BALTIC IMPULSE

Sustainable resource management for a healthy Baltic Sea

A synthesis report of the work done under Baltic Impulse – Baltic Sea Region Programme Water Cluster

Part-financed by the European Union
(European Regional Development Fund)

Baltic Sea Region
Programme 2007–2013

Baltic Impulse is a cluster of nine environmental projects running under the Baltic Sea Region Programme 2007-2013, operational between September 2012 and September 2013. The projects involved in the cluster are Baltic Compass, Baltic Deal, Baltic Manure, BERAS Implementation, COHIBA, PURE, PRESTO, SMOCS and Waterpraxis (see a summary list in page 30). The programme envisages the projects – all concerned with the quality of the Baltic Sea waters – forming a cluster to satisfy the need for more visibility for individual project results and to ensure closer cooperation as the problems and also their solutions are intertwined. Baltic Impulse aims to gather the existing projects results, find synergies between them and highlight the bridging elements and themes between the project fields.

Editors

Pia Frederiksen, (Aarhus University, Waterpraxis)
Paula Biveson (Baltic Sea Action Group, Baltic Compass)
Knud Tybirk (Agro Business Park A/S, Baltic Manure)
Irene Wiborg (Danish Knowledge Centre for Agriculture, Baltic Deal)

Contributors to the sections
Sustainable biomass resource practices and management
Nutrient management in the bio-based future BSR society

Lena Rodhe (JTI, Baltic Manure)
Markku Järvenpää (MTT, Baltic Manure)
Sari Luostarinen (MTT, Baltic Manure)
Johanna Logrén (MTT, Baltic Manure)
Eila Turtola (MTT, Baltic Manure)
Kari Ylivainio (MTT, Baltic Manure)
Ola Palm (JTI, Baltic Compass)
Sirkka Tattari (SYKE, Baltic Compass)
Hans von Essen (Södertälje municipality, Beras Implementation)
Knud Tybirk (ABP, Baltic Manure)
Irene Wiborg (KCA, Baltic Deal)

Contributors to the section
Improved assessment and monitoring of contaminants

Wolfgang Ahlf (TUHH, SMOCS)
Ansa Pilke (SYKE, COHIBA)

Contributors to the section
Good governance frameworks for water planning and management

Pia Frederiksen (AU, Waterpraxis)
Anne-Mari Rytkönen (SYKE, Waterpraxis)
Hannamaria Yliruusi (UBC, PURE/PRESTO)
Teemu Ulvi (SYKE, Waterpraxis)
Aleksandra Zieminska-Stolarska (TU Lodz, Waterpraxis)
Hans von Essen (Södertälje municipality, Beras Implementation)

All the cluster partners have contributed to this report by participating in the two cluster workshops.

Content

Summary and recommendations/next steps

Recommendations on how to improve the environmental conditions for the Baltic Sea by acting on land:

***Take steps to the biobased society** by improving the use of waste biomasses for integrated bioenergy production and improved nutrient management, e.g. by retrieving and recirculating nutrients from manure and waste water in biogas plants.*

***Resource management** on catchment level and the focus on the possibilities in producing multiple products creates optimal use of resources and reduce risks for runoff.*

***Improved mapping** of crucial parameters for improved farm - and public management. It is important to give the decision makers (farmers and planners) knowledge on where, how and when to act in the long term. Examples of useful maps are N and P risk areas.*

***Good farming practices** can contribute to improved water quality and quantity. These include improved handling of fodder, fertilizer and especially handling of manure. Farming practices can relate to structural aspects, (especially distribution of animals and correlation to fodder production and logistics of recycling manure), technical aspects such as stable systems, storage and spreading equipment and improved practices such as manure spreading at the time of crops needs, correct dosages, etc.*

***Involvement of the farmers** is of crucial importance. It is important that farmers have the proper knowledge on possible effects of their practices. Having this knowledge they can contribute towards finding good solutions for the benefit of the farmer and for the benefit of the aquatic environment. It is also important that the farmers be rewarded for good environmental practices through the price of their products or in other ways that recognizes the ecosystem services provided by farms.*

***Support for the farm advisory system.** The farm advisory systems employ persons who are knowledgeable on local contexts and who are trusted by farmers. They have the potential to be involved in discussions over and processes for innovative local solutions in sustainable water management on agricultural land.*

***Improved management of waste water.** Dissemination and use of improved methods for elimination of hazardous substances in the effluent and for monitoring chemicals.*

***Adequate risk assessment procedures** using multiple lines of evidence in a systematic analysis of risks, should be made widely known.*

***Improvements to governance frameworks** are needed. The focus should be on harmonization of national practises and HELCOM requirements. Moreover, the emphasis should be on improving multilevel and horizontal coordination mechanisms, communication and active involvement for bottom-up initiatives.*

Detailed recommendations are found in the sections below.

Sustainable resource management in the Baltic Sea Region

The Baltic Sea is a common basis for prosperity in the region, but its ecological condition is deteriorating. On the one hand, the Baltic Sea has been exposed to extensive use of chemicals since the beginning of the industrialisation in the region in the late 19th century, and its environment has a long history of contamination. On the other hand, eutrophication suffocates the life in the sea beds of which are the largest dead areas in Europe. Having realised this, the EU Baltic Sea Region Programme 2007-2013 has financed several environmental projects which try to define and find solutions to mitigate the environmental impact of different anthropogenic processes on the Baltic Sea and to improve common management actions.

The projects have, to a large extent, succeeded in connecting the overriding concept of sustainable development with the current of resource efficiency, restoration and maintenance of ecosystem services and innovative approaches to management of water. The finalisation of the projects getting closer, the EU Baltic Sea Region Programme has facilitated cluster projects to discuss and disseminate results from these projects. One such cluster is Baltic Impulse, gathering 15 partners from 9 projects, and focussing on eutrophication from nutrient leaching and pollution of hazardous substances. This synthesis is one of the deliverables from this cluster.

The sections below summarises some of the results derived from the cluster partners' participation in the projects funded by the Baltic Sea Region Programme 2007-2013, in areas of nutrient eutrophication and hazardous substances. The partners entered the cluster as institutions, not as project representatives, and during the workshops held, the cluster decided to present the results, as far as possible as coherent, cross-project summaries. Consequently, at the back page of this report the reader will find the projects from which the different parts of the report are derived and substantial background information for the small glimpse presented here. This also implies that authors are not mentioned for specific sections, but as a list of contributors in the initial pages, as well as participants to projects in the back of the report.

The bio-based societies keep track of the biomass. Manure and straw are no longer considered waste but resources, and the ways to use these resources for upkeep of soil quality, substitution of scarce resources and renewable energy are constantly being proposed.

Hazardous substances that have already ended up in the environment also need to be controlled and managed to reduce their effects on food-webs and human health, as described in the section on improved assessment and monitoring of contaminants.

Governance frameworks need to support improved planning and management by making sure that relevant stakeholders are included and their knowledge used, while coordination mechanisms must ensure that implementation of different policies will not result in contradictory processes. These issues are reported in the section on Good governance frameworks for water planning and management.

This peaceful landscape can produce biomass like food and fodder, but also other ecosystem services like increase in biodiversity and recreational opportunities. Photo: Eija Hagelberg

Sustainable biomass resource practices and management

Any sustainable future landscape/watershed/ecosystem should be able to produce multiple products based on the available types of biomass, i.e. food, fodder, fertilizer, fibres and fuels. In the future society, this will be reflected in the different handling chains of the biomass before and after feeding the animal feeding and human food consumption.

The integration of nutrient management and bioenergy production for improved use of the farmer's carbon reserve (all types of biomasses) is an important aspect of sustainable resource management and should be appreciated and treated as 'gold' in a future bio-based society in the BSR. This includes traditional farming products (food), agricultural waste, and in the end different societal waste of various quality that should ideally be used to recover the energy, nutrients and possibly other substances used to close the circles for sustainable agriculture.

Resource mapping

Mapping (local/regional distribution) of the landscape resources and landscape vulnerability is essential; consequently, these resources can be found partially and with varying detail mapped in some BSR-countries. Incineration or thermal gasification mainly extracts the energy of the resources and at the same time reduces the potential for nutrient recovery from resources. Biogas extracts energy and leaves some carbon and all nutrients for the soil and when combined with good management with the digestate is environmentally the best solution in most cases.

Some of the major categories that should be used for both energy and nutrient recovery include:

- **Manure** should be used for biogas (not all of the theoretical potential is usable, as the resource is dispersed on many farms). In fact, today, biogas is the only solution here. Waste from local food processing can be important to make farm biogas economically viable.

- **Food waste from industries and source-separated organic household wastes from municipalities** should be made available for biogas production and nutrient recycling.

- **Agricultural biomass** (e.g. energy crops, catch crops, straw, any silage) for biogas and/or thermal gasification or 2nd generation bioethanol/methanol (sustainable production to be developed).

- **Biomass from harvesting grass or scrubs** for the purpose of nature conservation for biogas and/or thermal gasification.

- **Sewage sludge** energy and nutrient recovery through anaerobic digestion for biogas is a potential source. However, sewage sludge quality varies considerably and the utilization of this resource is rather challenging. The regulation is based on the Sewage Sludge Directive. In some BSR countries, quality criteria to use the sewage sludge as fertilizer is being developed. It may be less problematic to use it to fertilize perennial energy crops rather than food crops.

Barriers to overcome

The classification of various types of biomass into either resource or waste (e.g. manure) should be altered to provide a legal definition for all biomass as a resource. The concept of 'end-of-waste products' will soon show some of the options to change the status of composted or digestated manure/waste into marketable products and thus improve the potential for more widespread use of the nutrient (and remaining carbon) resource for the soil.

However, we should continue to improve the quality of waste fractions and to reduce waste production in general. Biomass with hygienic risks or other contamination (e.g. sewage sludge) should be remediated and/or processed in a way which ensures control over the risks and thus enables utilization of all biomass as renewable energy fuels instead of treating it under the waste incineration directive.

Recommendations

- Manure should be used for biogas, including separated manure solids where appropriate and the digestate should be managed in a proper way.
- Waste from food industries and properly source-separated organic household wastes from municipalities should be made available for biogas production and nutrient recycling.
- Quality criteria should be enforced to use the sewage sludge as fertilizer.
- The status of composted or digested manure/wastes should be converted into marketable products.

Biogas production and co-substrates

Manure has traditionally been used for crop fertilization, but organically bound nutrients in raw manure are released slowly (in 1-2 years) with relatively poor plant uptake of the nutrients found in the manure. The result has been considerable nutrient losses, especially from solid manure and deep litter. Anaerobic digestion of the manure has proven to be an appropriate solution for several reasons. The anaerobic digestion converts much of the organically bound nitrogen into more readily available nitrogen for plants, and at the same time produces methane - a renewable energy source. In addition, biogas technology can recycle nutrients from agricultural and societal wastes as well as decrease the needs for mineral fertilizers.

Sewage sludge should also be treated in biogas plants, but strict quality standards are needed if mixed with agricultural wastes/manure and used as a fertilizer on the fields.

Biogas is in technological and environmental terms very suitable technology as it increases the energy and nutrient recovery of the agricultural system. However, under the present support schemes in most BSR countries, slurry-based biogas needs co-substrates to increase the dry matter content of the input before it can become economically attractive.

Biogas co-substrates

Anaerobic digestion producing biogas is based on a variety of substances. At the European level, a substantial part

Baltic Compass visited a biogas plant in connection with a big scale piggery in Brest, Belarus.
Photo: Sirkka Tattari

(almost half) is landfill gas, another part is biogas produced at wastewater treatment plants digesting sewage sludge, and the third - and fast growing - part is agriculturally based biogas.

The agriculturally based biogas is mostly a mixture of slurry and a variety of co-substrates, with a huge variation between countries and regions. Quantitatively, in terms of biogas being produced, maize-based farm-scale biogas plants resembling those in Germany are the most important, whereas manure-based biogas is clearly the environmentally most optimal way to produce biogas out of agricultural residues.

The following will give a brief overview of the different types and availability of sustainable co-substrates for slurry based biogas.

Manure types/fractions

Most animal husbandry in the BSR region is based on slurry systems, and just the reduction of water dilution by different measures in stable systems can reduce the water dilutions and thus increase the dry matter content. Still, slurry rarely exceeds 8-10 % in dry matter and more dry matter should be added.

Firstly, **separated manure fibres** have a substantial potential in animal-dense regions, where stationary and/or mobile slurry separators can create a valuable and sustainable co-substrate for biogas plants. The solid fraction carries much of the important P-content, and this will also increase the P-value of the digestate.

In addition to manure fibres, various **solid manure types**, such as deep litter, are suitable for biogas. However, for some biogas plant types, deep litter needs pre-treatment (cutting, extrusion) to physically mix it with the slurry for biogas reactors that are continuously stirred. This may cause some challenges, but technical solutions are available.

Manure fibres and solid manure types are very suitable and sustainable co-substrates for slurry and improve the quality and recirculation of the manure's nutrient content as fertilizer for crops.

Other agricultural residues

Agricultural residues, such as straw, catch crops, etc., are potentially interesting, but require pre-treatment that still has to be improved and refined for optimal balance and economy and environmental benefits. Agricultural residues do not imply what Life Cycle Assessment analysts' have termed induce land use changes (ILUC[1]). ILUC assumes that energy crops take up land from food production influencing land use and thereby prices of food on the world market.

Therefore, agricultural residues should be explored before turning to some easier available energy crops predominant in some BSR regions.

Energy crops

Maize is the most prominent energy crop for biogas, as it is easy to grow, ensile and handle during the transport to the biogas plant. However, many environmental concerns are linked to this – besides the Indirect Land Use Changes (ILUC) – such as high demand for pesticides, nutrient leaching, landscape issues (larger landscapes with tall plants), soil carbon, Green House Gas balance, etc. Sugar beet is gaining terrain, limiting the concerns for the landscape issue but otherwise facing the same challenges as maize. Perennial energy crops, such as grass ley/clover may be part of a solution, with positive effects on soil carbon.

Nature conservation meadows grass

Nature conservation requires harvesting of biomass for meadow nature types, and this harvested grass is suitable as co-substrate for biogas. Nature conservation aspects add to the sustainability of this particular biomass for biogas. Meadow grass adds dry matter (with proper pre-treatment) and does not compete with food production, and moreover it retains nutrients otherwise lost from the agricultural system and makes these available for farming as a form of digestate.

Industrial wastes

Industrial wastes (e.g. those produced by food industry including meat industry, starch production, dairies, bakeries and breweries, etc.) are important co-substrates, and most are already in use for the purpose or for animal feeding. Their safety with respect to pathogens must be carefully considered. The resource is difficult to quantify statistically and is rather heterogeneous. It needs to be noticed that all waste with animal origin has to apply to the EU's animal by-products regulation.

Sewage sludge

Sewage sludge is also converted in many countries to biogas – and mostly kept separate from biogas plants based on agriculture. This is partly due to potential hazardous substances in the sewage sludge – an issue that should be dealt with.

Municipal solid wastes (organic fraction)

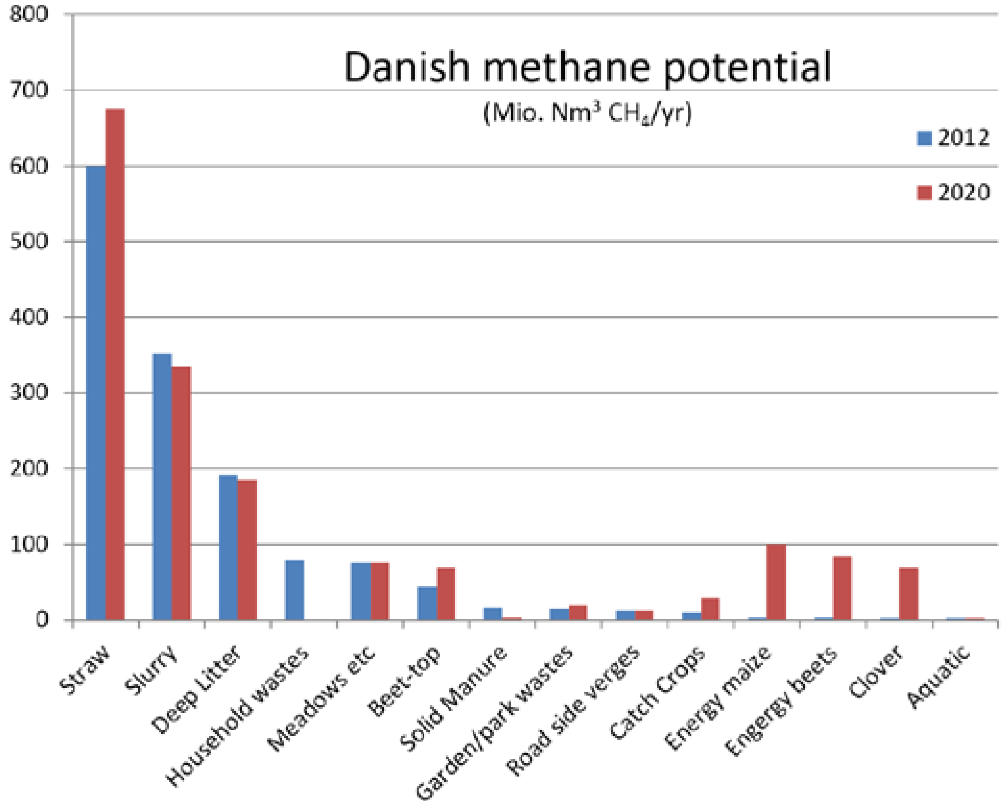
In some countries, a good system to separate the organic fractions in municipal solid waste has been developed, and thus the organic fraction is a very good co-substrate source for biogas plants. However, the sorting must be efficient and the input 'clean' of metals, glass, etc., and also here the pathogen and hazardous substances risks must be dealt with. The recycling of P from the waste back to the farming system is a strategic goal for the sustainability of the agricultural system in the BSR.

1 ILUC describes e.g. the need for replacement fields elsewhere to produce the food that could have been produced on a hectare used for energy crops.

New solutions are being developed to boil and enzymatically separate the organic fractions of unsorted municipal solid waste, the resulting pulp being a very good substrate for biogas. Further studies on this technology are required, especially regarding heavy metals and organic micro-pollutants

Other options

Many stakeholders enthusiastically promote algae, roadside verges, garden wastes, etc., for biogas, and these fractions have some potential. A recent Danish inventory shows the proportions of the methane potential of various co-substrates (see the figure) in 2012 and the extrapolated potential for 2020 in Denmark.



Based on Birkmose, T., Hjorth-Gregersen, K & Stefanek, K. 2013: Biomasse til biogasanlæg i Danmark - på kort og langt sigt. Agrotech, Skejby).

Nutrient management in the bio-based future BSR society

The farming system is a key to a sustainable future in the BSR region. For the sustainability of the farming system, the farm practices and the consumers requirements have strong impact on the Baltic Sea status and condition. Basically, the future agriculture of the Baltic Sea Region has two optional paradigms to follow:

- the 'conventional paradigm', with continued focus on intensifying the agriculture that has high animal density, responding to the global market needs, while at the same time tightening the nutrient cycles and reducing losses

- the 'systemic/organic paradigm', where agriculture is a multifunctional farming system like Ecological Recycling Agriculture and less animal intense, focusing on local self-sufficiency and high quality/ low production with low environmental impact

The following recommendations on farming practises are based mainly on the 'conventional' paradigm, where the focus is on minimizing the negative impacts and improving nutrient recycling in intensive farming systems. An example based on the systemic paradigm is described in a section on Ecologically Recycling Agriculture (ERA) below.

Farm practices – measures to reduce plant nutrient losses

In the Baltic Sea Region, a number of important agricultural measures that can be used to reduce nitrogen and phosphorus leakage have been identified. The implementation and status of each one of these measures in all Baltic Sea countries have been described with information on e.g. official goals, legislation and economic subsidy rules for each of 25 the measures found in Baltic Compass. In Addition, Baltic Manure are working on recommendations for manure handling.

BERAS Implementation has produced guidelines for conversion to Ecological Recycling Agriculture, including real farm examples from 9 countries around the Baltic Sea and from different farm types.

Measures regarding fertilizer management and animal feeding are in focus in the Baltic Impulse cluster as they strongly relate to manure management.

Animal feeding

Under this heading, different measures could be identified. However, normally they are not regarded as environmental measures, and for that reason they are not evaluated.

Adopting phase feeding for livestock means grouping of livestock on the basis of their feed requirements allowing a more precise formulation of individual rations. This increases the animal's nutrient use efficiency and results in reduced excretion of nitrogen and phosphorus in animal faeces and urine.

Ruminants can digest plan-based food as no-one else can. However, animal diet need to be adjusted as surplus intake of N and P just leads to high N and P content in manure. Photo: Anu Suono

In ERA farming, the idea is to feed animals according to respective species specialization (for example roughage and grazing for ruminants) and not let them compete with humans for food.

Roughage production has positive side effects on humus content and soil structure, and higher humus content also entails increased capacity to hold plant nutrients in the soil.

Farm animals are often fed diets with higher than recommended contents of nitrogen and phosphorus as a safeguard against loss of production arising from a deficit of these nutrients. The surplus intake of nitrogen and phosphorus is not utilised by the animal; it is excreted with faeces and urine, leading to a higher nitrogen and phosphorus content in the manure. Therefore a proportional balancing of nutrients in feed is a key factor to ensure animal health and production requirements and to minimize adverse environmental impacts.

Supplementation of synthetic phytase to pig feed reduces the need for addition of mineral phosphate. Phytase increases the availability of phosphorus in the feed and allows total phosphorus content to be reduced without affecting productivity.

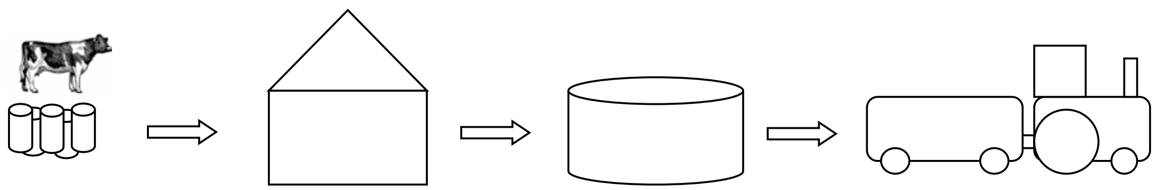
Recommendations

- Adopt phase feeding.
- Use synthetic phytase in pig feed.
- Feed animals according to their requirements – balance their nutrient intake with production.
- Increase the proportion of roughage in the feed

Manure management

Manure management on farms is only one part of livestock farm management, and it is strongly related to farm-specific conditions: availability of land, feed and feeding practices, animals, housing technology, manure processing, storage technology and, finally, usage of the manure on crops within or outside the farm. Therefore, there are no "one-size solutions" fit to every situation, the recommended activities in individual farms being different. It is suggested, that large farms should have a clear strategy and plan for manure management. In the following, major manure handling steps will be described, from animal feeding to field application.

An example chain and list of partial solutions is illustrated in the figure



FEEDING	HOUSING	PROCESSING	STORAGE	APPLICATION
Feeding strategies	Controlling water use	Energy recovery (i.e. biogas production)	Sufficient storage volume	Knowing the nutrients
Phase feeding	Removing frequently	Separation of liquid- from solids	Covering the storage	Making a fertilizer plan
Nutrient-balanced feeding	Cooling the channels	Further processing (fertilizer product)	Checking for leaks	Timing and precision application
P and N optimisation and Phytase use	Keeping urine and feces apart			Low emission technologies (injection, acidification)

Adequate collection and covered storage facilities allow choosing the time to apply manure to fields when the crops can utilize nitrogen and phosphorus. This basic requirement might be neglected in the search for more advanced manure treatment methods. Sufficient storage capacity enables the farmer to spread manure at optimal times to fulfil the nutrient requirements of the crops.

Recommendations for manure handling techniques on farms

- Minimize water addition to manure in stable and storage by reduced spillage, choice of drinking and feeding technology, source separation of dirty water.
- Ensure covered storage capacity for slurry.
- Increase the use of slurry injector techniques.
- Use spreading technology that has a high precision in dosage and spreading evenness, based on actual nutrient contents of the manure and site-specific conditions in field.

Farmers, advisors, researchers, policymakers and industry must jointly take the responsibility and co-operate for a more environmentally friendly end-use of manure, for example through these methods:

- free or low-cost, skilled advisory service for manure management,
- compliance with the legislation,
- fuse of planning tools for crop fertilization,
- fuse of reliable, verified technology on the market.

Recommendations for manure processing technology

- Make a farm-specific business plan for investment in processing equipment (realistic, accurate).
- Remember that external incomes could be the driver for good economy for in manure processing.
- Look at the whole handling chain; all components should be understood (for instance, how to spread, plant nutrient availability for new fertilizer products, etc.).

Recommendations for manure processing economy

The following requirements for economic sustainability with manure separation technology in Finland have been adopted:

- Restrictions on P application on fields
- Positive P balance on whole farm level
- Long manure transportation distances (= sparse field plot structure)
- Medium or high, P separation efficiency is recommended at swine farms
- There must be enough slurry to be treated (to make the investment profitable > 3000 m3)

Large swine farms, even those with fields in a short distance, that import a substantial share of the feed used in livestock production are most likely to invest in separation technology.

Sound fertilizing practices

Adapting the amounts of chemical and organic fertilizers applied. Animal density is a measure relating the number and type of animals kept on the farm to the arable area available for spreading their manure. Animal density is used as a tool to balance the amounts of nitrogen and phosphorus which are spread on the farm. This tool is needed in order to avoid excess application of N and P with manure.

Considering crop requirements of N and P in the fertilization plan is essential in order to avoid excessive applications. The N and P content of manure must be considered in the fertilizer plan in order to adjust the need for chemical fertilizers and avoid excessive applications. Sampling and analyzing nitrogen and phosphorus in manure provides information on their concentrations and the distribution of plant-available nitrogen (NH_4-N + NH_3-N) and organic nitrogen. The effect of the manure can then be evaluated in the fertilization plan, as manure characteristics can vary widely depending on e.g. type of production and its intensity. This measure is regulated, on one way or another, by law, in all Baltic Sea countries.

Calculating nutrient balances on farm and/or field level. Calculating nitrogen and phosphorus inputs/outputs and balances on a farm and/or field level is a performance- and policy tool for assessing the environmental impact. The tool can also be used to monitor and evaluate the impacts of alternative manure and chemical fertilizer management practices and technologies on nitrogen and phosphorus use on the farm. When farm nitrogen and phosphorus balances can be linked to within-farm sources and flows, there is a good possibility of identifying the weakest link and possible improvements for the farm. The tool can also be used to assess the risk of ammonia losses from manure management and the risk of nitrogen leaching losses to water. Five of the nine Baltic Sea-countries have regulated this measure in their national legislation.

Avoiding the spreading of chemical fertilizers and manure during high-risk period. The timing of chemical fertilizer and manure application is a key factor in achieving high efficiency in plant nutrient use. Poor timing is one of the most important sources of large nitrogen leaching loads. This measure is legally regulated in all Baltic Sea countries.

Avoiding the application of chemical fertilizers and manure to high-risk areas. High risk areas on arable land include the areas with significant slope, with flushes draining to a nearby watercourse, soils with cracks over field drains, fields adjacent to water or fields with phosphorus values beyond the agronomic optimum range. This measure is regulated by law in all Baltic Sea countries.

Fields differ due to their inherent productivity and due to past inputs of P fertilizer. **No application of phosphorus fertilizer or its reduced application on fields or parts of fields with high soil phosphorus content.** When the soil phosphorus values increase beyond the agronomic optimum range, there is a reasonably consistent pattern whereby phosphorus leaching increases significantly. However, phosphorus leaching has large spatial and temporal variations and can be influenced by several factors interacting with each other. It is therefore important to consider site-specific factors in order to identify measures to reduce phosphorus leaching. Five of the nine Baltic Sea countries have regulated this measure in their national legislation (see section below on risky areas for P application). Analyzing soil test P values (STP) is a tool for farmer planning of fertilisation needs.

Improved spreading technology for manure and chemical fertilizers. There are different ways to deal with this issue. Site-specific dosage, often with the use of GPS and different steering aid systems for the application of manure or chemical fertilizer is one way. Equipment for uniform distribution of liquid manure helps to avoid manure overloading in some places and in other places manure may not be made available at all. Combi-drilling involves placing seed and fertilizer in the soil, using a single machine in one work operation. In addition to saving time and providing better nutrient use efficiency, combi-drilling reduces competition for plant nutrients by weeds and reduces the risk of nutrient surface runoff. Incorporation of manure and chemical fertilizers helps to prevent the exposure of manure to surface runoff and drain-flow losses. It also increases the utilization of manure nutrients compared with surface application. For the handling of solid manure, disintegration equipment has been developed to break up the manure better and to give greater working width and facilitate more uniform lateral spreading.

Although most of the measures related to fertilizer management are well known and regulated in most Baltic Sea countries, they are not fully implemented and when implemented, it is done in many different ways. This means that there is still much more nutrient reduction potential, both in quantity and in quality, which can be put to use by better implementation.

Application of fertilizers near watercourses should be avoided. Photo: Martin Sundberg

Recommendations

- Animal density should balance the amounts of nitrogen and phosphorus provided for the available spreading area on thefarm (In ERA farms, the animal density balances the farm's own capaci-ty for fodder production).
- Farm-specific fertilizer plans are needed.
- Nitrogen and phosphorus inputs/outputs and balances on a farm and/or field level should be seen as a performance tool.
- Avoid spreading chemical fertilizers and manure during high-risk periods.
- Avoid applying chemical fertilizers and manure to high-risk areas.
- No phosphorus fertilizer or only a reduced amount of it should be applied on fields or parts of fields with high soil phosphorus.
- Use improved spreading technology for manure and chemical fertilizers.
- Improve P recommendations by intercalibrating STP methods.

Identification of P risk areas

The risk of losing P from the agricultural system by leaching to the Baltic Sea, which increases eutrophication, stresses the need to identify and map the P vulnerable areas.

P vulnerable areas are areas from which substantial quantities of phosphorus can leach. Phosphorus risk is often present in areas vulnerable to the risk of erosion. These erosion risk areas are mapped mostly with the USLE (Universal Soil Loss Equation) based methods. In these maps, the risk areas are mainly located on steeply sloped fields. When topographic mapping is used as the index calculation methodology, flat areas are classified as risk areas because this method put weight on gentle slopes with fairly large catchment areas above them. A third mapping option is based on physical GIS-based models, which can simultaneously model hydrology and nutrient transport.

Drainage systems, such as subsurface and open drainage, effectively link the cultivated fields to water, allowing rapid movements of water and nutrients into the surface waters. Subsurface drainage has many benefits in cultivation and is more commonly used than open drainage. Unfortunately, the ability of the models to describe the distribution of runoff into these two flow paths is inadequate due to the lack of input data.

Sediment and nutrient leaching from a high risk field. Photo: Pasi Valkama

USLE describes high risk areas mostly by surface processes, generally ignoring the transport of P and solids through soil matrix and via macro-pores. Therefore, a methodology that accounts for both surface runoff and subsurface drainage, including macro-pore flow, is recommended as it allows risk areas be mapped more diversely and reliably.

The P-index is often considered to be a cost-effective tool to reduce P leaching. This empirical model emphasizes different risk parameters to form a combined risk factor number, which can be used as a guiding factor when selecting practices and policies that reduce P leaching both at a field and catchment level. The major challenges include lack of data such as soil P status.

Major risk areas in agriculture:

- steep slope fields
- fields that flood repeatedly
- fields with high soil P
- peat soils
- erodible soils and poor vegetation cover
- history of high fertilization levels
- high animal density.

The possibilities of the Baltic Sea region countries to identify nutrient vulnerable area vary widely, mainly due to differences in basic background data required for inventories. Risk assessments are usually made at the municipality or catchment level. The differences in soil classification systems and accuracy of the data needed for mapping prevent uniform assessments and comparisons between the countries.

Barriers to overcome

With more accurate map-based material, it is possible in the future to identify the field parcels that pose the highest loading risk. A more accurate elevation model, good information on the soil P status, on the manure spreading areas, and on the vegetative cover outside the growing season would improve the reliability of risk assessment. Therefore, it is important to increase resources that would improve the availability and quality of the materials and, at the same time, produce maps with currently available ma-terial to serve as a basis for a wide-ranging debate. Risk maps could be presented to various stakeholders and, in addition, the accuracy of the maps could be examined by means such as questionnaires.

Recommendations

- Use mapping of nutrient leaching risk to target the farm management efforts.
- Improve the accuracy and scale of eutrophication risk maps.
- Support the development of quality maps as decision support tools for farmers and policy makers.

Management of sludge involving re-use

Organic materials in our society contain plenty of energy, phosphorus, nitrogen and other valuable nutri-ents and substances. These materials tend to concentrate spatially: in the form of manure around inten-sive animal production areas and, in human societies, around municipal waste water treatment plants, biogas plants and dumps. These nutrient-rich spots create environmental risks. In the past, several steps have been taken to deal with the problem, especially with regard to sewage sludge:

Phase 1: Lead it away. Traditionally, municipal sewage systems just transported the waste to a river or to sea. This phase has created severe environmental problems around the Baltic Sea from the 20th century until today.

Phase 2: Clean it. Waste water treatment plants have been built since the 70s, and this task will be final-ised in municipalities around the BSR in the coming years. The advantage of this phase is that the envi-ronment will be protected, as waste water is cleaned to a degree that it can be led, without the risk of eutrophication, to a river or to a sea. However, valuable nutrients in the waste water are often removed from it with methods not allowing the utilisation of these nutrients. For example, phosphorus is often fixed and separated from the waste water by means of salts of iron and aluminium. These chemicals bind to phosphorus so strongly that it won't be usable for living organisms. Therefore, the resulting sludge will be rich in nutrients. Practically useless as fertilizer, these nutrients, which are non-renewable resources, are thus removed from the food cycle and wasted by scattering them around the environment.

Phase 3: Circulate and productize it. This is the next step to be taken in the coming years: instead of ”cleaning and disposing” with the motivation to protect the environment, nutrients and part of the organ-ic material should be recovered and returned to the food system. As a side effect, the environment will be protected.

This step is technically possible, but requires a systemic change in the business logic of waste water plants. In addition, it requires technology development to ensure safety, efficacy and economy of the products. Also, it requires a regulatory mainframe to support the change and development of public atti-tudes against the use of waste-based fertilizer products.

To get to this phase and to attract adoption of the new business logic, new example business models should be build, keeping in mind:

- techno-economic feasibility of phosphorus fixing technologies which keep the P soluble for agricultural plants, improving current technologies in this respect,
- technologies for making P that is fixed to a non-soluble format available to plants (such as thermal, chemical and thermo-chemical treatments),
- technologies to control and inactivate the eventual harmful organic and inorganic contaminants which may limit the agricultural use of these materials,
- evaluation of the nutritional value and safety of the end products,
- improvement of the manageability of the sludge-based products, especially by reducing the original volume and mass of the raw material, thus allowing cost effective transportation of nutrients to primary production areas,
- establishing the necessary network of actors for a new business model, and
- establishing the necessary supportive regulatory framework.

The ”Phase 3” technologies should have vast and growing global markets and, thus, the potential of this new approach reaches far beyond the BSR-region. This potential is likely to bring more work, welfare and prosperity to the region.

Improved assessment and monitoring of contaminants

Sustainability criteria are increasingly included in management strategies. Management for environmental sustainability can be supported by risk assessment procedures, e.g. of persistent pollutants.

The best way to assess the environmental quality of marine environment with respect to hazardous substances is to use a suite of chemical and biological measurements in an integrated approach. That includes a simultaneous measurement of contaminant concentrations in biota and sediments, parameters of biological effects and a range of physical and other chemical measurements for interpretation of local impacts.

One key to understand the emergence of environmental risks is by asking how bio-available the contaminants are and how strong their impact on marine organisms is. Therefore, techniques dealing with biological effects have become increasingly important, and management strategies have been modified due to the appearance of options to make contaminants unavailable by treatment processes.

Control of contaminated marine sediments

Contamination of marine sediments poses a potential threat to marine resources and human health with regard to persistent bioaccumulative chemicals contaminating seafood. For sustainable management of contaminated sediments, the nature and magnitude of the sediment pollution needs to be determined to categorize sediment quality. The basic process of environmental risk assessments consists of the analysis of contaminant concentrations and a comparison with SQC (Sediment Quality Criteria) derived from toxicity data. Assessment of sediment toxicity by using bioassays has become the state of the art to complement chemical analysis for quality classification. For some specific contaminated sites, assessment of the potential effect of food chain poisoning (evaluation of bio-accumulation and bio-magnification) has to be explicitly addressed.

Essential risk assessment information includes the sediment concentrations of 33 priority substances (according to Annex II of Directive 2008/105/EU) and the ecotoxicological effects measured with a set of bioassays. The risk-based decision-making to manage contaminated sediments relies upon EU legislation providing a framework for risk assessment and on an increasing understanding of the importance of bioavailability of pollutants. Bioavailability of contaminants is the key issue regarding toxic effects and consequently sediment quality, and is increasingly seen as the primary issue in risk management.

When considering a cost-effective procedure, the following recommendations will provide an assessment strategy of sediment quality in marine ports and waterways.

Scope

In order to formulate risk management decisions, an approach that gathers multiple lines of evidence into a systematic analysis of risk is required. Thus we need a methodology to best integrate the data generated using a variety of assessment tools, including toxicity tests, benthic community evaluations, bioaccumulation studies and sediment chemistry for accurate assessment of sediment quality and the risks associated with various sediment management options. In general, the minimum prerequisite for a basic risk assessment is a combination of chemical and biological analyses. Normally, most of the contaminants are more or less strongly bound to sediment particles. Those contaminants are partly available for organisms. Bioassays are used to indicate the relevance and bioavailability of contamination measuring toxicity. Biological investigations provide information about integrated short-term and long-term effects of sediment material that cannot be acquired by chemical analyses alone.

A test battery based on standardized assays is recommended to indicate the ecological hazard potential. Low cost and little work, as well as a standardized methodology (OECD, ISO or DIN-guidelines), are important considerations for the combination of the bioassays endorsed. An improved test set that has been established for the marine environment includes:

Methods for ecotoxicological testing

- Marine algae test modified for brackish/marine water (DIN EN ISO 10253)

- Luminescent-bacteria test modified for brackish/ marine water (DIN EN ISO 11348-1-3)
  These tests are performed with sediment elutriates.

- Acute amphipod test (ISO DIN 16712)
  The test is performed directly in sediment

In addition a simple, rapid and low-cost test system with bacteria was modified for the testing of sediments in contact, in accordance with a German standard bio-test (DIN 38412 L48), using a miniaturized test system with V. proteolyticus. The test is suitable for assessing toxic effects of brackish and marine sediments.

Important considerations

No standardized and harmonized assessment method of ecotoxicological effects caused by contaminated sediments is currently available in Europe. Nevertheless, to make the necessary assessments of integrated contaminant effects in marine sediments, an interim test set is recommended based on the three methods described above.

Wastewaters

Municipal wastewater treatment plants (WWTPs) are an important part of urban infrastructure system in regard to hazardous substances. They receive wastewater from private households, as well as from small and medium-sized enterprises and from other indirect dischargers. In addition, WWTPs may receive urban run-off waters (in case of combined sewer systems) and landfill leachates. Therefore, WWTPs receive a myriad of chemical substances in influents. Treatment systems are challenged in terms of techniques and capacity. Besides many chemicals in the influent, transformation products of substances, also produced during the treatment process by microbial activity, may exhibit harmful properties. Some of the chemical compounds or their transformation products are persistent, bio-accumulating and potentially toxic (PBT). The main focus for wastewater treatment techniques has been the removal of nutrients and organic matter. The methods may not have been optimised to tackle hazardous compounds, especially at low concentrations. The existing process of wastewater treatment is not sufficient for the treatment of persistent chemicals. Hazardous substances are only partially degraded, and the remains are dispersed to air, treated waste water and sludge.

High-quality analytical methods are valuable for monitoring individual chemicals. Since municipal wastewaters are a mixture of various substances, an approach where effluent quality is evaluated only substance by substance can become extremely laborious and expensive. A whole effluent assessment approach offers a practical and flexible tool for assessing the effluent quality with the aid of eco-toxicological methods. It enables the assessment of potential risks and effects for both identified and unidentified substances. By combining chemical analyses with eco-toxicity tests, it is possible to identify sources of hazardous substances and to plan preventive actions. This procedure should be an effective tool to increase the level of protection of the Baltic Sea and to improve its ecological status.

To eliminate hazardous substances from effluents of large municipal WWTPs, advanced technologies such as ozonisation or activated carbon treatment are available. These measures should be assessed for individual WWTPs, because efficiency of a plant strongly depends on the kind and the load of pollutants in wastewater. Advanced wastewater treatment technologies can also simultaneously reduce the amount of several hazardous substances. If one particular hazardous substance shows elevated levels in wastewater due to an indirect discharger, measures at the source of the discharge should be implemented. This is usually more cost-effective and also follows the 'polluter pays' principle.

Local authorities and water administrations should introduce programmes to restrict emissions of hazardous substances to municipal wastewater systems. Since urban run-off is a highly relevant source for some substances, it is recommended that an overview of the urban run-off emissions is elaborated and, if necessary, sufficient control and treatment implemented on a local or regional level.

Riga Daugavriga sewage treatment plant, the pilot investment site of PURE project. Photo: Lotta Ruokanen

Other sources and emissions

Sources and pathways of hazardous substances can be assessed by substance flow analysis (SFA). The basic idea of SFAs is to make industrial, service-life and waste-related as well as environmental flows of a substance visible and comparable and to facilitate identification of the major sources. Emissions from the sources have been estimated for air, land and surface water for 11 substances or substance groups of the HELCOM Baltic Sea Action Plan.

Chlorinated paraffins, phenolic compounds and heavy metals had the highest total emissions in the whole Baltic Sea area. According to the results, different substances end up in different environmental compartments. Heavy metals were mainly emitted to air, while phenolic compounds, especially nonylphenols and their etoxylates, were emitted to surface water. Chlorinated paraffins were mainly emitted to the terrestrial environment.

Although the emission data in SFAs may be associated with high levels of uncertainty, SFA has proven to be a useful tool for finding the most important sources for emissions of substances into the environment, a tool that can be recommended when considering counter-measures for hazardous substances.

Industrial sources remain relevant within the Baltic Sea region, but diffuse sources (including emissions during the service life of consumer articles) are becoming increasingly important. Municipal WWTPs are important conveyors of emissions, and it is therefore important to track upstream sources. It is also important to find demolition techniques which reduce emissions of hazardous substances from e.g. building materials. Combustion facilities for energy/ heating (especially residential) and to some extent waste are important emission sources for which measures to decrease emissions to air should be proposed.

Good governance frameworks for water planning and management

Good governance frameworks concern the establishment of effective administrative structures and organisation, the selection of adequate and cost-efficient instruments and measures, and the timely and appropriate ways of involving the stakeholders to the planning and management processes. Broadly speaking, water management is carried out using all types of instruments: regulatory, market-based and informative - i.e. by changing perceptions, values and attitudes through communication and re-framing of the issue of water management, while also promoting bottom-up initiatives. When EU regulation is involved, it also concerns the adaptation of multilevel and horizontal coordination mechanisms necessary for implementing the regulations in different policy and institutional cultures. Management of common resources such as the Baltic Sea, also requires supra-national coordinating platforms. A special challenge is to find adequate methods for monitoring and control of hazardous substances.

Towards sustainable waste water management

Situation in the Baltic Sea Region

The importance of sufficient wastewater treatment has been recognised at the highest level in the Baltic Sea region. One of the three objectives, representing the key challenges in the EU Strategy for the Baltic Sea Region (EUSBSR), is saving the sea. Helsinki Commission (HELCOM) demands better nutrient treatment results than the EU wastewater directive since eutrophication, caused by excessive nutrient loading, is one of the most challenging problems of the sea. Concern and strict treatment requirements are justified by alarmingly poor condition of the marine environment of the Baltic Sea. In general, attitudes towards municipal wastewater treatment have changed during the past years. This sector is no longer seen as merely unattractive waste disposal sector. It has been understood that wastewater treatment has an important role in environmental protection.

Wastewater treatment industry has developed rapidly. In the northern and western parts of the Baltic Sea region, wastewater treatment plants have been upgraded and advanced technologies, for example for nutrient removal, are widely applied. From the technical point of view, HELCOM recommendations for nutrient removal (phosphorous and nitrogen) can be reached anywhere. During the resent years, Poland has made significant investments in wastewater treatment, and, for the most part, plants have been modernised. Up-grading of plants has been on-going in the Baltic countries and in Russia as well. Major wastewater treatment investments have been finalised for example in St Petersburg, and now the focus in Russia is being switched on suburbs and smaller villages around the city. Moreover, the renewal of sewer systems has started. Currently all eyes are on Belarus, where renovations of municipal wastewater treatment plants are starting and on Kaliningrad where plants will finally start their operation in the near future.

In addition to the technical reforms, plants currently undergo administrative changes like privatisation. Traditionally, wastewater treatment plants have been owned by municipalities but now, in many municipalities and treatment facilities, public-private partnerships are established. Experiences about privatisation are mixed, and the changing roles of municipalities from wastewater treatment operators to service purchaser require support, knowledge and new skills. In cases where the state central administration stipulates water tariffs, up-grading of plants can be complicated. Investments, maintenance and development of operation processes need money, and, if it is not possible to cover these costs by consumer fees, there are very few options for municipalities and water utilities in getting funding. This problem is a burning issue for example in Belarus and Russia.

Next steps - challenges in governance frameworks

Despite the fact that the importance of sufficient treatment has been recognised, there are challenges. Harmonizing the regulatory framework should be one of the objectives in this field. In several countries, including Belarus, municipal wastewater treatment plants are responsible for treating industrial wastewaters, while, at the same time, for example in the northern parts of the region, industry is responsible for the quality of their wastewaters. More importantly, countries see the validity of the HELCOM recommendations

*Jurmala wastewater treatment plant in Latvia.
Photo: Hannamaria Yliruusi*

differently. It is encouraging that some countries, like Estonia, are adopting the stricter HELCOM requirements by law. However, the HELCOM recommendations are in many countries interpreted literally as recommendations, and to reach the HELCOM limits voluntary actions are necessary. It is obvious that when the stakeholders are doing more than the law stipulates, these actions need incentives and support. To be able to further improve purification results, wastewater treatment plants need motivation, inspiring examples and funds.

Because of the current economic situation, it might be difficult for wastewater treatment plants and municipalities to find funding for investments and increased operational costs. The situation can be even more difficult if it is against national policy to raise water tariffs. However, experience indicates that problems are not always resolved with money. At the grass root level, it seems that the origin of funds might hinder trans-boundary investments in cases where the EU project funds are used, for example in Belarus. Difficulties arise because the EU and Belarus interpret quite differently the financial agreements they have signed. Resulting from different interpretations, it can be very difficult for an individual investing in a wastewater treatment plant to clarify, for example, what kind of tendering rules to apply. Strict implementation schedules, stipulated usually by the EU project funding rules, might cause challenges as well since investment processes are complicated and delays are quite usual due to time-consuming tendering procedures and long delivery times.

On the other hand, the EU project funding has very positive aspects as well, as it enables joint actions and trans-boundary experience exchange between water treatment professionals. Advanced water treatment technologies are spreading still from the northern and western parts of the region towards the east. Resulting from this, the dialogue concerning the lessons learned in the Baltic Sea region, where conditions for wastewater treatment are quite specific, should go hand in hand with technical development. In addition to investment funding, treatment plants in the near future need systematic capacity building opportunities, including training, site visits and exchange of experiences. Training and information exchange will support professional development, but it will also motivate treatment operators of the region to apply the HELCOM recommendations.

Privatization process and public-private-partnerships will highlight the important role of experience exchange. For example in Belarus, establishment of public-private-partnerships in the wastewater treatment sector will be legally possible in the near future. It is important that Belarusian municipalities and operators will have an opportunity to learn from the experience of other stakeholders of the region. Education and training regarding public procurement is necessary to guarantee high quality treatment results and application of the HELCOM limits.

The interest of the wastewater treatment sector is currently focusing on sufficient sludge management and on energy efficiency issues. Sludge is still seen in many regions as waste and not as a valuable resource. Decreasing phosphorous reserves and pressure to increase renewable energy production is forcing us to reassess the value of sludge. Moreover, wastewater treatment plants need to tune their processes to be more energy efficient and they need to start utilizing the potential energy of wastewater when striving to reduce operational costs. General recommendations for best practices for sludge handling and energy efficiency measures from the HELCOM would help these plants to improve their operation.

Recommendations

- Funding and incentives are needed to support plants to reach the HELCOM recommendations.
- Technical obstacles that hinder trans-boundary investments between the EU and non-member countries should be overcome.
- Lifelong learning in the wastewater treatment sector should be supported and training and experience support professional capacity and motivation to comply with the HELCOM recommendations.
- BSR actors should agree on general recommendations for best practices for sludge handling and energy efficiency measures in order to help plants to improve their operation - for example through HELCOM.

Governance for the Water Framework Directive planning process

Introduction

Governance frameworks dealing with management of the aquatic quality in freshwater and coastal water bodies have changed considerably during the last decade, due to the implementation of the Water Framework Directive (WFD). Moving from a command and control framework, the WFD combines emission limits and aquatic quality standards, enforced through a procedural approach with a well-defined timeline of activities and deadlines, requiring definition of baseline, quality elements and targets, development of programs of measures, involvement of citizens and stakeholders, and mandatory monitoring and reporting to the Commission. The implementation process and elements of the WFD are defined at the general level by the content of the directive, and guidelines have been developed for different elements in the implementation process. However, organisational structures or instruments are not required, leaving scope for variety in the planning and management framework, to reflect cultural contexts and planning traditions. By focussing on the river basin as a management unit, the management framework is ecosystem oriented, and spatial planning aspects and localization of measures have moved into the water planners' toolbox. Spatial planning is, however, a policy area under national jurisdiction, and hence, policy integration across levels of decision-making and administration become an important issue. Policy integration across policy areas is also crucial, as there are obvious interactions between different environmental EU policies such as the WFD and the Habitats Directive, as well as between important sector policies such as the Common Agricultural Policy and the Renewable Energy directive.

Adaptation of governance frameworks for the implementation of the WFD

Governance frameworks for implementing the WFD requirements in the planning phase have been made operational across the Baltic Sea region countries. This involved decisions on the structure and organisation of decision-making and administrative structures, as well as on the measures to be used. One option could be the creation of a new institutional structure matching the river basin units, another to adapt the existing water management institutions to the requirements of the WFD. And the River Basin District Authority could be a central or a more decentralised solution.

Only Sweden has opted for a spatial fit between river basin authority and the territorial unit managed as response to the WFD implementation, while the other Baltic Sea countries have adapted their existing management frameworks to take care of the river basin management planning. This has implied either a high degree of top-down government for producing the planning documents or a need for coordinating bodies and mechanisms to involve those administrative units that overlap the planning unit but are not a decision-making authority for the River Basin Management Plans (RBMPs).

Vertical integration and coordination

Hence, in countries with more centralized structures, coordination across levels of governance has been achieved through a high degree of top-down direction. National guidelines for river basin planning ensure that water management is applied consistently across all levels of water management. This one-size-fits-all approach potentially offers economies of scale and reduces coordination costs. Government officials argue that a uniform approach to water management is necessary in order to have equitable conditions across regions. Moreover, they point out that national steering is important for effective decision making, both because the national level has access to resources (in competition with other policy areas) and because centralized decision making involves fewer decision points, each of which might slow down the river basin planning process. In several countries, the pressure to meet the WFD procedural deadlines pushed the process in the direction of centralization more than was originally intended.

Although centralized decision-making may offer economies of scale, it also misses potential efficiency gains at the local level. Harmonised RBD plans cannot adapt to local conditions as well as they do when planning takes place at a lower scale. E.g. some local governments (Denmark) have argued that they could achieve more positive coordination across policy areas and more cost-effective solutions if the RBMPs allowed more flexibility and influence at the local level, and some local and regional planners (Finland) have found national guidelines too binding and too superficial at the same time, and the division of responsibilities too unclear for integrated decision making to work.

Elsewhere (Sweden) national coordination was rather weak and required a greater effort to coordinate river basin authorities to ensure similar conditions across the districts. This was later amended in a new administrative structure, taking over planning responsibilities under the WFD. One planner suggested that stronger national coordination might actually have encouraged the involvement of a wider group of actors in the decision-making processes and might also have generated stronger interest and support at the political level.

Multilevel structures posed other types of challenges. Integrating decisions across multiple levels of government was meant to consist of iterative processes, but it could not be sufficiently accommodated within the deadlines of the WFD. Consequently, regional influence on national planning guidelines was inadequate, according to a survey among planners (Finland), and a rather extensive dispersion of competencies across multiple levels of water management and political-administrative structures inhibited comprehensive water planning (Poland).

While experiences around the Baltic Sea have not established the superiority of either of the structural approaches, they point out the advantages and shortcomings of both centralised and multilevel structures, especially in the initial stage where the WFD is transposed into national policy in the form of RBMPs and Program of Measures (PoMs). In general, a clear division of competencies has emerged as a prerequisite for effective coordination. The experiences of these countries indicate that the central governments play a crucial role in setting up a framework for integrated management across functionally linked policy areas. But it would be premature to conclude that lower level coordination matters less. Rather, the potential gains from locally integrated decision making have not yet materialised.

Horizontal integration and coordination

In order to overcome sectoral divisions of policy areas, most Baltic Sea countries have charged the ministries of environment with coordinating river basin planning across ministries. Cross-sectoral implementation is complicated by the fact that competencies are distributed across governmental levels in heterogeneous patterns. Agricultural policy may be decided upon primarily at the national level, while spatial planning and nature conservation may be dispersed across national, regional and local scales. Moreover, the hydrological boundaries of river basins do not follow the boundaries of local political-administrative structures involved in the implementation of the RBMPs and related sectorial policies.

Thus, conflicts may arise when spatially-based policy measures under the PoMs interact with other claims to land use, and it is not always evident how different spatial interests are reconciled. A typical instrument for land use coordination would be territorial development plans. These serve to ensure that different interests can be weighed against each other. Some countries (e.g. Denmark, and to a certain extent Poland) have given RBMPs priority over the regional or local development plans. In Sweden, Finland and Latvia, reference to water planning is made in development planning or vice versa, but no clear hierarchy is established among the objectives.

A structural response to the challenge of policy integration and vertical interplay has been to establish coordination forums at the level of the river basin district with representatives of different policy sectors, local authorities such as municipalities, non-governmental organisations, private parties and others who may have a say in water management. The authority of these entities varies.

Financial aspects

Financing the efforts needed seems to be a common barrier across the countries, and it is a challenge to align ambitions and resources, so efforts are not wasted on the production of plans without opportunities for realisation in practice. It is common to perceive the EU funding as the main source for financing WFD measures. Especially the Rural Development Programme is central in limiting limit the diffuse pollution from agriculture, and this programme is also increasingly targeting the WFD. Importantly, however, the agri-environmental schemes in this program are mainly voluntary, highlighting the importance of facilitation of a good dialogue with farmers and other stakeholders at local levels - and the resources for this.

Programme of Measures can i.e include the hydrological conditions in streams such as here, where Fladså river in Denmark is re-meandered. Photo: Naestved Municipality, DK

Recommendations

- Governments should secure a clear division and delegation of responsibilities and competences in the administrative set-up for water planning and management as a prerequisite for effective coordination.
- Governments should seek a relevant balance between centralised knowledge build-up and guide-lines and room-for-manoeuvre at regional and local levels, creating scope for both local knowledge and decision-making at one hand, and for seeking integration with other policy areas on the other.
- The need for targets and action plans at sub-basin levels should be recognized.
- Local action plans can be a good way to follow up on River Basin Management plans, but should be followed by financial commitments corresponding to measures adopted.
- Potential funding sources, e.g. environmental subsidies, should have increased visibility as they are important for bottom-up initiatives.
- Cost-effectiveness of agri-environmental measures should be calculated for the Programs of Measures, as measures may require considerable incentives to entice participation.

Experiences of stakeholder participation in river basin management

Introduction

Public participation can generally be defined as allowing people to influence the outcome of plans and working processes, and stakeholder involvement is increasingly recognized as an essential part of environmental planning. Inclusion of non-governmental actors is expected to lead to better decisions and more effective implementation of policies. Different types of involvement can be conceived, from information and consultation to active involvement, according to different policy situations and different ambitions. The Water Framework Directive (WFD) guideline on participation states that the first two are to be ensured and the latter should be encouraged, thereby indicating that outcomes are better realised under active involvement of those concerned. Regional River Basin District authorities in member states are, therefore, not only responsible for water management planning but also organizing the involvement of stakeholders in production, review and updating of the plans.

The WFD sets certain standards for public involvement, for example on publishing and making documents available for comments to the public. The involvement of public bodies and NGOs is mandatory in the planning phase, and recommended at any stage in this process, but in which form (consultation or active involvement) is ultimately a matter for the member states. How stakeholders are represented in the implementation phase is up to the individual countries. Public participation practices have been studied in seven member states around the Baltic Sea (Denmark, Finland, Germany Poland, Latvia, Lithuania and Sweden) in the production of the first river basin management plans (RBMPs) in selected river basins. The study focused on who were involved, how and when participation was arranged and how it was perceived. Good practices for down-scaling the plans to local level were collected from pilot areas in four countries.

Participatory experiences from member states

There is a large scope for stakeholder involvement in the production of the RBMPs because of the broad scope of the policy, addressing all water-related activities in the river basin. Member states have set up various types of coordinating bodies to facilitate the involvement. Some of these support coordination among authorities from different administrative units and sectors and some participation of stakeholders and the public in river basin or sub-basin level. The extent to which external stakeholders have been invited into the planning and later implementation processes, apart from the minimum requirements, varies from country to country.

Generally, stakeholders asked in the countries studied felt that they were given a chance to participate in the RBMP processes and that there was good responsiveness to their viewpoints. However, involvement opportunities were mainly through information and consultation, while access to active involvement was limited and restricted to certain parties. In Finland, for example, regional cooperation groups were closely engaged in preparing the plans and selecting the measures. In Sweden, some interested stakeholders were excluded from regional water councils in order to keep the size of the group manageable.

Member states have applied several methods for communicating with the general public and stakeholders. In Poland, for example, surveys, thematic brochures, guidebooks, leaflets, handouts, articles in the press, film spots, Internet branch meetings, seminars, debates, panel discussions, press conferences and activities in the National Water Forum were used. In Denmark, many stakeholders and citizens used the opportunity to send in ideas to the authorities during an additional “ideas stage”, while the involvement was in the later process almost abolished. The success of these communication efforts varied among member states. In Poland, the involvement was broad, as a variety of methods were used and many people showed up in events. In Finland, on the contrary, reaching ordinary citizens with information about river basin management planning and participation opportunities were found challenging, and participation rates were rather low. For some stakeholders, using too much expert knowledge and organizing events in daytime, were obstacles to involvement.

The experiences have also shown that practical application of RBMPs and PoMs involves very challenging tasks. In many Baltic Sea member states it is not completely clear who are in charge of implementation of the measures planned in the official river basin planning process and how the costs should be divided between the public and the private sectors. The environmental authorities have an important role in promoting the plans and encouraging the actors to implement the measures required for achieving the environmental targets set by the WFD. Several new policy measures have been developed to enforce the process. Pilot studies from different member states show that the countries in the eastern and western part of the Baltic Region face different problems in meeting the objectives of the WFD. Also traditions for public participation vary a lot between the countries. However, some common recommendations can be given to improve participation processes and to avoid some mistakes.

Identify relevant stakeholders

- All sectors are part of water management: the dialogue between the authorities responsible for sectoral policies, as well as between national and local level should be strengthened.
- Trusted organizations, such as farmers’ unions, interest groups, nature associations etc., may act as mediators of information to the grassroots level.
- If ordinary citizens’ input is wanted, they should be motivated and encouraged to participate.

How and when to organize participation?

- Use multiple communication channels (field excursions, thematic workshops, events in local level...)
- Consider the size of committees and groups. Groups can become too large and also too small for meaningful discussions.
- Clarify the roles of stakeholders and participants, i.e. advisory or consultation, to avoid frustration over unfulfilled expectations.
- Schedule the meetings at those hours that are feasible for all desired participants.
- Make material for hearings and consultations available in time. Use language and terminology that is understandable to the desired audience (experts or ordinary citizens)

From regional to grassroots level

- Communication and raising awareness can contribute to the increased sense of responsibility for the state of waters, and thus to the acceptance and legitimacy of the plans and measures.
- It is important to increase the willingness of local stakeholders to take action to enhance the status of waters in their neighbourhood.
- Attention should be paid on provision of correct information on ecological status and the pressures without accusing or pointing the finger at any individual stakeholder group or sector.
- Highlighting the importance of waters as a natural value, for recreation and well-being of people as well as promoting measures that serve multiple objectives.
- Communication should be of positive nature and focus on future efforts and opportunities rather than on current problems.
- Focus on nearby water bodies that are interesting for local population and set up concrete goals.

Water management and farmer participation

Introduction

For a number of years farmers have had the double role of being producers of food as well as fibre and managers of the land and thereby of the ecosystem services that agricultural land can and should maintain. The success of this double role is increasingly valued.

Due to the large share of agricultural land in the Baltic Sea catchment, it is crucial for water management that farmers acknowledge and accept this role and that society provides the framework in which they can succeed. The foundation for farmers to undertake this responsibility is improved by the increasing knowledge and technological innovation, including improved spatial detail of soil information facilitating adequate timing and proportioning of fertiliser, improved knowledge of catchment processes and run-off enabling more advanced management of farm operations and crop rotation to prevent erosion and flooding. This can be supplemented by smaller constructed wetlands at appropriate sites in the catchment.

Real involvement of farmers to take on the role of environmental manager requires a different mind-set in the conception of regulatory instruments where room for finding local solutions locally is often limited. By involving the farmers in the solutions right from the beginning, the water authorities will create en-hanced understanding and support for the water management goals. And the farmers might find new business opportunities in their role as water managers.

Reaping the benefits of farm advisory systems for the farmers and for the water

A farm advisory system is usually accessed by farmers for optimizing their production. Most advisors are known in the farm sector as people who build their advice on a good knowledge platform. Some advisors have good skills as intermediaries and facilitators, and many have an agronomic background which has given them a solid biological understanding.

Facilitating organizations/persons are important for finding sustainable solutions for the water environ-ment, for food production, etc. In areas where farming is the most important factor to handle in order to secure good water management, the farmer will be the most important stakeholder.

As many farmers have a lack of trust in water authorities, knowledgeable people from the farm advisory sector can act as facilitators. In addition, validation and communication of alternative solutions can be an important task for farm advisors in improving the uptake of sustainable innovations for the management of farm business.

Farmers can take care of the water management i.e. by building wetlands. Here is the Rantamo-Seitteli wetland in Finland. Photo: Sirkka Tattari

Recommendations

No single tool exists on how to secure farmer participation. To involve stakeholders and include farmers, the specific context and ecosystem services must always be taken into consideration, and the following recommendations should be considered:

- Focus at the local problems and context.
- Involve the farmers who have something at stake, and be sure to make real progress, e.g. by using a facilitator.
- Make use of the fact that all stakeholders can bring in different knowledge. When this knowledge is taken into account, the solutions will become more valid.
- Everybody should be flexible – meaning that they need to be ready to change routines without changing the basic foundation for being a farmer, an authority, etc.
- Commitment from background organizations is crucial.
- Funding for testing new environmental solutions is important for farmers to realise different future management options.

Barriers/gaps/problems to solve

- Lack of trust between water authority and farmers.
- Lack of knowledge about agricultural impacts on water quality in the water cycle.
- Lack of knowledge, amongst decision makers, of the opportunities involving the farmer as a water manager.
- Lack of water boards or similar institutions where, in cooperation between water authorities, local stakeholders and knowledge agents, local solutions can be found.
- Too little use of intermediaries/facilitators for identifying solutions adapted to the local context.
- Too little acknowledgement of farm advisors' potential for facilitating sustainable solutions.

Farm self-sufficiency as an environmental governance model (ERA)

The Ecological Recycling Agriculture (ERA) farming system builds on the combination of farm self-sufficiency, crop rotation and organic farming. The economic sustainability of ERA farming builds on cooperation in the whole food chain and thus requires a new kind of participatory approach.

ERA farming has several environmental benefits: it significantly lowers the leaching of nitrogen and phosphorous to the Baltic Sea; it also rebuilds the soil, enhancing fertility, increasing water holding capacity and preserving biodiversity of the soil. Building up soil organic matter with the help of nitrogen fixating plants (such as clover), crop rotation and balanced animal stock also has the positive effect of removing large amount of carbon from the atmosphere. Another benefit is a reduction in energy-consuming production and in transport of fodder and fertilizers. As with organic farming, no pesticides or artificial fertilizers are employed in ecological recycling agriculture. In addition the following principles are required by ERA:

- **crop rotation,** including leys with legumes etc
- **balanced animal stock,** 0.5 – 1.0 animal livestock units per hectare. 1 livestock unit is approximately equivalent to the energy requirements of a cow weighing 550 kg and providing 6000 kg milk/year
- **self sufficiency in resources,** more than 80 % self-sufficiency with fodder and manure

ERA creates opportunities for rural development. High quality products of ERA farms are in several cases the basis for local or regional clusters, i.e. Sustainable Food Societies. However, stretching the scope from agricultural producers to consumers requires new skills. Conversion of a farm to an ERA farm means going into depth with the whole structure and business idea of the farm, including the art of engaging the local network. The bottleneck for developing ERA is that the required skills are both in farming techniques and market management. The educational system to provide knowledge for this purpose is poorly developed. The few farmers who have the competence for ERA need to come across a supportive network to build not only the farm but also the infrastructure, including food processing, distribution and marketing. The ERA farm should not deliver its products to an anonymous price-dampening food market, but to a market that appreciates both the quality of the products and the positive effects on waters, carbon balance and biodiversity.

Therefore the strategy in the BERAS Implementation project has been to build up full scale learning centers in all countries around the Baltic Sea. These centers both demonstrate the potential of the ERA system and spread the learning. There are now 18 learning centers in the 9 countries of the Baltic Sea Basin.

A participatory approach with regard to contaminated sediments

A participatory approach to a sustainable management of contaminated dredged materials (sediments) has been developed. In all phases of the management procedure, interaction with several stakeholders is a key issue for a successful project and a requirement based on law, especially when performing so called Environmental Impact Assessments (EIA). Insufficient information policy and risk communication may lead to project changes (e.g. project relocation, dropping of favored management options) resulting in time delays and additional costs for the project owner.

The stakeholders in sedimentary issues could be (no ranking implied):

- Port authorities, environmental authorities
- Public, media, local organizations, non-governmental organizations (NGOs)
- Municipalities and regional/federal bodies
- Construction industry, contractors and consultants

Dredging companies, government officials and local authorities often fail to inform and involve the public during the early stages of dredging and disposal operations, often generating unfounded concerns and even widespread protests among the local population. The approach and knowledge developed entail the following processes:

– Initially an assessment of concerns using questionnaires or public meetings can be carried out. Such an assessment represents an important part of risk management and risk communication because it collects and summarizes information on public concerns. The resulting communication can be more targeted, and public reservations on dredged material handling can be reduced. However, the public risk perception does not necessarily match with the scientific outcome of risk assessment. People are influenced by their personal beliefs and values. It must be explained that potential adverse effects on human health or environmental resources are minimized as far as possible.

– The second step is to interview individual experts and stakeholders in detail. The objective of this type of survey is to examine different opinions on future visions and alternative solutions for management of contaminated sediments in the Baltic Sea Region.

The overall aim is to find a shared interpretation of the sustainability concept in the Baltic Sea region for the problem in question; i.e. to identify important environmental, economic and social criteria for management of contaminated sediments.

SMOCS project developed participatory approach for the management of contaminated sediments. Here is an information meeting for stakeholders in Gävle Port, Sweden. Photo: Bo Svedberg

Cluster partnership

Baltic Sea Action Group, Finland (Baltic Compass)
Paula Biveson
Marja Koljonen

SYKE - Finnish Environment Institute
(Baltic Compass, COHIBA, Waterpraxis, Baltic Manure, Beras Implementation)
Seppo Hellsten
Jukka Mehtonen
Päivi Munne
Ansa Pilke
Anne-Mari Rytkönen
Sirkka Tattari
Teemu Ulvi

HELCOM (PURE, Baltic Compass, COHIBA, [SMOCS])
Mikhail Durkin
Johanna Laurila
Kinga Polynzcuk

Aarhus University/ENVS (Waterpraxis)
Pia Frederiksen

Agro Business Park, Denmark
(Baltic Manure, Baltic Compass)
Knud Tybirk

Baltic Environmental Forum, Lithuania
(Baltic Compass, COHIBA)
Juste Buzelyte
Zymantas Morkvenas

JTI – Swedish Institute of Agricultural and Environmental Engineering (Baltic Compass)
Ola Palm
Lena Rodhe

Knowledge Centre for Agriculture, Denmark
(Baltic Deal)
Irene Asta Wiborg

MTT - AgriFood Finland
(Baltic Manure, Baltic Compass, Beras Implementation)
Markku Järvenpää
Johanna Logrén
Sari Luostarinen
Eila Turtola
Kari Ylivainio

Södertälje Municipality (Beras Implementation)
Hans von Essen

Tallinn University of Technology
(Baltic Compass, COHIBA)
Arvo Iital

Technical University of Hamburg (SMOCS)
Wolfgang Ahlf

Technical University of Lodz (Waterpraxis)
Miroslav Imbierowicz
Ireneusz Zbiciński
Alexandra Zieminska-Stolarska

Union of the Baltic Cities, Finland (PURE, Presto)
Björn Grönholm
Pekka Salminen
Hannamaria Yliruusi

University of Rostock (Baltic Manure)
Karola Elberg
Bettina Eichler

Photo: Helena von Limburg Stirum

Project presentations and links

The references to scientific results which appear in the report can be found in the deliverables and websites of the projects in which cluster partners has worked. Individual projects' websites are available until 2017.

Baltic Compass promotes sustainable agriculture in the Baltic Sea region. The special emphasis is on reducing eutrophication. The project works in five areas: best practices, investment facilitation, water assessment and scenarios, and policy adaptation.
www.balticcompass.org

Baltic Deal gathers farmers and farmers' advisory organisations around the Baltic Sea in a unique effort to raise the competence concerning agri-environmental practices and measures.
www.balticdeal.eu

Baltic Manure aims to change the general perception of manure as a waste product to that of a resource. With the help of the best available manure handling technologies and a developed policy framework, the project will identify the inherent business opportunities of manure.
www.balticmanure.eu

Beras Implementation promotes a good environmental status of the Baltic Sea as a genuine ecological alternative that mitigates adverse climate effects from agriculture and secures a sustainable and prosperous development in the region.
www.beras.eu

COHIBA – Control of hazardous substances in the Baltic Sea region. The COHIBA project supports the implementation of the BSAP with regard to hazardous substances by developing joint actions to reach that goal. COHIBA has identified the sources and inputs of eleven hazardous substances and developed measures to reduce them.
www.cohiba-project.net

PURE is a project on urban reduction of eutrophication. PURE promotes better treatment of urban wastewaters in the Baltic Sea region and combats eutrophication by enhancing phosphorus removal at selected municipal wastewater treatment plants in the region.
www.purebalticsea.eu

PRESTO is a project on reduction of the eutrophication of the Baltic Sea today. Presto improves the quality of local waters and the Baltic Sea by reducing nutrient load through transnational investments, education and by raising awareness.
www.prestobalticsea.eu

SMOCS - Sustainable management of contaminated sediments. The SMOCS project, in cooperation with ports, authorities and industry, will produce a guideline on treatment of contaminated sediments.
www.smocs.eu

Waterpraxis – From theory and plans to eco-efficient and sustainable practices to improve the status of the Baltic Sea. Waterpraxis aims to improve the status of the Baltic Sea by assisting the implementation of river basin management plans into practice in the region.
www.waterpraxis.net

Baltic Impulse – Saving the Baltic Sea Waters is a cluster of 15 partners who represent 9 environmental projects running under the Baltic Sea Region Programme 2007 – 2013. All projects were concerned with the quality of the Baltic Sea waters. The cluster is operational between September 2012 and September 2013.

Baltic Impulse partnership

Cluster coordination
Paula Biveson, Baltic Sea Action Group, Finland

Cluster Steering Group
SYKE, Finnish Environment Institute, Finland
Aarhus University/ENVS, Denmark
The Baltic Marine Environment Protection Commission HELCOM

Cluster partners
Agro Business Park, Denmark
Baltic Environmental Forum, Lithuania
JTI – Swedish Institute of Agricultural and Environmental Engineering, Sweden
Knowledge Centre for Agriculture, Denmark
MTT - AgriFood, Finland
Södertälje Municipality, Sweden
Tallinn University of Technology, Estonia

More information about Baltic Impulse:

www.helcom.fi/projects