Innovative Approaches Towards Sustainable River Basin Management in the Baltic Sea Region: The WATERPRAXIS Project

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Abstract This paper describes the scientific background, main elements and final results of the WATERPRAXIS project, which was implemented in 2009–2012 under the Interreg IVB Baltic Sea Region Programme 2007–2013 between seven coastal countries of the Baltic Sea Region (BSR). The special focus of this project was on the reduction of excessive nutrient loads to the Baltic Sea through support in implementation of cost- and eco-efficient water protection measures in the region. The rationale behind the WATERPRAXIS project was the need to tackle the continuing eutrophication of the Baltic Sea, a phenomenon which concerns scientists and governments alike. The clear dependencies between the bad quality of river waters flowing into the sea and its ecological state are well known and are already reflected in the European Union (EU) Water Framework Directive (WFD) (Schernewski et al. in J Coast Conserv 12(2):53–66, 2008). The EU WFD requires large-scale river basin management plans (RBMP) to be developed and implemented for each river basin district, aiming to achieve at least good ecological status in all European water bodies, including coastal seas, by 2015. However, this idealistic approach is hindered in practice by several barriers, in particular the large cover of RBMP and lack of good examples of the best local practices in river basin management. The WATERPRAXIS project tried to overcome these challenges and offer examples of successful water

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management initiatives from several countries around the Baltic Sea (Ulvi 2011). As a concrete output of the project, four different investment plans which realise water protection measures were implemented in Poland, Lithuania, Denmark and Finland.

Keywords Water quality Baltic Sea · Eutrophication · River basin management plans · EU Water Framework Directive · Eco-efficiency

1 Introduction

1.1 Key Issues

Marine eutrophication has become a worldwide problem in many coastal areas (Ryding 1994; Smith et al. 1999). However, the Baltic Sea is especially sensitive to this process because of its very slow water exchange, while the plant nutrient loads, mainly nitrogen and phosphorus, are high delivering from a wide variety of sources within its drainage basin (Wulff et al. 1990).

Over the last 100 years, since the industrial revolution in the region, the Baltic Sea has been slowly changing from a nutrient-poor (oligotrophic), clear-water sea into a nutrient-rich (eutrophic), murky sea (Smith et al. 1999). To date, eutrophication is considered to be one of the biggest environmental problems for the Baltic Sea, leading to imbalanced functioning of the entire marine and coastal ecosystems (Lundberg et al. 2009; Ulen and Weyhenmeyer 2007). The main cause of this marginally reversible process is excessive nitrogen and phosphorus loads from various activities, such as clearing of forests, development of farms and cities and increased use of fertilisers and detergents of the approximately 85 million people living in the catchment area. According to the latest data, total input of phosphorus and nitrogen to the Baltic Sea in 2008 reached 29,000 and 859,600 tons, respectively (HELCOM 2011).

In recent decades, many sea-protective measures have been successfully implemented in the Baltic Sea Region (BSR). These include different international programmes and projects with the overall objective to prevent eutrophication of the Baltic Sea and improve the state of its nature and water quality. Furthermore, several European water legislations are now demanding concrete measures aimed at combating eutrophication in the Baltic Sea, for example, the HELCOM Baltic Sea Action Plan, the EU Strategy for the BSR, the EU Water Framework Directive (WFD) and the EU Marine Strategy Framework Directive. The WATERPRAXIS project contributed to the EU Strategy for the BSR for reducing nutrient inputs to the Baltic Sea and enhanced the implementation of the EU WFD, which aims to ensure a good water quality in all European surface waters during the next decade.

2 Sources of Nutrient Inputs to the Baltic Sea

Nutrients which cause eutrophication reach the sea mainly from various human activities in the sea's drainage basin and, in smaller extent, from natural background sources. For simplicity, the total *external* input of nutrients into the Baltic Sea can be divided into three main pathways:

1. Direct emissions into the sea from industrial and urban areas on the coast (point sources)
2. Atmospheric deposition of nutrients on the sea surface
3. River-based run-off

The river run-off originates from point sources, such as industrial or municipal wastewater plants, as well as from diffuse sources such as agriculture, scattered dwellings and atmospheric deposition within river basins. It also includes natural background sources, which mainly refers to natural erosion and leakage from unmanaged areas that would occur irrespective of human activities (HELCOM 2006). Additionally, *internal* fluxes from sediments and the fixation of atmospheric nitrogen by cyanobacteria in the sea can also be a substantial factor when calculating total nutrient supply to the Baltic Sea.

The origin of nutrients can also be described using a scheme of waterborne and airborne inputs. In this scheme, nitrogen and phosphorus sources are analysed separately to demonstrate more clearly the most significant sector of nutrients pollution.

According to HELCOM 2006, waterborne discharges are the major source of nutrient inputs to the Baltic Sea, corresponding to about 75 % of the nitrogen input and 95–99 % of total phosphorus input (Fig. 1).

Diffuse losses (mainly from agriculture, forestry and scattered dwellings) are responsible for the largest portion of waterborne nutrient inputs. Furthermore, agriculture alone contributed to about 80 % of the reported total diffuse load (HELCOM 2009).

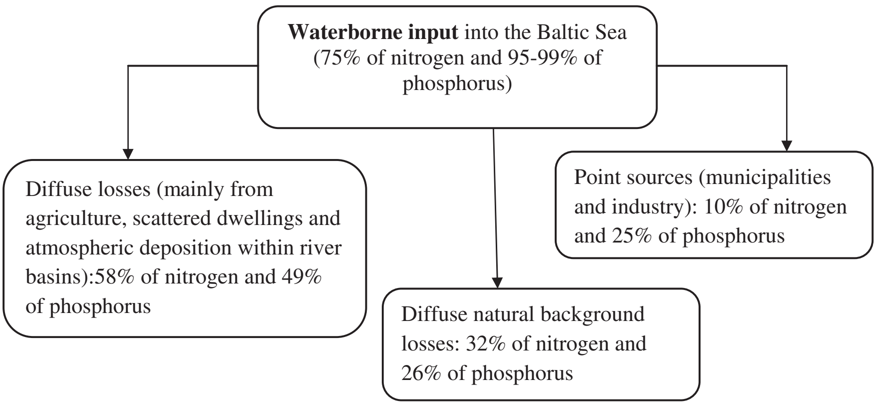

Fig. 1 Waterborne nutrient inputs into the Baltic Sea according to HELCOM 2006

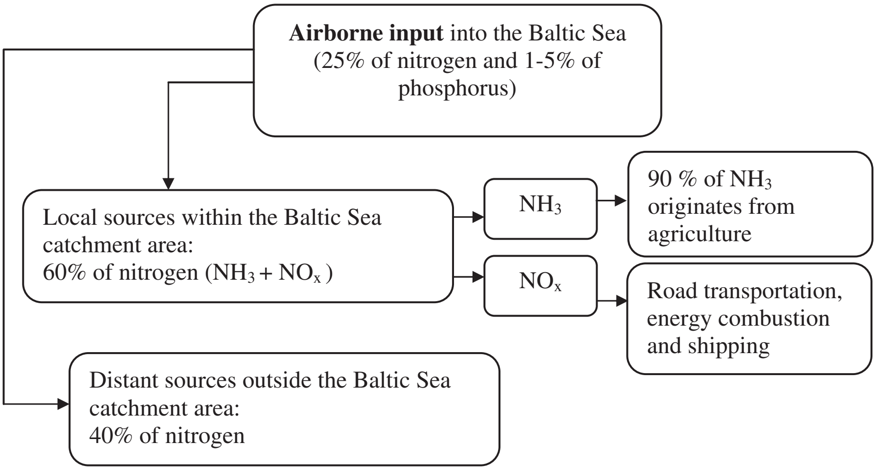

Fig. 2 Airborne nutrient inputs into the Baltic Sea according to HELCOM 2006

About 10 % of nitrogen and 25 % of phosphorus originate from point sources (municipalities and industry). The proportions of natural background losses were 32 % of nitrogen and 26 % of phosphorus.

The airborne deposition of nitrogen compounds comprises about quarter of the total anthropogenic load to the Baltic Sea (Fig. 2). The estimated airborne contribution of phosphorus is only 1–5 % of the total phosphorus load to the sea.

Nitrogen compounds are emitted into the atmosphere as nitrogen oxides and ammonia.

Road transportation, energy combustion and shipping are the main sources of nitrogen oxide emissions in the BSR; in the case of ammonia, roughly 90 % of the emissions originate from agriculture.

3 WATERPRAXIS Supported Efforts to Tackle Eutrophication

Thus far, a series of different measures have been undertaken to prevent eutrophication of the Baltic Sea and to support the sustainable development of the region. First and foremost, this includes tackling the point sources of nutrient pollution. In this field, significant progress has been made in recent decades by improving the efficiency of wastewater treatment and increasing the number of households connected to wastewater treatment plants in countries across the Baltic Sea catchment area (HELCOM 2007). Nevertheless, further improvements in wastewater treatment are required, especially concerning the reduction of phosphorus load.

However, non-point sources of pollution, which are often much more difficult to control, are the primary contributors to eutrophication in the Baltic Sea.

The list of measures for reducing the amount of nutrients from diffuse sources includes development of sustainable practices in agriculture (which, for example, include bans on the use of pesticides and fertilisers in farming, transformation of arable land into pastures, restrictions on stocking density and use of ecological farming methods), reducing pollution from transport, marine shipping and households, and pollution limitation from the energy sector. The final strategy to decrease diffuse nutrient load is fixation of nutrients after they have been discharged into the environment. This includes range of measures, such as protection of watershed forest cover and creation of buffer zones and buffer strips between streams and modern farmland (Fuerbach and Strand 2010), restoration and creation of wetlands and sedimentation pools (Rydén et al. 2003) and implementation of other measures, for example mussel cultivation in certain Baltic Sea lagoons to remove nutrients in the coastal waters (Stybel et al. 2009).

The WATERPRAXIS project also aimed to prevent the eutrophication of the Baltic Sea. The project enhanced the implementation of the EU WFD, aiming to achieve good ecological status, as a minimum, for all European waters by 2015. With the WFD, the EU specifically provides for long-term sustainable water protection management of the aquatic environment by requiring that its member states develop river basin management plans (RBMP) for each river basin district using the river basin approach instead of administrative or political boundaries (European Community 2000). The EU WFD also introduces the economic analysis of water use in order to estimate the most cost-effective combination of measures in terms of water use and requires active public participation in the development of RBMP by involvement of stakeholders, non-governmental organisations and citizens. However, applying water pollution control methods and changing land-use practices are sometimes hindered by many barriers. For example, RBMPs cover large geographical areas which are often transnational and, therefore, it is difficult to apply common public participation to the planning process and obtain joint acceptance on the local level for planned measures. Also, the cost-effective and eco-efficient calculation of measures is missing, but without proper knowledge of the environmental and economic efficiency of different water protection actions, it is virtually impossible to get sufficient political and financial support for their implementation. Furthermore, climate change has increased hydrological extremes by reducing the efficiency of water pollution control measures, and additional climate change impacts remain largely unknown (HELCOM 2010).

The WATERPRAXIS project was created to assist in overcoming these barriers and develop sustainable water management practices, as well as preparing water protection action plans and measures for selected pilot sites around the BSR. It was based on the previous Interreg BSR project Watersketch (http://www.watersketch.net/) and expanded on the results gained in other BSR projects, such as TRABANT, BERNET CATCH and ASTRA. The project partnership consisted of professionals who are specialised in river basin planning, environmental technology, environmental education and public organisations which implement water protection measures. The project was carried out in cross-national collaboration among seven coastal countries of the BSR: Finland, Denmark, Germany, Poland, Lithuania, Latvia and Sweden. Additionally, Kaliningrad, Russia, was integrated into the associated partnership status in order to secure greater Baltic coverage (Fig. 3).

Fig. 3 Schematic view of the Baltic Sea drainage basin and location of project partners (*Source* http://www.grida.no/baltic/)

List of the partners:

1. Finnish Environment Institute, FIN
2. North Ostrobothnia Regional Environment Centre, FIN
3. Hamburg University of Applied Sciences, DE
4. National Environmental Research Institute, Aarhus University, DK
5. Municipality of Naestved, DK
6. Technical University of Łódź, PL
7. Kaunas University of Technology, LT
8. Charity and Support Fund Šešupė Euroregion, Šakiai office, LT
9. Luleå University of Technology, SW
10. Rēzekne Higher Education Institution, LV.

4 Objectives of WATERPRAXIS

The overall aim of the WATERPRAXIS project was to contribute to the efficient management of river basins to improve the ecological status of the Baltic Sea.

To move towards this strategic objective, its specific goals were identified as follows:

1. Determine and suggest improvements to current water management practices by analysing the contents and planning processes of RBMPs.
2. Establish RBMP-based action plans for pilot areas which incorporate best practices and measures for water protection and public participation.
3. Prepare investment plans (including technical and financing plans) for water protection measures at selected sites in Poland, Lithuania, Denmark and Finland.
4. Disseminate information on water management measures and best practices via publications, seminars and websites.
5. Offer training and education programmes for planners in the water management sector.

The action plans, investment plans and planning methods were prepared in close, transnational cooperation between project authorities and scientific partners. They are planned to be implemented in selected BSR countries, 2 years after project completion.

4.1 Project Pilot Areas

Four different river districts in Finland, Denmark, Lithuania and Poland were selected as the project's pilot sites for the drafting of concrete investment plans. These locations were given priority based on the urgent need for economically and environmentally feasible solutions to improve their ecological state.

All water bodies in the four pilot sites were facing water quality problems. Moreover, water quantity was considered as an important environmental issue in the pilot area in Finland. A major challenge for these sites was to create synergies which would contribute to the implementation of targets for the aquatic environment, while taking into account the social and economic needs of local communities.

When preparing concrete investments plans for these sites, cost-effective principles were also taken into consideration in order to reduce nitrogen loading at the lowest cost to society.

4.2 Project Set-up and Work Packages (WPs)

For project management, from its start to the very end, a clear project planning methodology is always needed. It describes the general structure of the project and makes every step in project implementation clear, so all project partners know exactly which objectives must be completed by what time and how this can be accomplished. WATERPRAXIS was structured as an empirical research project which tied together five different work packages (WPs).

WP1 Project management and administration. Lead partner (LP): Finnish Environment Institute (SYKE).
The main objective of this WP was general management of all project activities. WP1 was led by the main coordinator of the project with the help of management members, financial managers and members of the steering group. The coordinator monitored the overall progress and assesses the quality of work being performed. The tasks carried out included organisation of all meetings, monitoring and combining partners' activities and financial reports, preparation of periodic reports every 6 months, final reports, etc.

WP2 Communication and information. LP: Hamburg University of Applied Sciences (HAW Hamburg).
The main aim of WP2 was to facilitate effective external and internal communication among project partners and ensure that all partners and other target groups across the Baltic Sea were aware of all project activities and results. WP2 raised awareness about WATERPRAXIS by disseminating the materials and documents produced as a part of this project and promoting the project's findings using, for example, the following instruments: project website, brochures, posters and newsletters, project dissemination in external events, such as conferences, fairs and exhibitions. The overall purpose of WP2 was to achieve high recognition for decision-makers, stakeholders and end users for the long-term goal of successful implementation of project results

WP3 Reviewing RBMP and processes. LP: National Environmental Research Institute, University of Aarhus (NERI).
The main purpose of this WP was to analyse recently drafted RBMP, including their implementation processes from various BSR countries in order to identify different approaches to river basin planning. WP's work started with developing a framework and guidelines for analysing RBMP. During the analysis, the primary focus of this WP was on institutional set-up, planning approaches and procedures, institutional structure, interplay, public participation, integration with other policy goals and climate change issues. Based on the results, the best practices and solutions in river basin planning were identified, which have the potential to be widely applied throughout the BSR

WP4 From RBMP to local water protection action plans. LP: Kaunas University of Technology.

WP4 summarised the existing regional water protection action plans covering defined regional target areas and prepared consolidated recommendations for the implementation of best practices. In this transnational work, with the participation of all partners, barriers, innovative measures and funding instruments for local implementation were identified. Furthermore, improvements for existing action plans were suggested, and new plans were created for pilot areas in Finland, Denmark, Poland and Lithuania. The capacity of local stakeholders in the environmental economy was strengthened by organising a university course and cost-efficient analysis of proposed measures. The WP was consistent with the principles established by the WATERSKETCH project and was aimed at strengthening the scientific, technical and social capacity to implement sustainable water resource management

WP5 From action plans to local investments in water resource protection. LP: Technical University of Łódź.The main aim of WP5 was to create a solid bridge between action plans and local water protection investments by implementing best available water protection practices in selected BSR countries. These best applicable water protection measures at river basins, which have a significant impact on the Baltic Sea and where environmental goals are not met (pressures/impacts/mitigation measures), were provided as examples and a showcase for the general public and local politicians in charge of environment issues. The ultimate goal was to involve local politicians and, thus, secure local water protection investments for an extensive period of the project

5 Final Results from the WATERPRAXIS Project

The expected final results at the end of the WATERPRAXIS project were:

1. Examples and guidelines of the best water management practices for river basin planning at several levels (official river basin districts, single river basins and

local investments) based on previous experiences from different countries and results attained from the project's pilot studies (published as a report and online).
2. Practical examples of good investment projects (published as a report and online).
3. Training courses for regional and local planners on general river basin management focusing on environmental economy and cost-effectiveness analysis.
4. Water protection action plans for pilot areas in some partner regions.
5. Investment plans (including technical and financing plans) for water protection measures in pilot areas in Finland, Denmark, Poland and Lithuania.

Since the project's inception in January 2009, various activities have been implemented within the project framework. This includes the organisation of several workshops, training courses and symposiums as well as producing of numerous reports and publications.

The most significant training and educational events are briefly described below.

1. Workshop on land-use modelling, 11–13 November 2009, Helsinki, Finland.
   The aim of this training workshop was to provide participants with knowledge and methods of the challenges posed by climate change and land-use development on river basin planning and management. Sessions focused on hands-on exercises using the GIS-based software developed in the earlier EU Forum Skagerrak and RiverLife and Watersketch projects.
2. Symposium on climate change and sustainable water management, 9 December 2009, Lyngby, Denmark.
   The event was organised by the Hamburg University of Applied Sciences parallel to the 15th Conference of the Parties (COP 15) of the United Nations Framework Convention on climate change. Its precise aims were as follows: to discuss the links between climate change and sustainable water management, present the work of some of the organisations working in the field, introduce some of the ongoing projects and initiatives dealing with sustainable water use and sustainable river basin management, identify areas where action is needed to facilitate a better understanding of the impacts of climate change on water systems and the measures which may be adopted to promote sustainable water management.
3. Workshop on acid sulphate soils (ASS) and land use, 1–2 November 2010, Luleå, Sweden.
   The workshop was organised as a result of increasing environmental problems caused by land use in ASS for ditching and ditch cleaning. The workshop aimed to disseminate information about ASS from a scientific, administrative and practical perspective; exchange different experiences with activities on ASS; identify future research needs; and plan feasible cross-border projects for the future.
4. Training course on economical tools for WFD implementation, 13–14 January 2010, Kaunas, Lithuania.
   The training course aimed to provide river basin planners with insights and hands-on training on how economic analyses on costs and benefits can be used in water resource planning, particularly related to the implementation of the WFD.

The contents of the course were an overview of the economic requirements in the WFD, an introduction to the fundamentals of environmental economic assessments of costs and benefits, and examples of applied cost-benefit studies and cost-effectiveness studies. Additional values connected to the action plans were also analysed, for example, improved recreational possibilities and tourism alternatives.

5. Symposium on climate change challenges in river basin management, 17–19 January 2011, Oulu, Finland.
   The international symposium was organised to discuss the challenges climate change poses for the use of water systems, water protection and how the EU can best tackle these challenges. During the two symposium days, presentations covered climate change challenges and adaptation from a variety of perspectives, including observed climate trends, effects on surface and ground waters, scenario studies, socioeconomic aspects and participatory tools related to water management planning.

In addition, during the project lifetime summarising final reports were produced within the WPs 3–5:

1. WP3: RBMP. Institutional framework and planning process. Cross-country analyses. The main body of the report analysed and compared the RBMPs, the planning processes and the structures and mechanisms laid down for implementation among the involved countries, namely Sweden, Finland, Latvia, Lithuania, Poland, Germany and Denmark. Based on this, the main challenges for implementation were discussed, as they could be recognised at this point in time, when RBMPs had been finalised for most countries, whereas Denmark still did not adopt the RBMPs.

The conclusions of the report are as follows:

- Institutional fit is low, a few countries opted for spatial fit
- All countries opted for coordinating bodies, and coordination seems more important than fit in all cases
- Compliance with procedures was high (except for Denmark where the focus was on implementation and financing)
- Ambitions are variable in the short distance, but high ambitions may be challenged by financial commitment
- Implementation gaps seem to be large, but learning processes may be more important for implementation successes in the long run

2. WP4:

Examples of Applied Water Management Practices in the BSR.

- WATERPRAXIS Pilots: Finland, Denmark, Poland and Lithuania.
  Water Protection Action Plans.
  Within the project local areas have been chosen in the above mentioned countries as pilot areas. For each of these areas action plans have been produced. The action plans describe existing ecological problems in the areas as well as existing management measures. Furthermore, the existing measures have been

promoted and supported and additional measures were suggested based on economic and cost-efficiency analyses.
- WATERPRAXIS Case studies. Latvian case study: Daugava River. Swedish case study: ASS. The project has also investigated important water management problems in Sweden and Latvia.

3. WP 5:

- WATERPRAXIS pilot reports of environmental, economical and social impact assessment. From Action Plans to Local Investments in Water Resources Protection. For each of the four pilot areas in Finland, Lithuania, Poland and Denmark, social, economical and environmental assessments have been conducted. The results for each pilot area are described within this report.
- Description of Investments and Investment Plans. Pilot projects from Finland, Denmark, Poland and Lithuania. In addition, the project described or established a set of investment plans for selected measures in the project‘s pilot areas in Poland, Lithuania, Denmark and Finland.

All these reports are available on WATERPRAXIS Web site at www.waterpraxis.net and have a wide range of information and experiences from the countries which took part in this project.

6 Conclusions

Based on the project work undertaken over the years 2009–2012, a set of conclusions can be made.

Firstly, the different challenges in water management and river basin planning in the BSR countries and also the different approaches towards meeting these challenges were identified. Therefore, it was concluded that there is still great need for further scientific cooperation between BSR countries and mutual learning is imperative in the field of water management and river basin planning.

Secondly, in the frame of the project, the current status and the needs for improvements to water management practices in the BSR countries as a whole and the pilot project areas in Poland, Lithuania, Denmark and Finland in particular were identified and some changes to these present practices were proposed.

In addition, the project has suggested improvements on water management measures and practices and prepared a set of investment plans for selected measures in the project‘s pilot areas in Poland, Lithuania, Denmark and Finland. Furthermore, the project has investigated important water management problems in Sweden and Latvia. WATERPRAXIS has also offered education on sustainable water management, economic analyses and land-use planning for river basin planners (Ulvi 2011).

So far, substantial progress has been made in water protection in Europe and individual European countries, as well as in tackling important issues at the European level. Nevertheless, European water bodies require continuous effort to get or keep them clean. Almost all European waters have a clear transboundary nature; thus, their sustainable use and protection can only be carried out based on hydrological boundaries and via close international cooperation between scientific communities, citizens and environmental organisations. WATERPRAXIS project succeeded to fill some existing information gaps and tried to offer examples of successful water management to BSR stakeholders at local level.

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