


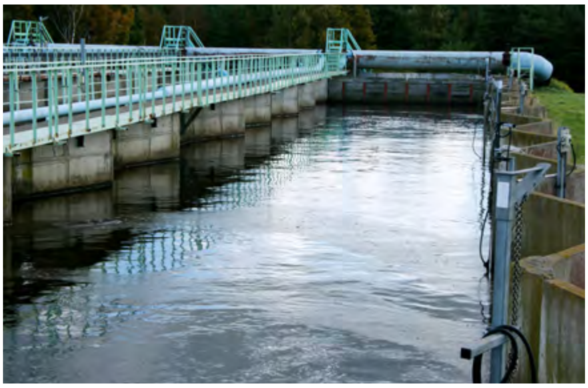


Executive summary

Cost-benefit analysis of municipal water protection measures: Environmental benefits versus costs of implementation

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citywater Life

THE BALTIC SEA CHALLENGE

Cost-benefit analysis of municipal water protection measures: Environmental benefits versus costs of implementation

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Download the report

http://www.hel.fi/static/ymk/julkaisut/julkaisu-21-14.pdf

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http://www.waterprotectiontools.net/index.php/en/economics-financing/cost-benefit-analysis

The cost-benefit analysis study was compiled in the 'CITYWATER – Benchmarking water protection in cities' project (2012-2015). The project was co-funded by the European Commission Life+ funding instrument (50 %), the Finnish Ministry of the Environment and its partners, the City of Helsinki (lead partner), City of Turku, Tallinn City and Tallinn University. The CITYWATER project was realised under the umbrella of the Baltic Sea Challenge network, a joint initiative of the Cities of Helsinki and Turku, Finland, for saving local waters and the Baltic Sea.

Further reading
www.waterprotectiontools.net
www.citywater.fi
www.balticseachallenge.net

City of Helsinki Environment Centre, 2015
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Introduction

The current ecological state of the Baltic Sea is alarming due to severe eutrophication, which is threatening marine life and the benefits that the sea can provide for humans. The main reason for eutrophication is the excess nutrient load caused by human activities, which calls for urgent and radical nutrient load reductions in the entire Baltic Sea catchment area. While, in practice, nutrient reductions should be achieved at local level by cities, municipalities and other local organisations, their impact is wider, affecting the state of both local waters and the Baltic Sea.

However, there is a lack of information on the role of local actors, e.g. cities and municipalities working to save the Baltic Sea. What impacts can be related to local water protection measures and how large are such impacts? How are they affecting the state of local water systems or that of the Baltic Sea? How large are the environmental benefits gained compared to the costs of such measures? Are the measures worthwhile from the perspective of social welfare?

These questions were evaluated through five case studies of various water protection actions implemented by municipalities in the Baltic Sea region. The measures studied included improvements in waste water treatment plants in the cities of Pori and Liepaja, the reception of sewage waters from ships in the Port of Helsinki with no special fee praxis, a constructed urban wetland in the City of Lahti and agricultural buffer zones in Turku. The case measures were selected from among those of partners in the Baltic Sea Challenge network, in which over 200 local organisations are committed to working towards a healthier sea.

The purpose of the study is to provide information on the impacts of municipal water protection measures, the environmental benefits in monetary terms and the net benefits gained by society. A cost-benefit analysis, which compares the overall benefits and costs of a measure, is the main research method used. As a method, cost-benefit analysis was initially developed in support of decision-making. Such an economic approach is required in the field of water protection because it constitutes a way of taking account of environmental benefits in decision-making.

In a cost-benefit analysis, all relevant impacts related to a measure are first identified and then quantified in monetary terms over the lifespan of the measure. In the current study, the benefit estimates for nutrient reductions in the sea were based on people's willingness to pay for the better condition of the sea in two scenarios. In the first scenario, the state of the Baltic Sea develops in accordance with HELCOM's Baltic Sea Action plan and in the second as a result of business as usual (i.e. nothing changes our present behaviour). Finally, the monetised impacts based on the two scenarios were summed up in order to obtain net present values, which indicate whether the measure is worthwhile from the social perspective.

The cost-benefit analysis study was conducted as part of the CITYWATER – Benchmarking water protection in cities project, which aimed to promote the implementation of water protection actions to improve the state of local waters and the Baltic Sea. The project was realised through collaboration between the cities of Helsinki, Turku and Tallinn, as well as Tallinn University. The project was co-financed by the EU Life+ financial instrument and the Finnish Ministry of the Environment during 2012–2015.

Case studies of municipal water protection actions

Luotsinmäki WWTP in the City of Pori, Finland

Waste water treatment in the Pori region was centralised with Luotsinmäki WWTP in 2008–2010. New transfer sewers were built leading from the surrounding municipalities and the old Luotsinmäki WWTP was renovated.

Porin Vesi (Pori Water) is a municipal water supply and sewage treatment company based in the City of Pori. Porin Vesi runs three waste water treatment plants (WWTPs) of which Luotsinmäki WWTP is the largest. Major renovations and expansions were carried out in the Luotsinmäki WWTP during 2008–2010.

At the same time, the surrounding municipalities of Harjavalta, Ulvila, Nakkila and Eura and fabric-producer Suominen Kuitukankaat Ltd established a new company, Jokilaakson Ympäristö Ltd, to build up and manage a sewer line connecting the sewerage networks of the abovementioned partners to the new Luotsinmäki WWTP.

After the completion of these two investments, the municipal WWTPs of Harjavalta, Ulvila and Nakkila and the WWTP of the Suominen Kuitukankaat factory were shut down. Two other treatment plants – the municipal WWTP of the coastal municipality Luvia and the WWTP located in the Pihlava region of the City of Pori – were also closed. Waste water treatment in the region was centralised in the Luotsinmäki WWTP via transfer sewers.

Due to the centralisation of waste water treatment in the renovated Luotsinmäki WWTP, the nitrogen and phosphorus load of the River Kokemäenjoki and the Baltic Sea fell by ca 127,500 kg N/y and 3,100 kg P/y. The relative reductions were 61 % and 69 % respectively. Depending on how the condition of the Baltic Sea develops in the future, the annual social benefits gained from nutrient reductions in the sea will be MEUR 2.6–25.6 per year. The net present value would then be between MEUR –41 and MEUR 120 (over an expected lifespan of 30 years). The many positive local impacts e.g. on local waters, as well as those on municipal collaboration and the effects of reduced traffic, noise and odours in the surroundings of the closed plants could not be measured and are thus not included in the analysis.

Liepaja WWTP in the City of Liepaja, Latvia

The municipal company Liepaja Water invested in new aerators and a new PC-program in a wastewater treatment plant during 2008–2010.

The municipal company Liepaja Water (Liepajas Udens) takes care of the sewerage system and wastewater treatment in the City of Liepaja, in addition to providing drinking water. Liepaja Water invested in the replacement of new aerators and a new PC-program in 2008–2010. The main reason for replacing the three old aerators with five new ones was the many problems experienced with the old aerators, which were close to the end of their lifespan, since 2002. Aerators are important to the biological treatment process. Due to the new technology forming the basis of the replacement aerators, the PC-program controlling the entire process had to be replaced at the same time.

These investments have reduced the nutrient load in the sea in two ways. The new aerators have improved the aeration of the biological process, thereby increasing the efficiency of treatment during this phase of the process. In addition, the new program has enhanced the controllability of the entire process due to fewer bypass situations and other problems related to controllability. On an annual basis, the nitrogen load has been reduced by 18,000 kg N/y and the phosphorus load by 1,000 kg P/y. In addition, annual energy consumption was reduced by a third, 0.8 MWh/y, which also provides climate-associated benefits and energy cost savings.

Depending on how the protection of the Baltic Sea develops, the annual social benefit from nutrient reductions in the sea will be MEUR 0.1–1.5/y. When the overall costs and benefits during the expected 15-year lifespan are summarised, the estimated net benefit of the investments total between MEUR 2.1 and MEUR 18.6. These results suggest that a single investment of this type in a WWTP would be worthwhile from both a global and local perspective.

Port of Helsinki, Finland

The Port of Helsinki receives sewage water from passenger ships without a special fee and delivers it to the local municipal WWTP for treatment.

The Port of Helsinki, Finland's main passenger port, receives wastewater from passenger ships, which is treated in Helsinki's municipal WWTP. The Port of Helsinki applies a no-special-fee system by charging only a general waste fee, which depends on the size of the ship. The visiting ship pays the same waste fee whether or not it discharges its sewage into the harbour facilities. To take sewage from vessels, the Port of Helsinki has been investing in port reception facilities (PRF) since 1990 and is continuing the expansion of its sewer system alongside the construction of new quays. The no-special-fee policy was launched in May 2008.

The Baltic Sea has been defined as a special area since 2013, which means that when the port reception capacity of Baltic Sea ports is sufficient, the dumping of sewage water into the sea will be prohibited. The Port of Helsinki has already fulfilled this aim. According to the Port, in addition to fulfilling legislative requirements, the measure has been implemented in order to benefit from an improved image. Combined with the location of the port, fulfilment of a high level of social responsibility is a clear competitive advantage.

This leads to an estimated reduction in nutrient loads in the Baltic Sea of 21,000 kg of nitrogen and 3,000 kg of phosphorus each year. Depending on the future scenario related to the condition of the Baltic Sea, these amounts would provide MEUR 0.3–3.6 in annual benefits. Compared with the overall costs of investment, the long-term (40-year lifespan) net benefits would be between MEUR –7.5 and MEUR 76.2.

The quantitative results should be interpreted with caution, since many assumptions had to be made and some data was lacking. However, the study provided some useful lessons learned. The main costs were incurred from investing in the sewerage system and due to waste water treatment costs. The Port of Helsinki has installed a system in both its existing and new quays, on the basis of which it has observed that installations in new quays are more cost-efficient. The cost-efficiency of the investment would also increase if the port were located near the WWTP. Investments in the PRF system are recommended because treatment in a single onshore plant is likely to be more efficient than on vessels.

Constructed urban wetland in the City of Lahti, Finland

Stormwater from a residential area of Karisto in the City of Lahti is collected, retained and purified in a constructed stormwater wetland system.

During 2008–2011, a large stormwater wetland was built in a new residential area in Karisto, in the City of Lahti. Stormwater is retained and purified in the wetland before entering the eutrophicated Lake Kymijärvi. This also means that the stormwater is handled in an open system which provides recreational benefits for local people. The Karisto wetland consists of a large sedimentation pond and a wetland area. A meandering creek collects stormwater from a 138 ha large catchment area, which is mainly used for residential living.

Based on the data available on stormwater quality, the wetland is estimated to have reduced the annual nitrogen load flowing from the catchment area into Lake Kymijärvi by 38 % (61 kg N/y) and the phosphorus load by 33 % (2 kg P/y). Because the City of Lahti is located in the Baltic Sea catchment area, some of this reduction in nutrients is also beneficial to the Baltic Sea. The wetland system also provides recreational benefits for citizens. Because the number of residents will increase in the future, the number of people enjoying the benefits of the wetland will also rise. As a result, it is estimated that the value of the annual recreational benefit will grow from EUR 10,000/y to EUR 20,000/y.

A comparison of the investment and maintenance costs with the benefits related to recreation and the improved condition of the Baltic Sea over a 50 year lifespan resulted in a net present value of ca EUR 100,000. This did not include the costs avoided by eliminating the need for conventional underground stormwater solutions such as drainage pipes and wells. Furthermore, ecological benefits, such as the positive impact on local water systems related to biodiversity and groundwater generation, could not be included in the analysis. Stormwater solutions therefore seem to be worthwhile investments from the social perspective.

Buffer zones by the river, City of Turku, Finland

The City of Turku owns agricultural land and leases it to local farmers with the special condition that extra-wide buffer zones must be built in the riverside fields.

The City of Turku is one of the largest agricultural landowners in Finland: it owns 2,000 ha of arable land and leases 1,600 ha of this to local farmers. As a landowner, the city can influence the water protection of local agriculture. In 2005, the city added the special condition of establishing extra-wide buffer zones in land lease contracts. These buffer zones are at least 15 metre wide vegetated zones on average, which are established between a field and a water course to reduce the surface runoff of nutrients and soil erosion.

Nowadays, there are approximately three kilometres of buffer zones by the River Aurajoki and other rivers in the Turku area. The buffer zones are 100 m wide at most. In practice, the location and width of the buffer zones are usually decided by the city, but sometimes together with the farmer. In order to obtain special agri-environmental subsidy rights from the EU, the landowner should establish the buffer zone in a place where the risk of nutrient leach and erosion, and the impact on the local water system, are high. In addition, a 5 or 10-year plan on how to establish and maintain the buffer zone is required. The use of fertilisers and chemical protectants is further prohibited in the buffer zone.

Two case fields were studied for the cost-benefit analysis. The larger field is located by the River Aurajoki and the smaller by the River Vähäjoki, which flows into the River Aurajoki. It is estimated that annual nitrogen leaching will fall by 70 % and phosphorus leaching by 50 % due to the buffer zone by the River Aurajoki, and by 75 % and 21 % due to the buffer zone by the River Vähäjoki. The differences in efficiency are due to differences in tilling practices, the characteristics of the fields and the width of the buffer zones. These two buffer zones cover a 5.6 ha area in total, reducing annual nutrient leaching from the fields by 240 kg N/y and 40 kg P/y.

When account was taken of the nutrient reductions to the Baltic Sea and the profitability impact on farmers, the net benefits during the leasing periods totalled EUR 41,000–507,000 by the River Aurajoki and EUR –4,000–20,000 by the River Vähäjoki, depending on the future Baltic Sea protection scenario applied. The results are promising because the reductions are subject to a multiplier if buffer zones are applied widely throughout the area. In addition, buffer zones seem to be worthwhile both for farmers and from the wider social perspective.

Conclusions and recommendations

The results from the case studies show that local actors play a crucial role in protecting the Baltic Sea. Remarkable nutrient load reductions are likely to be achieved by investing in WWTPs in Pori and Liepaja, and in port reception facilities in Helsinki. It was estimated that natural or non-technical solutions such as the stormwater wetland in Lahti and agricultural buffer zones in Turku would efficiently reduce the nutrient load. The case-studied measures can provide various other benefits in addition, such as energy savings, reduced climate emissions, biodiversity and recreational values.

If the condition of the Baltic Sea remains poor in the future (a business as usual scenario), the value of single nutrient reductions will be very high. In such a case, the studied measures are likely to provide substantial positive net benefits, suggesting that they are clearly worthwhile from society's point of view. However, if the condition of the Baltic Sea becomes good in the future (the Baltic Sea Action plan scenario), while the overall benefits accruing from this will be higher, additional single-nutrient reductions will become less valuable. This will lead to a decrease in the value of the estimated net benefits, or even to negative net benefits in the case of single measures, depending on the measure in question.

Although a comprehensive sensitivity analysis was performed in all of the case studies, the results include some uncertainty about the prediction of future impacts and the lack of data. While many key local impacts were identified, only some of these could be measured and monetised, which means that the net benefits were probably underestimated. The quantitative results should therefore be treated as rough estimates.

The final step in the cost-benefit analysis involved providing recommendations in support of decision making. Based on the lessons learned from the case studies, the following recommendations were made:

1. Use the information provided by the **CITYWATER Cost-benefit analysis** study to support the implementation of water protection work at local level.
2. Implement different kinds of water protection measures in order to achieve as many different benefits as possible. Prefer measures with a connection to other fields of environmental protection in order to gain multiple benefits.
3. Use cost-benefit analysis as a tool for taking account of the benefits of water protection in decision-making when choosing between the potential measures to be implemented or improving the effectiveness of implemented measures.
4. Step up water protection research and data compilation.
5. Make use of existing networks, for example the **Baltic Sea Challenge**, for sharing ideas, experiences and best practices regarding water protection as a form of support for your own work.

In conclusion, various kinds of water protection actions are needed around the Baltic Sea: the protection of the Baltic Sea should be viewed as a whole and every individual measure is an important part of such a whole. The study showed that different measures can have varied impacts, making it possible to achieve diverse and multiple benefits through carefully planned water protection. A great deal of help and support is available for planning and implementation, for example in the lessons learned from the studied cases and experiences derived from the Baltic Sea Challenge network.

In addition, a cost-benefit analysis is a useful method of comparing measures, improving the efficiency of previous measures, and promoting environmental discussion. Using a cost-benefit analysis also requires more information on the condition of local waters and the impact of measures. In addition, such information is needed in order to take better account of water protection issues in decision-making.

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