus and Russia that fall within the borders of some RBDs. Thus the nutrient averages for districts in Portugal or districts shared with Portugal, Belarus and Russia (in total, nine RBDs) may not be fully accurate.

6. CONCLUSION AND RECOMMENDATIONS

When looking at the results of this kind of study, one must keep in mind that “no two rivers are alike; and no single indicator captures all the factors” [6]. The indicators used for the characterization of the RBDs provide a general idea of the water resource conditions in that district – they do not, of course, account for all the problems or positive conditions that may also exist. Neither do they show trends over time, for example, improvements or degradation of water resources over the past decade. While trends analysis was not possible within the scope of this study due to time constraints and information availability, it should be undertaken in the future as it would add a whole new dimension of information to the results presented here and provide a picture of European water resources that perhaps more closely matches the reality.

While recognizing the ongoing ambitious plans and developments towards a Water Information System for Europe, the aim of this study was to provide a first, very general assessment of the RBDs established under the EU WFD. By doing this, one can now get an initial comparative overview of the districts, possibly assisting policy making in identifying regions that are most in need of support in terms of reaching the WFD goal of “good ecological and chemical status” for Europe’s water resources. The results reveal clear patterns in that, on the whole, northern waters fair well in a Europe-wide comparison while southern waters fair poorly in terms of pressure on and status of water resources. The comparison and rankings also highlight some regional hot spots. The identification of these hot spots could be helpful in promoting cooperation between RBDs that, while geographically distant, may have common water problems and information to exchange concerning the solutions. Furthermore, parallel independent assessments of this kind can prove very useful, not least because they are not based on official reporting obligations. They can assist with environmental benchmarking, particularly when looking at how pressures on water resources relate to their status. This kind of study can highlight differences in performance in terms of pressure management and, after investigation, spread information about best practices. If applied properly, these could in turn lead to increased effectiveness of water resource management systems.

What made this study interesting but also particularly challenging was its lack of precedent. Common European, or even regional, definitions for what constitutes good or poor status of water resources are conspicuously absent, being left to individual Member States to decide for themselves. Furthermore, robust and sound approaches to aggregate and simplify monitoring data and report these on a RBD level also require additional thinking. As we approach 2009, the end of the first WFD management period, such information will increasingly become available. The current study suggests some simple approaches that may possibly be used.

Thus, this study was a first attempt at a broad assessment of water resources and their pressures within the RBDs and as such it has several limitations. Nonetheless, the EU could in future not only perform similar kinds of studies periodically with varying indicators and the scientifically best data available, it could also go further and undertake more in-depth studies, such as examination of trends over time. It would thereby obtain a more complete picture of water resources throughout the established RBDs than compiled Member State reports can provide.

Distribution of material

The characterization maps for each of the RBDs, graduated color maps illustrating the indicator and aggregated indexes (in pdf-format), and an Excel table summarizing the extracted statistics and derived indicators are available upon request from the corresponding author.

7. REFERENCES AND DATA SOURCES

7.1 References

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