Project activities

After the initial planning and design period, the demonstration plants will be constructed, transported to and installed at the defined locations, i.e. Hanö bay outside the shoreline of Simrishamn and Kanholmsfjärden/Möja Söderfjärd in the outer Stockholm Archipelago. The pilots will then be tested during one year including the extensive monitoring and sampling of water and sediments in and around the pumps.

This period is followed by the technical, environmental and economical evaluation, which is necessary to prove the project suggestion of a cost-effective wave-powered device for enhanced ventilation/mixing of low-oxygen bottom water layers to mitigate oxygen depletion in marine environments. Finally, the information dissemination will be undertaken to promote the WEBAP project results and achieve communication objectives for the different target groups.

Expected results of the project

The proposed WEBAP-system will improve the situation in marine environments suffering from oxygen depletion. The project is expected to lead to enhanced ventilation/mixing of oxygen-free bottom water-layers with the primary environmental results of increasing oxygen levels in oxygen-free deepwater layers and significantly decreasing phosphorus concentrations in the bottom water due to a decrease in the phosphorus leakage from bottom sediment.

Further, secondary effects of the project are:

- Recovery of benthic animals and deepwater living fish.
- Less algal bloom during summer months.
- Improved water quality and increased catches of high quality fish.
- Restoration of natural marine ecosystems, including natural habitats.
- Halting the loss of biodiversity.

Project duration

The WEBAP project will be performed during 36 months from January 1st 2010 to December 31st 2012.

Project organisation

The WEBAP project is be performed by IVL Swedish Environmental Research Institute in close cooperation with the Royal Institute of Technology (KTH) and the Municipality of Simrishamn. IVL is the project coordinator and responsible for the overall management, and the design and operation of the pilots. KTH is responsible for monitoring, evaluation and dissemination actions of the project.

In addition to the main project partners, a number of other European stakeholders, such as KIMO – Local Authorities International Environmental Organisation, Marint centrum, Åbo Akademi University (Finland), the Institute of Oceanology of the Polish Academy of Sciences (Poland), Erken Laboratory (Uppsala University), Österlens Fishing Association and Österlen Trade Society are involved in the project.

Project partners

IVL Swedish Environmental Research Institute

KTH Royal Institute of Technology

Simrishamn Österlen

Life

Collaboration partners

KIMO Baltic Sea

Uppsala Universitet

IBP PAN

Marint centrum

Åbo Akademi

Handelshuset Österlen

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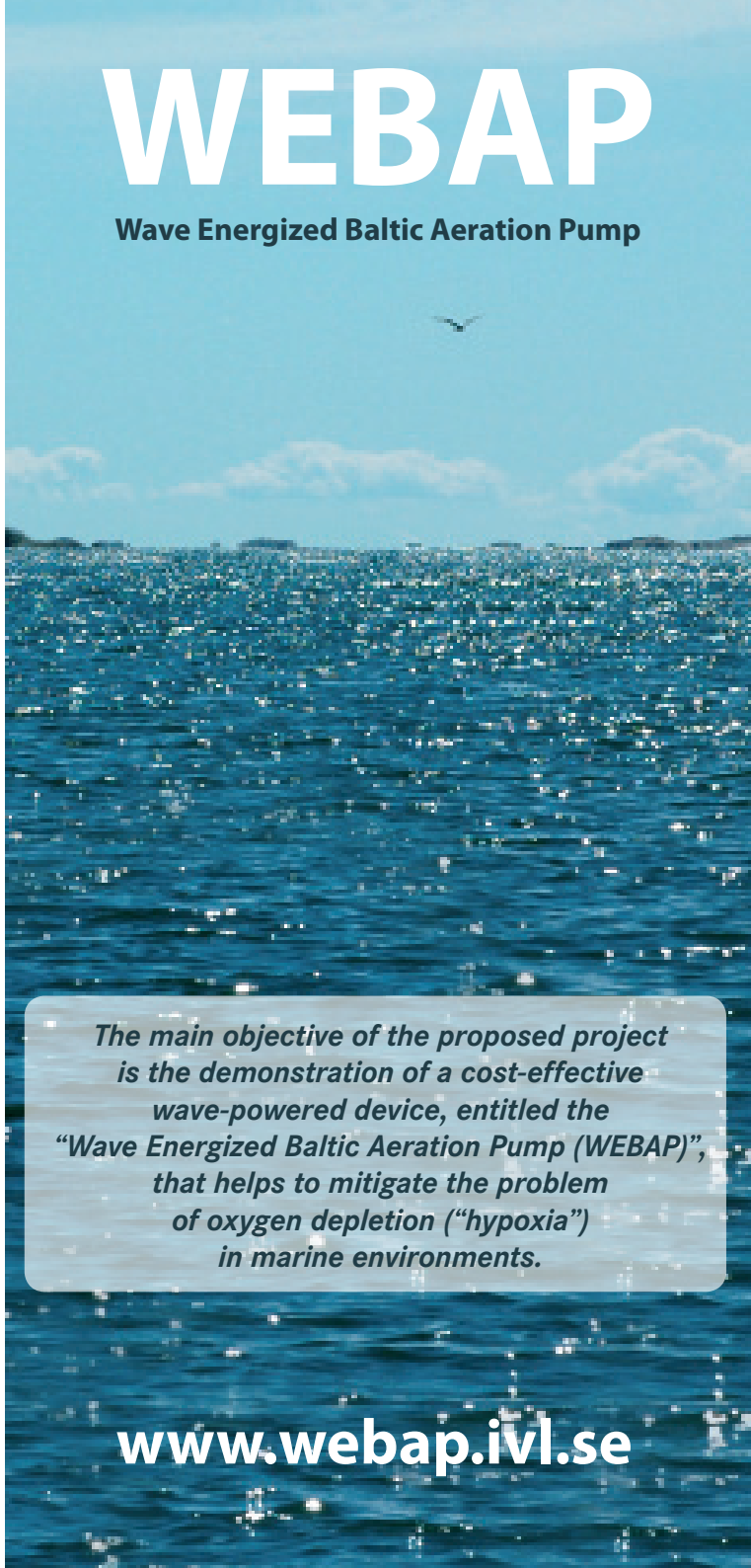
WEBAP

Wave Energized Baltic Aeration Pump



The main objective of the proposed project is the demonstration of a cost-effective wave-powered device, entitled the "Wave Energized Baltic Aeration Pump (WEBAP)", that helps to mitigate the problem of oxygen depletion ("hypoxia") in marine environments.

www.webap.ivl.se

Project background

Recent studies show that marine environments that suffer of oxygen depletion have increased exponentially since the 1960's and have serious consequences for ecosystem functioning.

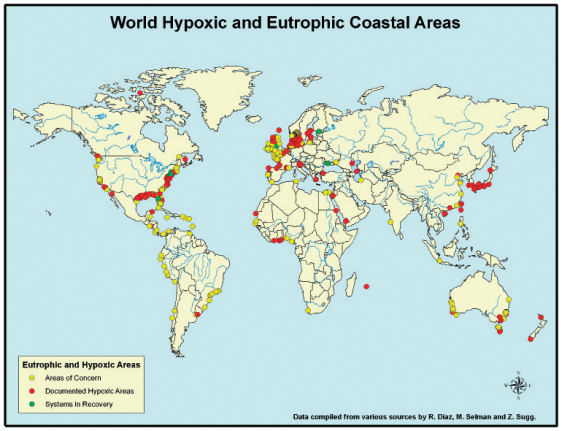


Figure 1. Hypoxic and eutrophic coastal areas in the world. (Map available at http://www.wri.org/map/world-hypoxic-and-eutrophiccoastal-areas. © 2008, World Resources Institute)

These so-called dead zones, existing at approximately more than 400 aquatic systems worldwide of which one is the Baltic Sea, affect a total area of more than 245 000 km^2.

Because oxygen depletion is a direct consequence of nutrient pollution and eutrophication, it is essential to reduce the amount of nutrient loads to marine environments. Upstream nutrient reductions, however, are difficult and may not be sufficient as it takes a very long time before effects in marine environments are observed. In addition, global warming is expected to increase the affected areas and which in turn will enhance the build-up of atmospheric greenhouse gases and thus intensify climate change. This implies that mitigation measures that lead to direct improvements are required.

The increasing spread of oxygen-free water layers in the open Baltic Sea over the last hundred years, for instance, directly impacts the coastal ecosystems by driving fish away from important feeding and nursery habitat and killing the less mobile forms of marine life that fish eat. The lack of oxygen in deep water may also affect the benthic fauna and fish recruitment. It has further caused an increased leakage of phosphorus from the bottom sediments, which contributes considerably to an increased eutrophication. For that reason, oxygen depletion has developed into a serve environmental problem for the Baltic Sea and its dependents. The ecological

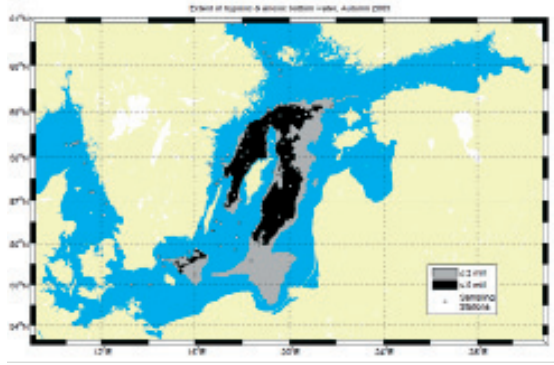


Figure 2. Extent of oxygen-depleted bottom water in the Baltic in autumn 2009 (Swedish Meteorological and Hydrological Institute (SMHI; www.smhi.se), 2009)

changes caused by the lack of oxygen also affect human in different ways. Many communities along coasts depend fully or partly on healthy marine ecosystems for fisheries in order to provide food and income. Already over-fishing and habitat loss makes such communities suffering from declines in fish populations. Another impact regards the water quality in coastal areas that are used for recreation and tourism. This of course also comprises health aspects.

Proposed technique

The main idea of the WEBAP-system is to use wave power to pump oxygen-rich surface water through pipes to deeper oxygen-free water layers. The concept has several advantages: without any moving parts, the constructions can be kept simple, stable and robust.

The physical principle of the aeration pump is very simple. It is based on the concept of a floating breakwater that collects overtopping oxygen-rich waves into a reservoir inside the pump. This creates a higher water level within the reservoir than in the surrounding sea which makes the oxygen-rich water in the reservoir flows downwards though a hole in the bottom of the pump. Pipes are connected to a chosen depth that can be adjusted to local conditions. A general sketch of the principle of the aeration pump is shown in *Figure 3*. The transport of high-oxygen surface water will solely dependent of the incoming over-topping water as the water head inside the pump is high enough to overcome the pressure at the bottom of the pipe that is caused by e.g. buoyancy forces, friction and salinity differences. Because of the simple and robust design, the aeration pump is expected to be very cost-effective. Environmental impacts may be exclusively positive as only natural services such as wave energy and oxygen-rich surface water are used to mimic and enhance existing processes in nature.

Because the project suggests mimicking and enhancing naturally occurring processes, possible unforeseen side effects represent risks that are not to be considered as exogenously imposed but are repeatedly occurring naturally.

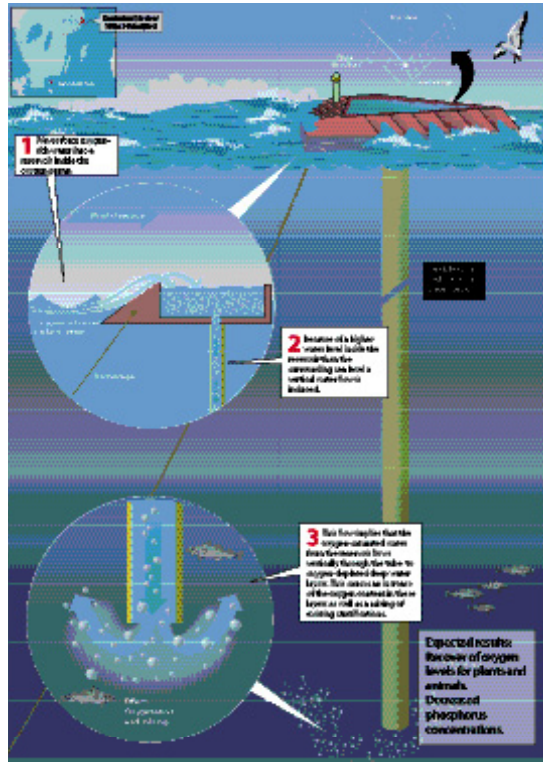


Figure 3. Schematic figure explaining the physical principle of the wave-powered aeration pump.

Important note

Because nutrient loads to marine environments are the main cause for oxygen depletion, also the implementation of mitigation measures that reduce anthropogenic nutrient loads to the environment is required.