

A close-up of the BONUS AFISMON AFISys prototype to collect and preserve reliable samples, the Baltic Divers GmbH dock, Rostock.



PHOTO: SOPHIE CHARVET



briefing

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BONUS-funded INNOVATION projects: For healthier marine environment and safety on the sea

The consortia funded from the 'BONUS call 2012: Innovation' have ended their projects' implementation. Thirteen innovation projects have demonstrated that collaboration between industrial and academic partners can produce tangible results that are readily applicable to the current challenges of improving the marine environment and maritime safety on the sea. BONUS projects foster cooperation between countries of the Baltic Sea basin while the results and experience can be applied also in other sea basins. This collaboration benefits both: the industrial partners who recognise the real-life needs and constraints, and research partners who provide the state-of-the-art research and scientific knowledge. The projects contribute directly to the Blue Growth Strategy of the EU especially in areas of maritime safety and Marine Knowledge 2020 as well as the goals of the EU Strategy for the Baltic Sea Region.

■ The 13 projects selected from 33 proposals by international review panel included a total of 53 participants representing all eight BONUS member states of Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Sweden, and one from France. The total costs of the projects amounted to EUR 7.2 million.

The selected projects covered well the three key themes selected from the BONUS strategic research agenda¹ for the call: eco-technological approaches, in-situ remote sensing and laboratory techniques as well as information and communication technology for environment, safety and security.

The best way to prevent the nutrients from ending up in the Baltic Sea is to cycle them

■ With the underlined negative impact nutrients from agriculture and other sources have to the fragile Baltic Sea and its greatest problem of eutrophication, *BONUS PROMISE Phosphorus recycling of mixed substances* tackled an important question of how to improve phosphorus utilisation from manure and sewage sludge and this way prevent phosphorus from ending up in the Baltic Sea. The project found that positive attitude of consumers towards recycled fertilizers is an utmost importance for efficient phosphorus recycling. BONUS PROMISE provided knowledge

on how thermophilic anaerobic digestion and pasteurization may reduce the contamination risk of some pathogens but not those of heavy metals or antibiotics. The study also demonstrated ways to eliminate most of the risks by gasification and further treatment of the ash. These results are now available for the decision makers to promote better quality of recycled fertilizers and to enhance the circular economy of valuable phosphorus resources.

www.bonusportal.org/promise

¹ BONUS strategic research agenda 2011–2017, update 2014. BONUS publication No. 14.

■ Due to the load of phosphorous and nitrogen entering the Baltic Sea, also small dwellings' onsite wastewater treatment is of a great concern which was investigated by **BONUS OPTITREAT** *Optimisation of small wastewater treatment facilities*. A further concern is posed by the load of hazardous substances, especially as while there are numerous onsite wastewater treatment facility alternatives on the market, reduction of hazardous substances has been only sparsely investigated. In remote areas, onsite wastewater treatment is the only option available and besides being relatively cheap constructions, they can also be optimised to mitigate wastewater pollution. The results of BONUS OPTITREAT found ways to improve removal of macropollutants, pharmaceuticals and hormones. BONUS OPTITREAT also delivered recommendations of regulations and support actions on maintenance of small wastewater treatment facilities. All scientific and technological findings within BONUS OPTITREAT have been published and the results are freely available for use of any technological development.

www.bonusportal.org/optitreat

■ **BONUS MICROALGAE** *Cost efficient algal cultivation systems – a source of emission control and industrial development* demonstrated that use of microalgae provides a promising tool for partial nutrient recovery from wastewaters. Wastewaters provide also both the growth medium as well as the necessary nutrients required for cultivation of algae. Wastewater composition is a very important factor when considering microalgae treatment as a potential step within a wastewater treatment process. Nutrient uptake by algae can vary a lot depending on the species as well as the quality of wastewaters, e.g. the content of nutrients and their ratio. BONUS MICROALGAE found that development of two-phase cultivation strategies could be feasible and provide a cost-efficient solution: first microalgae are kept in optimal growth conditions to generate high biomass yield, and then stressed to increase the high added value products content in the same biomass. Furthermore, wider use of microalgae could be enhanced by supporting research on cost-efficient industrialisation of algae production following the wastewater based algae-to-fuel approach, conducting market surveys about potential products, and by creating markets for new products. Also, commercialisation of microalgae could be enhanced by integrating the delivery of multiple products (e.g. fertilizers, high-value products, biofuel) and services (e.g. nutrient harvesting from wastewaters) and by internalising social and environmental benefits of algae cultivation and its biomass.

www.bonusportal.org/microalgae

Innovative solutions for improved safety in the harbours and at the sea

■ **BONUS ANCHOR** *The captain assistant system for navigation and routing during harbour operations* looked at what kind of solutions are needed to improve safety and efficiency of harbour operations. BONUS ANCHOR provided a digital 'captain assistant' for navigation and routing of large ship operations in harbour areas. It piloted a satellite-based assistance and navigation system targeting the approach of large vessels to (and from) dedicated docking positions in harbours. It offers a unique tool to analyse the influence of the traffic within coastal areas and to raise safety and efficiency of maritime traffic. The prototype has been introduced to a broad audience of stakeholders and potential users and now the environmental footprint of each ship can be now followed, analysed and assessed.

www.bonusportal.org/anchor

■ A novel citizens' crowdsourcing solution has been developed for increased sharing of and access to the maritime information by **BONUS ESABALT** *Enhanced situational awareness to improve maritime safety in the Baltic*. Conventionally, each information source has its own ecosystem and should be monitored independently. The novel BONUS ESABALT system, however, integrates various information sources into a common platform: satellites, buoys, commercial and pleasure vessels, autonomous sensor stations and land-based monitoring systems. After having been tested in real environment, the platform is now ready to be deployed and free-to-use by anyone. For instance, marine electronics manufacturer can integrate the BONUS ESABALT capability into their navigational plotters. This means that the new information platform offers a huge innovation and commercialisation potential to any European commercial manufacturer of maritime products and services.

www.bonusportal.org/esabalt



PHOTOS: ROBERT GUINNESS



Maritime test and data collection campaign onboard the VikingLine cruise ship M/S Amorella, BONUS ESABALT.

Boosted oil detection and pollution prevention above and below the sea surface

■ **BONUS GEOILWATCH Geopositional early warning system integration for disaster prevention in the Baltic Sea** integrated sensor data from multiple sources to tackle the critical problem of detecting oil spills on the sea. The project's aim was to reduce substantially the number of unnoticed oil spills. The innovative data management system gathers together data from Ferryboxes (automated monitoring systems on ships-of-opportunity), from drifters, from aerial monitoring using flying drone-devices and from satellites. Novel algorithms developed in the project allow satellite data to be used for detection of oil on seawater. A proof-of-concept of a data interface with the web platform that has resulted from the project provides now timely key data on oil spills.

www.bonusportal.org/geoilwatch

■ An add-on module to the existing onboard oily water separator system was developed by **BONUS ZEB Zero emissions in the Baltic Sea** and is now commercially available. By developing such device BONUS ZEB aims towards a Zero Emission concept for oily water emissions by large ships. The project conducted state-of-the-art research in pollutant concentration in bilge waters while it also studied and refined commercial bilge water

cleaning system in real-life environment. The target of the proof-of-concept is to remove pollutants to the level comparable to the standard drinking water. The results of the life cycle assessment performed indicated that the major ecological problems associated with the bilge water discharges relate to emissions of metals to the seawater.

www.bonusportal.org/zeb

■ **BONUS SWERA Sunken wreck environmental risks assessment** developed a new approach to the risk analysis of sunken wrecks. The new approach combines a novel oil removal risk analysis tool into the existing and widely used risk assessment tool VRAKA. This provides solid basis for more successful and economical salvage operations. The new tool and the knowledge of the academic partners were demonstrated and validated in real operational situations by the industrial partner using state-of-the-art technologies such as remotely operated underwater robots. BONUS SWERA project's results are of great importance to the HELCOM Submerged working group.

www.bonusportal.org/swera



The setup in the Wärtsilä facility (l.); filter cassettes (middle); bilge water after treatment in the add-on module (r.), BONUS ZEB.

Instruments and environmental monitoring for better insights of the state of the sea

■ A close-to-market prototype of a pH measurement system for application in the widest range of conditions encountered in the Baltic Sea has been developed by **BONUS PINBAL Development of a spectrophotometric pH-measurement system for monitoring the Baltic Sea**. A strong emphasis in the project was put on the needs for an instrument allowing a long-term traceable, accurate and precise monitoring of pH in the Baltic Sea that meets the requirements of the HELCOM Baltic Sea Action Plan and the EU Marine Strategy Framework Directive. In a broader perspective, BONUS PINBAL is regarded as a major step towards the vision of a full carbon system monitoring in the Baltic Sea, providing a valuable state-of-the-art approach for the assessment of acidification as well as eutrophication. The new system determines pH by injecting a pH-sensitive dye into a continuous sample stream (FIA approach) and allows for the measurement of samples from a continuous water flow, as well as for discrete sample analysis. Market launch of the instrument is planned for spring 2018.

www.bonusportal.org/pinball

■ Through development of the autonomous *in situ* fixation multi-sampler AFISsys, **BONUS AFISMON Development of the current Automatic Flow Injection Sampler to monitor microbially driven biogeochemical processes in the Baltic Sea water** has provided the basis for the generation of high-resolution and non-biased functional microbial genetic profiles. This will have tremendous impact on the scientific community involved in the study of microbial functions, but will also have wider societal implications. AFISsys constitutes an invaluable tool for the integration of molecular functional analyses in environmental monitoring in the Baltic Sea and in aquatic environments in general. One example of projected use of the AFISsys platforms is the project's plan to use the AFISsys to establish a long-term high-resolution survey of the waters of German Baltic coast. The eastern Baltic coast of Germany is the site of *Vibrio* infections ever summer and the AFISsys will be put to use to test if the presence of *Vibrio* can be detected early enough for the prevention of infections. This would also provide a possible proof-of-concept that the AFISsys can be efficiently used to establish unprecedented monitoring strategies in the Baltic Sea.

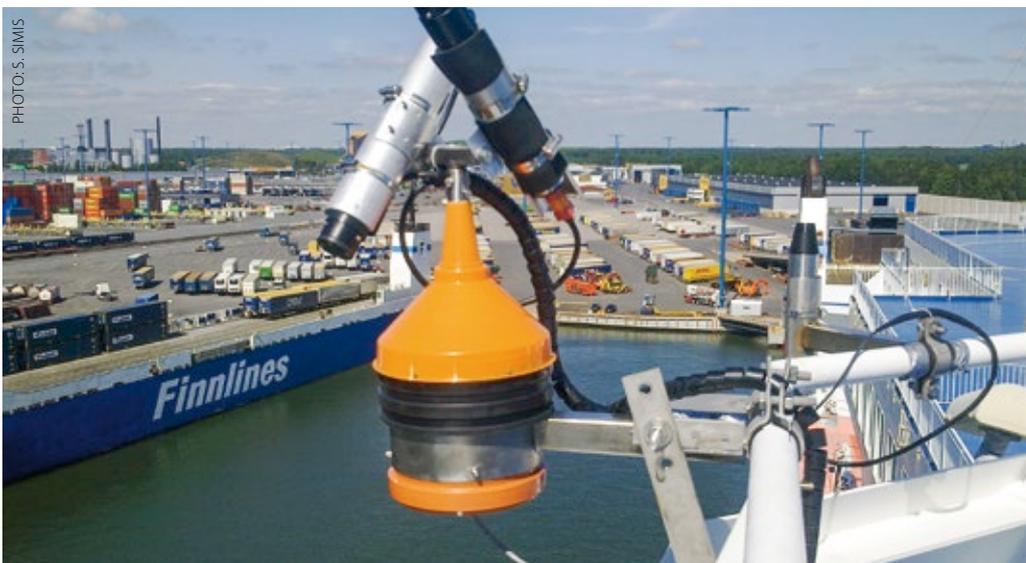
www.bonusportal.org/afismon

■ The applied open-source technology developed by **BONUS FERRYSCOPE** *Bridging the divide between satellite and shipborne sensing for Baltic Sea water quality assessment* is ready to be commercialised. The project focussed on sensor fusion to improve the assessment of the seawater quality. Both satellite and shipborne optical measurement data are integrated to generate a situational view of the water quality using the advanced algorithms and models developed in the project. The end-users, national monitoring agencies and researchers have been familiarised to the new system to ensure the deployment of the results.

www.bonusportal.org/ferryscope

■ Coastal radars have been used by Finnish Meteorological Institute since 2011. They provide a cost effective way to monitor marine environment e.g. determining environmental parameters such as ice drift and concentration as well as wave characteristics, and identifying oil and biogenic slicks in the Baltic Sea. **BONUS HARDCORE** *Harnessing coastal radars for environmental monitoring purposes* extended both the capabilities of the servers and the server network. The project work consisted collecting of data for development and research, radar software development, and radar backscattering research as well as two new installations with end user portal setup to the Tallinn Bay and to Szczecin Lagoon which are important navigationally. A marketable system has resulted from research results on environmental parameter extraction that have been implemented to the radar software.

www.bonusportal.org/hardcore



Installation of the Rflx system to collect data, BONUS FERRYSCOPE.

Robotic fish sensors enable better designed fish passes connected to the Baltic Sea

■ **BONUS FISHVIEW** *Assessing fish passages by the use of a robotic fish sensor and enhanced digital imaging* focussed on developing, testing and implementing a new technology to improve fish passages analysis in rivers connected to the Baltic Sea. BONUS FISHVIEW used a novel approach to give researchers the ‘inside view’ of a river pass by designing a ‘robotic fish’ that experiences water flows similar to the lateral line sensing organ of fish. This device immersed in three different ‘river fish passes’ recorded the signals in the flow. The differences between flow patterns provided a new metric to answer the question why are functional fish passes perceived differently from non-functional ones from the “fish’s point of view”. Through analysis, suggested

improvements on how to build fish passes that all migrating fish can use were made with the support of computer simulations. The first contacts with the hydropower companies have been made with BONUS FISHVIEW offering services for on-site inspections. BONUS FISHVIEW research continues currently in Horizon 2020 project FitHydro www.fithydro.eu, started in 2017 and through which BONUS FISHVIEW technologies can be applied all over Europe under a large variety of environmental conditions.

www.bonusportal.org/fishview

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