

BONUS research and innovation projects

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BONUS BAMBI

Baltic Sea marine biodiversity - addressing the potential of adaptation to climate change

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BONUS funding: EUR 3.9 million

Duration: 4 years, 1.1.2014-31.12.2017



The publishable summary of the BONUS BAMBI final report, including the main results achieved during the project, is available online at www.bonusportal.org/bambi

Introduction to the project as first published in BONUS in Brief December 2013

Written by Kerstin Johannesson, Coordinator of BONUS BAMBI

In the face of the rapid, ongoing environmental changes of the Baltic Sea, the survival of marine species is challenged. The potential for a species to adapt to a changing environment is given by its plasticity, demography and genetic diversity. Recent research shows that many of the Baltic Sea species are genetically isolated and have reduced genetic diversity, and hence have a lower adaptive potential than, for example, Atlantic populations. In light of this and the expected rapid change of the Baltic Sea environment, it will be critical - as soon as possible – to manage also today's common Baltic Sea species in an optimal way to mitigate losses of biodiversity. However, current governance structures and policies do not invoke species' evolutionary potentials (=genetic variation), and there are large gaps in the scientific knowledge that is needed to underpin new strategies.

Climate change will have unprecedented consequences for the Baltic Sea ecosystem. Already today, there is a measurable decrease in salinity and an increase in temperature, with further and more dramatic changes predicted. One approach to evaluate effects of climate change on organisms has been to use "climate envelope models". However, such models do not take into account the potential of evolutionary change of a species. Neither do these models take into account population demography, connectivity and species interactions, and thus may seriously misjudge the potential of species to resist rapid climate change.

It is quite obvious that environmental changes impose novel types of selection pressure on individuals and species, and if there is genetic variation for traits affecting fitness, selection will result in evolutionary changes and species may become better adapted to the new environment. It is now clear that evolutionary changes may act rapidly in a time scale relevant to climate changes. But how often will adaptation happen? And how do we conserve potentials of adaptation?

The overall objectives of the project BAMBI are to answer urgent questions, such as: Will species and ecosystems of marine origin have the potential to adapt and survive the coming 50-100 years inside the Baltic Sea? If so, what is needed in terms of population sizes, population connectivity and genetic variation? And, what governance structures, policy instruments and management measures can help provide the required population structures and traits?

BAMBI is a multi-disciplinary project integrating leading research competences in genetics and genomics, population ecology, biophysical modelling, conservation genetic and political sciences. In addition, BAMBI is establishing an

operational science- policy interface and a strong end-user involvement. Furthermore, BAMBI will take advantage of state-of-the-art research methods, such as the next generation sequencing, population genomics, climate-driven and spatially explicit modelling targeting four ecologically important Baltic Sea species that each contribute with different ecosystem functions (primary production, grazing, and predation), and together constitute a dominant part of a Baltic Sea seaweed ecosystem (one fish, two seaweed species, and one crustacean).

A main goal of BAMBI is to introduce new types of scientific data with high relevance for ecosystem-based management of biodiversity under environmental change, and use these results to outline new governance and policy principles. One additional important issue will be to identify governance systems and institutions that are important for the transfer of scientific knowledge on biological diversity into functional management policies and principles.

Project partners

Sweden

University of Gothenburg (coordinating partner)
Luleå University of Technology
Stockholm University

Estonia

Estonian Marine Institute, University of Tartu

Germany

Helmholtz Centre for Ocean Research Kiel

Finland

University of Turku

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

1.2 Causes and consequences of changing biodiversity

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressure

4.1 Governance structures, policy performance and policy instruments

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS BIO-C3

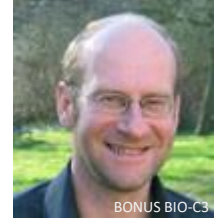
Biodiversity changes - causes, consequences and management implications

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BONUS funding: EUR 3.7 million

Duration: 4 years, 1.1.2014-31.12.2017



The publishable summary of the BONUS BIO-C3 final report, including the main results achieved during the project, is available online at www.bonusportal.org/bioc3

Introduction to the project as first published in BONUS in Brief December 2013

*Written by **Thorsten Reusch**, Coordinator of BONUS BIO-C3*

As a relatively well-studied semi-enclosed ocean basin, the Baltic Sea plays a special role for biodiversity research. Due to its young age and varying salinities only relatively few species are the key ecological players. Along with several available oceanographic and biological time-series, this allows for a systemic analysis of spatial patterns, temporal changes and lays the foundation for experimental work that addresses ecosystem functioning. Moreover, the present species assembly is under constant change, as non-indigenous species continue to establish in the Baltic, climate change alters the physical environment, and fishing changes food webs and predation pressure. Thus, while being species poor, human influences on the Baltic ecosystem are larger than in most other sea regions as this marginal sea is surrounded by densely populated areas, especially in the south and east.

BIO-C3 will investigate causes and consequences of changes in biodiversity, emphasising effects on ecosystem function and implications for environmental management. Applying a novel, integrated approach, biodiversity is addressed on genotype, species, population, trait, habitat and ecosystem levels. On the one hand, the existing biodiversity data and data on potential drivers are collected and synthesized, while on the other, additional research efforts will close important knowledge gaps in several key areas, for example, related to adaptation of organisms to climate change and foodweb alterations due to species invasions.

The key objectives of BIO-C3 are i) an assessment of the relative roles of acclimation, adaptation and colonisation of native vs. non-indigenous species, ii) an advancement of the understanding of functional links between biodiversity, external pressures and food-web interactions and iii) an improvement of our capacity to project future biodiversity.

Using improved knowledge obtained in BIO-C3, and existing large-scale data sets, biodiversity responses in space and time will be addressed by hind-casts and projections of abiotic/biotic/ anthropogenic drivers including their interaction (climate change, eutrophication, species invasions, fisheries) in spatially explicit models.

The participating scientists will take advantage of numerous preliminary and long-term studies of the participating institutes and universities such as studies on fish stocks, plankton organisms and environmental conditions that are conducted several times a year with the help of Kiel's research vessel ALKOR. This could become important when the Baltic continues to experience lower salinity, become warmer and suffer decreasing oxygen levels as predicted.

A central question is whether important organisms such as zooplankton and fish can adapt to the different environmental conditions, and if not, whether they alter their distribution or die out. Using the increased understanding of the processes gained during the course of the project, the scientists will formulate

recommendations on improving the management of the Baltic biodiversity. The identified gradients of human impacts will feed into impact assessments, guiding management policies including improved operationalisation of good environmental status indicators of the EU Marine Strategy Framework Directive, marine protected areas and management evaluation frameworks. Concerning adaptation to the expected climate change, the BIO-C3 researchers will cooperate closely with the BONUS project BAMBI.

Project partners

Germany

Helmholtz Centre for Ocean Research Kiel (coordinating partner)
Institute for Hydrobiology and Fisheries Science, University of Hamburg
Thünen Institute for Baltic Sea Fisheries, Rostock

Denmark

National Institute of Aquatic Resources, Technical University of Denmark, Kongens Lyngby
DHI, Hørsholm

Estonia

Estonian Marine Institute, University of Tartu

Finland

Finnish Environment Institute, Helsinki
Åbo Akademi University, Turku

Lithuania

Marine Science and Technology Center, Klaipėda University

Poland

National Marine Fisheries Research Institute, Gdynia

Sweden

Stockholm University
University of Gothenburg
Swedish Meteorological and Hydrological Institute, Norrköping

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

1.2 Causes and consequences of changing biodiversity

Supplementary themes

1.3 Food web structure and dynamics

2.2 The role of the coastal systems in the dynamics of the Baltic Sea

3.3 Improving stock assessments and resolving spatial heterogeneity and temporal dynamics of the Baltic Sea fish stocks

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS BLUEWEBS

Blue growth boundaries in novel Baltic food webs

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BONUS funding: EUR 2,8 million

Duration: 3 years, 1.4.2017-31.3.2020



The publishable summary of the BONUS BLUEWEBS final report, including the main results achieved during the project, is available online at www.bonusportal.org/bluewebs

Introduction to the project as first published in BONUS in Brief October 2017

*Written by **Laura Uusitalo**, Coordinator of BONUS BLUEWEBS*

BONUS BLUEWEBS sets out to understand the changes in the Baltic Sea food webs, and how the system should be managed in the uncertain future. In order to do this, the project will study the past changes of the system in terms of structure and function, predict how the food web dynamics are likely to change, and how they affect the ecosystem service provision.

Pressure towards the marine environment is increasing, as the humanity is turning towards marine ecosystems as yet-underutilized providers of food, abiotic resources, recreation, and well-being. Initiatives by the UN Food and Agriculture Organization and the EU Blue Growth agenda are recent examples of this will.

In order to guarantee the sustainability of the Baltic Sea socio-ecological system, it needs to be skilfully managed. Sustainable management requires a solid understanding of the current and expected future state of the ecosystem. However, the Baltic is changing in multiple ways that are producing new, previously unseen states and combinations of factors. The changes in the climate, nutrient loading, and fishery, together with the changes introduced to the food webs through establishment of non-indigenous species and the effects of contaminants, produce ecosystem states that have not been observed before. This sets new requirements for the management of the ecosystem: How to manage the environment and its uses so that the ecosystem functioning and, therefore, the ecosystem service provision, will be safeguarded even though we do not know what the future will look like?

BONUS BLUEWEBS sets out to investigate Baltic Sea food webs and how the system should be managed in the uncertain future. Through innovative data analyses, cutting edge trait-based ecology, ecological network analysis and other innovative approaches, e.g. the effects of environmental degradation on the capability of food webs to cycle and transform nutrients and hazardous substances will be assessed.

BONUS BLUEWEBS will also directly provide tools for ecosystem based management, such as indicators for Marine Strategy Framework Directive descriptors and Bayesian Network based decision support systems. Overall, as its major outcome, BONUS BLUEWEBS will provide an assessment of the consequences of achieving a Good Environmental Status (GES) on the capability of Baltic Sea food webs to sustainably produce blue growth. Also, collaboration with stakeholders is embedded into the project in order to facilitate the important two-way information flow between stakeholders and the scientific process.

Project partners

Finland

Finnish Environment Institute, Helsinki (coordinating partner)
Åbo Akademi University, Turku

Germany

Christian-Albrechts-Universität zu Kiel
University of Hamburg

Latvia

Institute of Food Safety, Animal Health and Environment BIOR, Riga

Poland

National Marine Fisheries Research Institute, Gdynia

Sweden

Stockholm University

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

1.3 Food web structure and dynamics

Supplementary themes

- 1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures
- 1.2 Causes and consequences of changing biodiversity
- 4.1 Governance structures, policy performance and policy instruments

BONUS BLUEWEBS is a flagship project in the policy area BIOECONOMY of the EU Strategy for the Baltic Sea Region (EUSBSR).



BONUS XWEBS

Taking stock of Baltic Sea food webs: synthesis for sustainable use of ecosystem goods and services

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BONUS funding: EUR 0,45 million

Duration: 1,8 years, 1.1.2019-31.10.2020



The publishable summary of the BONUS XWEBS final report, including the main results achieved during the project, is available online at www.bonusportal.org/xwebs

Introduction to the project as first published in BONUS in Brief November 2018

Written by **Jan Dierking**, Coordinator of BONUS XWEBS

BONUS XWEBS wants to take stock of the field of food web science in the Baltic Sea region (“what do we know, what do we not know?”), provide a vision for this field for the coming decade (“what do we need to know, and how can we obtain this knowledge?”), and assess barriers standing in the way of the integration of food web knowledge in sustainable management of ecosystems.

Where do we stand regarding Baltic food web knowledge?

Knowledge on Baltic Sea food webs has grown enormously and new methods and approaches have been developed, not least through the targeted efforts of BONUS. Unfortunately, knowledge integration and use in practical management are lagging behind. Moreover, new knowledge gaps have become evident. E.g., our ability to forecast future food web dynamics remains poor, but this information would be essential to allow managers to prepare for and mitigate future changes. Baltic food web science thus stands at a crossroad: a new synthesis, as well as decisions on where to direct future research efforts and on how to best transform and apply food web knowledge in practical management are urgently needed.

Where does BONUS XWEBS come in?

Our aim is to advance the field of Baltic food web science via a systematic review effort including a synthesis of syntheses to reap the harvest of the wealth of new information that has become available from BONUS as well as outside it. This will include topic reviews of particularly dynamic fields, like the food web interactions of non-indigenous species. As second step, we will assess existing knowledge gaps and develop a vision for priority studies in this field. In the more applied management context, we are then interested how complex knowledge can be best funnelled into “simple” decision support with the help of models and indicators. Finally, we will provide a systematic assessment of food web knowledge transfer into management advice and decision making: what is working, where are barriers, what can we improve and how to implement it in practice?

Project approach and call for participation

At the heart of BONUS XWEBS stands a series of scoping and writing workshops, in which we will bring together experts on various aspects of Baltic food webs, including researchers from within and outside BONUS XWEBS and stakeholders (e.g., HELCOM and ICES, but open to others). Watch out for calls for participation in the 2019-2020 XWEBS workshop series – and join us to contribute with your knowledge, views and expertise!

Project partners

Germany

GEOMAR Helmholtz Centre for Ocean Research Kiel (coordinating partner)

Denmark

Technical University of Denmark

Estonia

University of Tartu

Finland

Åbo Akademi University

Themes from the BONUS strategic research agenda, update 2014 covered

1.3 Food web structure and dynamics

1.2 Changing biodiversity

2.2 The role of the coastal systems



BONUS BALTHEALTH

Baltic Sea multilevel health impacts on key species of anthropogenic hazardous substances

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BONUS funding: EUR 2,8 million

Duration: 3 years, 1.4.2017-31.3.2020



The publishable summary of the BONUS BALTHEALTH final report, including the main results achieved during the project, is available online at www.bonusportal.org/balthealth

Introduction to the project as first published in BONUS in Brief October 2017.

*Written by **Rune Dietz**, Coordinator of BONUS BALTHEALTH*

BONUS BALTHEALTH sets out to investigate multilevel food web impacts of man-made pollutants, animal-borne diseases, and climate change in the Baltic Sea. By identifying and quantifying powerful indicators of individual, population, and ecosystem health, the project will provide new knowledge and novel risk assessment tools for Baltic Sea stakeholders.

The Baltic Sea ecosystem has undergone drastic change over the past century as a result of human activities. As is often the case, such change has come along with serious declines in economically and ecologically relevant and charismatic wildlife such as herring, grey and ringed seals, white-tailed eagles and otters. Adding to pollution stress, believed to be the major driver, are other man-made stressors such as shipping and underwater noise, over-fishing and hunting, eutrophication, and a changing climate. At the present day, however, there is little information available to assess the cumulative impacts of multiple stressors on the health of a single species, let alone the food web. It is therefore BONUS BALTHEALTH's aim to investigate multilevel food web impacts of man-made pollutants, animal-borne diseases, and climate change by identifying and quantifying powerful indicators of individual, population, and ecosystem health.

The cross-disciplinary philosophy of BONUS BALTHEALTH aims at a cumulative flow of data and knowledge among its working groups, each operating at the forefront of their specific field. One working group is dedicated to unravel spatial and temporal change in the composition of the Baltic food web using state-of-the-art chemical tracers and modelling approaches. This effort will provide the fundament on which two other working groups add the knowledge on the presence of known and new man-made pollutants as well as animal-borne diseases in the Baltic food web and how they are transferred among species, as well as to humans. Such information will then be combined with the evaluation of current and new health biomarkers. The last working group is tasked to combine all information in a comprehensive modelling framework dedicated to identifying and evaluating population and ecosystem-level health effects. Interwoven through all activities are continuous efforts to assimilate existing and organise project-based data and models pertaining the above efforts, and disseminate major outcomes through public media and the participating national history museums.

BONUS BALTHEALTH is indeed a unique cross-disciplinary synergism of specialists in toxicology, ecology, biogeochemistry, veterinary science, genetics, epizootiology, quantitative biology and conservation. Together, the eleven partners have state-of-the-art expertise, facilities and decades of acquired samples and data. BALTHEALTH is the first endeavour to culminate these in novel risk assessment tools for Baltic stakeholders, including the Marine

Strategy Framework Directive, the Helsinki Commission, the International Council of Exploration of the Sea, the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, and the International Union for Conservation of Nature.

Project partners

Denmark

Aarhus University, Department of Bioscience, Roskilde (coordinating partner)
University of Copenhagen, Natural History Museum of Denmark

Belgium

University of Antwerp

Canada

Carleton University, Ottawa

Finland

Natural Resources Institute Finland, Helsinki
University of Turku, Department of Biology

Germany

Umweltbundesamt, Dessau-Rosslau
University of Veterinary Medicine Hannover

Norway

Norwegian Institute of Nature Research, Tromsø

Sweden

Maritimas AB, Kärna
Stockholm University - Department of Environmental Science and Analytical Chemistry
Swedish Museum of Natural History, Stockholm
University of Gothenburg - Department of Biological and Environmental Sciences
Umeå University - Department of Chemistry

United States of America

Tufts University – Cummings School of Veterinary Medicine, North Grafton
Massachusetts Institute of Technology - Department of Biological Engineering, Cambridge
University of Connecticut - Department of Pathobiology and Veterinary Science

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

1.4 Multilevel impacts of hazardous substances

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures

1.3 Food web structure and dynamics

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

BONUS MICROPOLL

Multilevel assessment of microplastics and associated pollutants in the Baltic Sea

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BONUS funding: EUR 2,6 million

Duration: 3,25 years, 1.7.2017-30.9.2020



The publishable summary of the BONUS MICROPOLL final report, including the main results achieved during the project, is available online at www.bonusportal.org/micropoll

Introduction to the project as first published in BONUS in Brief October 2017.

*Written by **Sonja Oberbeckmann**, Coordinator of BONUS MICROPOLL*

BONUS MICROPOLL focuses on the multilevel impacts of microplastics themselves, of associated pollutants and of attached biofilms on the Baltic Sea ecosystem. The project aims at the assessment of the risks originating from microplastics, the development of indicators, and the suggestion of cost-effective and user-friendly monitoring strategies regarding microplastics and associated pollutants.

The scientific, public, and political awareness of the plastic accumulation in our global oceans has increased in recent years. Rough estimations assume a yearly plastic input into the marine environment of several million metric tons. A large amount of the plastic in the oceans are small particles <5mm, so-called microplastics. While a growing number of studies report on the distribution of microplastics in sediment, water, and even sea ice, the ecological consequences of this pollution are as of yet hardly understood.

Regarding the Baltic Sea, very few data exist. These do not allow for a comprehensive overview of the distribution, sources and sinks of microplastics, let alone the impact on the Baltic foodweb. Approximately 85 million residents live in the drainage area of the Baltic Sea, implying high human induced stress. In consequence, a notable microplastics accumulation in the Baltic Sea can be assumed.

BONUS MICROPOLL will determine the hazard potential and impacts of these substances by several means. It will set out to detect the recent status regarding microplastics in the Baltic Sea (abundance, composition, sources, sinks) and explore the vector function of microplastics for associated pollutants and microorganisms. Furthermore, through *in situ* and laboratory experiments, the project aims to expose marine organisms from different trophic levels to defined levels and size classes of microplastics and persistent organic pollutants. The gained knowledge will enable us to create spatio-temporal scenarios and simulations for microplastics transfer and circulation. This in turn will help us to understand the mitigation processes of microplastics and associated pollutants/biofilms in the Baltic Sea. One anticipated project result is the creation of a GIS -based Baltic Marine (Micro) Litter Atlas entailing a broad range of spatial microplastics data, expandable with other litter fractions.

We are aiming at the assessment of the risks originating from microplastics, the development of indicators, and the suggestion of cost-effective and user-friendly monitoring strategies regarding microplastics and associated pollutants. This way, the project can directly contribute to the implementation of the Marine Strategy Framework Directive. One potential application to reach good ecological status will be evaluated within the project, namely a

wastewater treatment technology, which retains efficiently microplastics and xenobiotics. The project results, in particular the monitoring and mitigation strategies, will be discussed with end users and other stakeholders in an annual end user forum.

Project partners

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock (coordinating partner)

Leibniz Institute of Polymer Research Dresden

Estonia

Tallinn University of Technology

Lithuania

Klaipeda University

Poland

National Marine Fisheries Research Institute, Gdynia

Sweden

IVL Swedish Environmental Research Institute, Stockholm

Stockholm University

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

1.4 Multilevel impacts of hazardous substances

Supplementary themes

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS SOILS2SEA

Reducing nutrient loadings from agricultural soils to the Baltic Sea via groundwater and streams

Geological Survey of Denmark and Greenland, Denmark

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BONUS funding: EUR 3.2 million

Duration: 4,25 years, 1.1.2014-31.3.2018



The publishable summary of the BONUS SOILS2SEA final report, including the main results achieved during the project, is available online at www.bonusportal.org/soils2sea

Introduction to the project as first published in BONUS in Brief December 2013

*Written by **Jens Christian Refsgaard**, Coordinator of BONUS SOILS2SEA*

Both the Baltic Sea Action Plan and the EU Water Framework Directive requires substantial further reductions of nutrient loads (N and P) to the Baltic Sea during the coming years. Achievements of these goals will only be possible by the implementation of fundamental changes in agricultural practices and land use. This will require the introduction of additional new and innovative measures, because the easiest applicable measures have, in most cases, already been utilised.

SOILS2SEA proposes to exploit the fact that the retention (removal by biogeochemical processes or sedimentation) of nutrients in groundwater and surface water systems shows a significant spatial variation, depending on the local hydrogeological and riverine regime to achieve the goals for nutrient load reduction set out in the Baltic Sea Action Plan. The traditional uniform regulations do not account for local data and knowledge and are much less cost-effective than spatially differentiated regulations with measures targeted towards areas where the natural retention is low. In order to fully exploit the potential of differentiated regulations it is required to utilise all local information and find locally designed and optimised solutions. Besides the need for improved knowledge on the subsurface and nutrient transport and retention processes on a local scale, this calls for new innovative governance regimes with active involvement of key stakeholders. Not the least as the new measures most probably will differentially affect stakeholder groups with conflicting interests.

If we more accurately can predict where in a catchment N and P are retained by estimating the retention in the different compartments along the flow path, and also include the delayed effects of mitigation measures due to long solute travel times in groundwater, then we can more cost-effectively design measures to reduce the nutrient loads to the Baltic Sea. SOILS2SEA will therefore study the retention of N and P between the soils/sewage outlets and the coast, including transport pathways such as overland flow and flows in macropores, subsurface tile drains, shallow and deep groundwater, rivers, wetlands and lakes. The concept and the Soils- 2Sea work packages are illustrated in the figure below.

The key outcomes of SOILS2SEA will be:

- New methodologies for the planning of differentiated regulations based on new knowledge of nutrient transport and retention processes between soils/sewage outlets and the coast.
- Evaluation of how differentiated regulation can offer more cost efficient solutions towards reducing the nutrient loads to the Baltic Sea.

- Analysis of how changes in land use and climate may affect the nutrient load to the Baltic Sea as well as the optimal location of measures aiming at reducing the load.
- A high-resolution model for the entire Baltic Sea Basin with improved process descriptions of nutrient retention in groundwater and surface water tailored to make detailed simulations of management regulations differentiated in space.
- New knowledge based governance and monitoring concepts that acknowledge the relevant aspects of EU directives and at the same time are tailored towards decentralised decision making. The proposed spatially differentiated regulations will aim for incorporation of local scale knowledge to optimally design solutions.

Project partners

Denmark

Geological Survey of Denmark and Greenland, Copenhagen (coordinating partner)
Aarhus University
Sorbisense A/S, Tjele
Eurofins Miljø A/S, Vejle

Germany

Ecologic Institute GmbH, Berlin

Poland

AGH University of Science and Technology, Krakow

Russia

Atlantic Branch of P.P.Shirshov Institute of Oceanology of the Russian Academy of Sciences, Kaliningrad

Sweden

KTH Royal Institute of Technology, Stockholm
Swedish Meteorological and Hydrological Institute, Norrköping

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of e.g. agriculture, forestry and urbanisation

Supplementary themes

4.1 Governance structures, performance and policy instruments

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS COCOA

Nutrient COcktails in COAstal zones of the Baltic Sea - Improving understanding of the transformation and retention of nutrients and organic matter in the coastal zone

Aarhus University, Denmark

jac@dmu.dk

BONUS funding: EUR 4.0 million

Duration: 4 years, 1.1.2014-31.12.2017



The publishable summary of the BONUS COCOA final report, including the main results achieved during the project, is available online at www.bonusportal.org/cocoa

Introduction to the project as first published in BONUS in Brief December 2013

*Written by **Jacob Carstensen**, Coordinator of BONUS COCOA*

Eutrophication caused by excessive discharges of nutrients from land is the largest ecological problem in the Baltic Sea. Consequences are large blooms of noxious cyanobacteria in summer and an unprecedented large dead zone extending more than 60,000 km², equivalent to the size of Latvia. Nutrient reductions are required to reestablish a healthy Baltic Sea, as acknowledged in the Baltic Sea Action Plan.

The coastal zone constitutes an important filter regulating nutrient inputs from land to the open sea. Nutrients are transformed and removed in a complex mosaic of processes by microbial communities, plants and animals with environmental conditions, such as salinity and oxygen concentrations, modulating the process rates. The project COCOA will investigate how these nutrient processes are regulated across different coastal zones around the Baltic Sea and how nutrient retention can be improved through coastal zone management.

COCOA will study seven coastal ecosystems in detail, representing four types of coastal systems: 1) river-dominated estuaries, 2) lagoons, 3) embayments with restricted water exchange, and 4) archipelagos. Using state-of-the-art techniques, nutrient transformation and removal rates will be measured during field campaigns at these learning sites to obtain an improved seasonal description across various coastal habitats, characterised by different salinity, temperature, nutrient, oxygen and light conditions as well as different benthic communities. These measurements will be used to improve the process description in current coastal ecosystem models, scaling-up knowledge obtained from the field measurement to the ecosystem level. This will allow quantifying nutrient retention across the many different coastal zones around the Baltic Sea and assessing the overall coastal nutrient retention. Experimental work and modelling are equally important in COCOA, and linking knowledge across disciplines will have particular focus in the project.

The improved understanding of the mechanisms regulating nutrient transformation and removal will be used to assess if changes in nutrient retentions may have occurred over time. In most parts of the Baltic Sea the coastal zone has undergone severe changes over the last century. Productive benthic habitats have disappeared due to reduced water transparency shading out the benthic vegetation and oxygen depletion changing faunal communities. These changes are believed to have ramifications for the removal and transformation of nutrients in the coastal zone, and consequently the nutrient filter capacity.

Using the established knowledge on nutrient processing in different coastal habitats, COCOA will investigate if coastal nutrient retention may similarly have changed over time with the loss of certain benthic communities. The potential loss of coastal nutrient retention has consequences for the export of nutrients from land to the open Baltic Sea, and this will affect nutrient reduction targets in the Baltic Sea Action Plan required to establish HELCOM's ecological objectives. COCOA will address how nutrient reductions may affect pelagic and benthic communities as well as the nutrient removal in the coastal zone.

Project partners

Denmark

Aarhus University (coordinating partner)
Technical University of Denmark, Kongens Lyngby

Finland

Åbo Akademi University, Turku
Finnish Environment Institute, Helsinki
University of Helsinki

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

Lithuania

Marine Science and Technology Center, Klaipėda University

The Netherlands

Utrecht University

Poland

University of Gdańsk

Russia

Zoological Institute of Russian Academy of Sciences, St. Petersburg

Sweden

University of Gothenburg
Lund University
Stockholm University
Swedish Meteorological and Hydrological Institute, Norrköping

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.2 The role of coastal systems in the dynamics of the Baltic Sea

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures

1.2 Causes and consequences of changing biodiversity

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures



BONUS BALTCOAST

A systems approach framework for coastal research and management in the Baltic

Leibniz Institute for Baltic Sea Research Warnemünde, Germany

gerald.schernewski@io-warnemuende.de

BONUS funding: EUR 2.9 million

Duration: 3 years, 1.4.2015-31.3.2018



The publishable summary of the BONUS BALTCOAST final report, including the main results achieved during the project, is available online at www.bonusportal.org/baltcoast

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Gerald Schernewski**, Coordinator of BONUS BALTCOAST*

The Baltic Sea is one of the most intensely exploited seas of the world. A balance between exploitation and protection on the basis of scientific expertise is needed to enable a sustainable use without the destruction of valuable ecosystem services.

BALTCOAST aims at further developing a stepwise, userfriendly method of practical relevance which allows a systematic input of scientific findings into societal processes, policy making and the complex management of coastal areas and seas.

The approach will be applied in six local coastal case studies in a systematic, stepwise, guided process to demonstrate its value and applicability for a wide range of highly relevant issues namely eco-technologies (mussel farms, artificial macrophyte belts) to support eutrophication management and local development in the Oder (Szczecin) Lagoon; channel deepening to support shipping and tourism development in the Vistula lagoon; developments towards a bathing water quality management system to support bathing tourism in the Curonian Lagoon; coastal municipal governance optimisation to support climate change adaptation in municipality of Salacgrīva, Bay of Riga; integrated coastal protection management in Pärnu, Bay and fish distribution; productivity & management in Danish coastal waters.

The System Approach Framework will also be applied in at least 15 in-depth retrospective analysis cases. Re-analysis studies of documented best practice cases of Coastal Zone Management (CZM) in the Baltic Sea region highlight the potential benefits of a System Approach Framework application and provide feedback for its improvement.

BALTCOAST gathers partners from seven Baltic Sea countries, runs from 1 April 2015 for three years and will be funded with ca. EUR 3 million. It is coordinated by the Leibniz Institute for Baltic Sea Research Warnemünde, Prof. Dr. Gerald Schernewski. For further information please visit our website: www.baltcoast.net.

Project partners

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock (coordinating partner)

Denmark

Technical University of Denmark - National Institute of Aquatic Resources, Copenhagen

Estonia

Institute of Ecology, Tallinn University

Latvia

University of Latvia, Riga

Lithuania

Marine Science and Technology Centre, Klaipeda University

Poland

Institute of Hydro-Engineering, Polish Academy of Sciences, Gdansk

Sweden

Swedish University of Agricultural Sciences, Uppsala

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.3 Integrated approaches to coastal management

Supplementary themes

4.1 Governance structures, policy performance and policy instruments

4.2 Linking ecosystem goods and services to human lifestyles and well-being

4.3 Maritime spatial planning from local to Baltic Sea region scale

BONUS CLEANWATER

Eco-technological solutions to remove micro-pollutants and micro-plastic from contaminated water

Aarhus University, Denmark

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BONUS funding: EUR 2,7 million

Duration: 3 years, 1.4.2017-31.3.2020



The publishable summary of the BONUS CLEANWATER final report, including the main results achieved during the project, is available online at www.bonusportal.org/cleanwater

Introduction to the project as first published in BONUS in Brief October 2017.

Written by Kai Bester, Coordinator of BONUS CLEANWATER

BONUS CLEANWATER aims at developing innovative eco-technologies to decrease input of organic micro-pollutants and microplastic particles into the Baltic Sea. Current wastewater technology is designed to remove (big) particles, matter that consumes oxygen if degraded in the surface waters as well as nutrients. To be able to achieve also removal of micropollutants and microplastics, BONUS CLEANWATER is aiming to substantially develop biofilm technology, ozonation, and membrane based technologies to tackle compounds such as pharmaceuticals and biocides.

To this end, BONUS CLEANWATER will conduct process development and optimisation with the help of pilot reactors that are able to treat several hundred liters to several m³ per hour. This will allow insights into costs as well as life cycle assessment.

Biofilm technology used in BONUS CLEANWATER, such as the moving bed biofilm reactor (Veolia Water Technology, SE), has the potential to treat large amounts of water such as in centralised wastewater treatment. It will also be tested, whether this technology can be operated together with an eco-effective ozonation reactor (Primozone, SE) to remove the last remaining products from a chemical oxidation.

Furthermore, the project will operate two porous medium biofilm reactors that are seen as i) a potential to treat waste and stormwater in decentralised installations (Aarhus University), as well as ii) a big chance to remove microplastic particles that could otherwise only be controlled using membrane separations.

Also, two kinds of membrane technologies are used in BONUS CLEANWATER: A membrane bioreactor equipped with innovative ceramic membranes (Liqtech, DK) that have the potential for adapting sludge biomass for the removal of micro-pollutants and using the microfiltration membrane for microplastic removal. Biomimetic forward osmosis membranes (Aquaporin, DK) for the targeted and low energy removal of organic micropollutants will also be studied.

Additionally BONUS CLEANWATER is assessing whether organic micropollutants and microplastics enter the Baltic Sea via (treated) wastewater or at times when strong rains result in overflowing sewers by combined sewer overflow or via rainwater wash-off. Preliminary results indicate towards the wastewater being the dominant source.

Finally, BONUS CLEANWATER will also develop innovative analytical tools for the determination of organic micropollutants and microplastics. Organic micropollutants will be collected by means of membrane based passive sampling with an inbuilt cleaning step (Aarhus University). Microplastics have until recently been analyzed by light

microscopy and visual inspection of the particles but BONUS CLEANWATER intends to move to a level of semi-automated system with inbuilt IR spectra comparison to databases (Aalborg University).

The academic partners will help the companies with dedicated further development of process understanding, specialised measurements, as well as assessment of scenarios, including life cycle and cost benefit assessments.

The utilities involved (BIOFOS and the consortium represented by Sweden Water Research) are supporting the project with basic measurements, making their treatment plants available for testing as well as providing a reality check.

Project partners

Denmark

- Aarhus University (coordinating partner)
- Aalborg University
- Aquaporin A/S, Copenhagen
- BIOFOS A/S, Copenhagen
- LiqTech International A/S, Ballerup

Germany

- German Federal Institute of Hydrology, Koblenz

Sweden

- Lund University
- Primozone Production AB, Löddeköpinge
- Sweden Water Research AB, Malmö
- Veolia Water Technology, Lund

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

- 2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

- 1.4 Multilevel impacts of hazardous substances
- 5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques



BONUS MICROALGAE

Cost efficient algal cultivation systems – a source of emission control and industrial development

Tallinn University of Technology, Estonia

arvo.iital@ttu.ee

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.2.2014-31.1.2017



The publishable summary of the BONUS MICROALGAE final report, including the main results achieved during the project, is available online at www.bonusportal.org/microalgae

Introduction to the project as first published in BONUS Briefing 29

*Written by **Arvo Iital**, Coordinator of BONUS MICRALGAE*

BONUS MICROALGAE 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.

Project partners

Estonia

Tallinn University of Technology (coordinating partner)

Denmark

Technical University of Denmark, Kgs. Lyngby

Sweden

SocEco Analysis & Education, Helsingborg

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressure

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of e.g. agriculture, forestry and urbanisation

3.5 Sustainable aquaculture in the Baltic Sea

4.1 Governance structures, policy performance and policy instruments

BONUS OPTITREAT

Optimization of small wastewater treatment facilities

IVL Swedish Environmental Research Institute

helene.ejhed@ivl.se

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.2.2014-31.1.2017



The publishable summary of the BONUS OPTITREAT final report, including the main results achieved during the project, is available online at www.bonusportal.org/optitreat

Introduction to the project as first published in BONUS in BONUS Briefing 29

*Written by **Heléne Ejhed**, Coordinator of BONUS OPTITREAT*

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. 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.

Project partners

Sweden

IVL Swedish Environmental Research Institute, Stockholm (coordinating partner)

Germany

Development and Assessment Institute in Waste Water Technology, RWTH Aachen University

Poland

The Institute for Ecology of Industrial areas, Katowice

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

1.4 Multilevel impacts of hazardous substances

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of e.g. agriculture, forestry and urbanisation

4.1 Governance structures, policy performance and policy instruments

BONUS PROMISE

Phosphorus recycling of mixed substances

Natural Resources Institute Finland

eila.turtola@luke.fi; kari.ylivainio@luke.fi

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.4.2014-31.3.2017



The publishable summary of the BONUS PROMISE final report, including the main results achieved during the project, is available online at www.bonusportal.org/promise

Introduction to the project as first published in BONUS Briefing 29

*Written by **Kari Ylivainio**, Coordinator of BONUS PROMISE since 1 January 2016*

*(Coordinator of BONUS PROMISE until 31 December 2015 **Eila Turtola**)*

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 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.

Project partners

Finland

Natural Resources Institute Finland, Jokioinen (coordinating partner)

Germany

Julius Kühn-Institut, Quedlinburg

Outotec GmbH, Oberursel

Sweden

National Veterinary Institute, Uppsala

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of agriculture, forestry and urbanization

2.2 The role of the coastal systems in the dynamics of the Baltic Sea

BONUS PROMISE is a flagship project in the policy area BIOECONOMY of the EU Strategy for the Baltic Sea Region (EUSBSR).





BONUS RETURN

Reducing emissions by turning nutrients and carbon into benefits

Stockholm Environment Institute, Sweden

marcus.carson@sei-international.org

BONUS funding: EUR 3 million

Duration: 3,5 years, 1.5.2017-31.10.2020



The publishable summary of the BONUS RETURN final report, including the main results achieved during the project, is available online at www.bonusportal.org/return

Introduction to the project as first published in BONUS in Brief October 2017.

*Written by **Marcus Carson**, Coordinator and **Brenda Ochola**, Communications Officer of BONUS RETURN*

Degradation of the Baltic Sea due to marine and land pollution is an on-going problem. Its ecosystems are threatened, thus endangering its current and future benefits to society. We must act quickly to save our sea, protect marine life, and support people. BONUS RETURN aims to support smart innovative solutions, with market-readiness of its eco-technologies at the core of its approach tackling these problems.

Previous efforts to address deterioration of Baltic ecosystem have focused primarily on technology and lacked the engagement of a broader range of stakeholders in the market. Moreover, investments in measures to reduce pollutants and nutrients are often designed based on single objectives that limit opportunities for multiple benefits. BONUS RETURN shifts the mode of thinking about what has been considered waste materials in the past, i.e. unwanted, unusable, and undesirable substances. It aims to employ ecologically friendly and helpful technologies to convert what might otherwise have been waste or pollutants into useable, valuable materials – and to do so in an ecologically friendly manner.

The project brings together a variety of stakeholders – researchers, policymakers, municipalities, investors, innovators and civil society – to find practical solutions for reducing nutrients and carbon and turning this waste into profit. The project sets out to engage scientists and policy makers to reduce knowledge gaps on policy performance through researching which technologies work, where, and under what conditions.

The process includes the identification of existing eco-technologies for re-using nutrients and assessing their economic, social, health, technical and environmental sustainability. It will assess the effectiveness of these eco-technologies in reducing nutrients, phosphorous and carbon at the environmental modelling stage, and finally, deploy them by using test-beds and commercialisation in our case study sites in Sweden, Finland and Poland.

The project envisions a collaborative approach with small and medium enterprises (SMEs) that produce these eco-technologies, and they will be engaged through interactive platforms of knowledge exchange to have access to the project's outputs, networks, established methodologies and services.

The focus will be on systematic eco-technologies that reduce present and future pollution in marine environments, also addressing regional challenges such as policy coherence, food security, energy security and the provision of ecosystem services.

A key strength of BONUS RETURN lies in its unique focus on a combination of societal needs and technological strengths. The project envisions win-win solutions that will combine traditional technologies with innovative development addressed to ecosystems, society, and the economy in a sustainable manner. With sustainability at the core of project goals, the model will be adaptable to future societal changes and conservation challenges.

Project partners

Sweden

Stockholm Environment Institute, Stockholm (coordinating partner)

RISE Research Institutes of Sweden, Borås

Uppsala University - Campus Gotland, Visby

Denmark

University of Copenhagen

Finland

Finnish Environment Institute, Helsinki

Poland

Warsaw University of Life Sciences

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

4.1 Governance structures, policy performance and policy instruments

5.3 User-driven new information and communication services for marine environment, safety and security in the Baltic Sea area

BONUS SWERA

Sunken wreck environmental risk assessment

Finnish Environmental Institute

Jorma.Rytkonen@ymparisto.fi

BONUS funding: EUR 0.4 million

Duration: 2 years, 1.5.2014-30.4.2016



The publishable summary of the BONUS SWERA final report, including the main results achieved during the project, is available online at www.bonusportal.org/swera

Introduction to the project as first published in BONUS Briefing 29

*Written by **Jorma Rytkönen**, Coordinator of BONUS SWERA*

BONUS SWERA 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.

Project partners

Finland

Finnish Environment Institute, Helsinki (coordinating partner)
Alfons Håkans Ltd, Turku

Estonia

Marine Systems Institute, Tallinn University of Technology

Sweden

Chalmers University of Technology, Gothenburg

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

1.4 Multilevel impacts of hazardous substances

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

3.2 Assessing the effects of air and water pollution and introduction of energy (including noise) by shipping activities on the marine environment and integrated water management in harbours

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures



BONUS ZEB

Zero emissions in the Baltic Sea

IVL Swedish Environmental Institute

hulda.winnes@ivl.se

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.6.2014-31.5.2016



The publishable summary of the BONUS ZEB final report, including the main results achieved during the project, is available online at www.bonusportal.org/zeb

Introduction to the project as first published in BONUS Briefing 29

*Written by **Hulda Winnes**, Coordinator of BONUS ZEB since 01.05.2015*

*(Coordinator of BONUS ZEB until 01.05.2015 **Fredrik Norén**)*

An add-on module to the existing onboard oily water separator system was developed by BONUS ZEB 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.

Project partners

Sweden

IVL Swedish Environmental Institute, Stockholm (coordinating partner)
Wärtsilä Sweden AB, Gothenburg

Finland

Wärtsilä Oy, Helsinki

Lithuania

Marine science and Technology Centre, Klaipeda University

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

Supplementary themes

1.4 Multilevel impacts of hazardous substances

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

3.2 Assessing the effects of air and water pollution and introduction of energy (including noise) by shipping activities on the marine environment and integrated water management in harbours

Theme 3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

BONUS STORMWINDS

Strategic and operational risk management for wintertime maritime transportation system

Aalto University, Finland

pentti.kujala@aalto.fi

BONUS funding: EUR 1.8 million

Duration: 3 years, 1.4.2015-31.3.2018



The publishable summary of the BONUS STORMWINDS final report, including the main results achieved during the project, is available online at www.bonusportal.org/stormwinds

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Floris Goerlandt**, Research scientist*

*(Coordinator of BONUS STORMWINDS **Pentti Kujala**)*

Maritime transportation is of vital importance to the countries surrounding the Baltic Sea area. During winter, ship navigation is challenging due to the presence of sea ice. Navigational accidents occur rather frequently. While these usually lead to minor consequences, there is a risk of serious accidents harming the marine environment.

The STORMWINDS project aims to contribute science-based analyses and practice-oriented tool developments for enhancing maritime safety and accident response, during winter in the northern Baltic Sea. Consequently, regional and subregional policies highlight the need for developing preventive measures to improve the safety of navigation in ice conditions. A key aspect is strengthening the cooperation between organisations facilitating safe navigation, and safety management tools available to these organisations.

The first research theme addresses accident prevention through the development and application of systems-theoretical accident theories to the vessel control system. This is manifested in two development paths. The first concerns the development and application of a new framework for maritime risk management, linking systems-theoretic accident theories to maritime spatial planning tools and processes.

The second development path builds on systems-theoretic accident theories to develop an indicators-based safety management model for Vessel Traffic Services (VTS). A second research theme addresses accident prevention through the development of e-navigation services, focusing on information and route planning services to support voyage planning in sea ice environments. One development concerns methods for classifying satellite images in terms of expected ship performance. Another development concerns a method for optimal routing in actual sea ice environment, accounting for both efficiency and safety. These methods can be implemented in onboard navigation equipment as an additional information layer and used in operational planning.

A third research theme addresses pollution response in winter conditions. A risk management model is developed to support policy decisions related to the organization of the pollution response fleet. Questions such as the appropriate number, location and equipment of response vessels are addressed through a risk analysis which integrates navigational accident and traffic system analyses, future sea ice climate scenarios and accidental spill and recovery modeling. Another development path addresses improvements in situation awareness tools for use in accident response operations. Several web-based applications are developed for improved tracking of oil spills in sea

ice environments and for integrating information services relevant for operational decision making in spill response operations. Thus, STORMWINDS aims to advance maritime risk analysis and management, taking an interdisciplinary approach to improve maritime safety.

Project partners

Finland

Aalto University, Espoo
Finnish Meteorological Institute, Helsinki
National Land Survey of Finland, Finnish Geospatial Research Institute, Helsinki
Novia University of Applied Sciences, Turku
Finnish Environment Institute, Helsinki

Estonia

University of Tartu
Tallinn University of Technology

Russia

Institute of Numerical Mathematics, Russian Academy of Sciences, Moscow

Sweden

Swedish Meteorological and Hydrological Institute, Norrköping

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

Supplementary themes

4.1 Governance structures, policy performance and policy instruments
4.3 Maritime spatial planning from local to Baltic Sea region scale
5.3 User-driven new information and communication services for marine environment, safety and security in the Baltic Sea area

BONUS STORMWINDS is a flagship project in the policy area SAFE of the EU Strategy for the Baltic Sea Region (EUSBSR).



Theme 3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

BONUS BALTIMARI

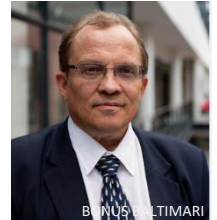
Review, evaluation and future of Baltic risk management

Aalto University, Finland

pentti.kujala@aalto.fi

BONUS funding: EUR 0,45 million

Duration: 1,75 years, 1.10.2018-30.6.2020



The publishable summary of the BONUS BALTIMARI final report, including the main results achieved during the project, is available online at www.bonusportal.org/baltimari

Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Pentti Kujala** Coordinator of BONUS BALTIMARI and **Ketki Kulkarni**, BONUS BALTIMARI*

The BONUS BALTIMARI sets out to review the current state-of-the-art in risk analysis and decision support, focusing on the Baltic Sea area. We target the areas of Maritime transportation systems (MTS) and offshore energy production systems (OEPS). In collaboration with stakeholders, we aim to identify priorities for future research in risk management.

Review of current state-of-the-art

We review several R&I projects in the Baltic Sea area which have developed analysis methods for decision support in accident prevention, response and risk mitigation. The key factors that will be studied are:

- Utility: cost-effectiveness and technology readiness level
- Quality of the underlying evidence
- Firmness of the method's scientific basis
- Existing knowledge gaps
- Intended end users.

Evaluation of and assessment of uptake of past R&I

The assessment of R&I investigates whether the results of research are being used in practice. We aim to understand factors affecting successful uptake of R&I. We will compile a document of best practices based on interactions with relevant stakeholders. Selected projects with varying uptake and of different budgets in different organizations will be analysed through interviews. Evaluation of uptake will involve understanding the end users' thoughts on R&I. This will help identify pathways for improving the transfer of research to industry and policy environments.

Identification of knowledge gaps

Knowledge gaps related to risks in the MTS and OEPS, e.g. related to human behaviour aspects, autonomous vessels, and environmental pollution will be identified, along with gaps in analysis and decision support tools.

During its 18-month implementation period, BONUS BALTIMARI aims to complete:

- State-of-the-art reviews of maritime risk analysis and decision support systems for shipping and offshore energy
- Report on the uptake of R&I actions for relevant end-users and make suggestions for improvements
- Systematic overview of main knowledge gaps and future R&I through identification of risks in the MTS and OEPS
- Policy briefs directed at policy makers and industry stakeholders.

We are now reaching out to industry and public end-users and stakeholders with previously implemented research. If you are interested in identifying gaps and setting priorities for future research or you have an experience to share with us, please email: [ketki.kulkarni\(at\)aalto.fi](mailto:ketki.kulkarni(at)aalto.fi) and get involved!

Project partners

Finland

Aalto University, Espoo (coordinating partner)

University of Helsinki

Estonia

University of Tartu

Germany

Hochschule Wismar

Poland

Gdynia Maritime University

Sweden

World Maritime University

Themes from the BONUS strategic research agenda, update 2014 covered

3.1 Maritime risk analysis and management

3.2 Effects of air and water pollution by shipping

5.3 User-driven ICT services



BONUS SHEBA

Sustainable shipping and environment of the Baltic Sea region

IVL, Swedish Environmental Research Institute

jana.moldanova@ivl.se

BONUS funding: EUR 2.9 million

Duration: 3,3 years, 1.4.2015-31.7.2018



The publishable summary of the BONUS SHEBA final report, including the main results achieved during the project, is available online at www.bonusportal.org/sheba

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Jana Moldanová**, Coordinator of BONUS SHEBA*

SHEBA brings together lead experts from the fields of ship emissions, atmospheric, acoustic and oceanic modelling, atmospheric and marine chemistry, marine ecology, environmental economics, social sciences, logistics and environmental law in order to provide an integrated and in-depth analysis of the ecological, economic and social impacts of shipping in the Baltic Sea and to support development of the related policies on EU, regional, national and local levels.

The objectives of SHEBA are:

1. Update shipping activity data using Automatic Identification System (AIS) data from HELCOM and data on activity data for pleasure boats.
2. Determine today's scenario of shipping emissions, different categories of water pollutants, noise and production of liquid and solid waste as a function of vessel activity.
3. Assess the current situation of air and water pollution from shipping and the effects of scenario emission changes in the Baltic Sea region and in selected harbours by means of modelling systems.
4. Conduct an impact assessment of ship generated underwater noise in the Baltic Sea area using a proxy for the shipping induced noise.
5. Develop an analytical framework for the integrated assessment of effects of shipping and harbours in the Baltic Sea region.
6. Assess changes in ecosystem services in different shipping scenarios compared to a Baseline.
7. Evaluate various technology and policy options to reduce pressures and impacts from shipping and harbours in the Baltic Sea and identify and analyse trade-offs between these options as well as marginal changes in costs and benefits (Cost-Benefit Analyses).
8. Make inverted model scenarios in order to propose required levels of actions which would ensure that the impact from shipping will not escalate due to forecasted growth.

SHEBA will analyse the drivers for shipping, obtain the present and future traffic volumes and calculate a set of scenarios which will then feed into calculations of emissions to water, to air, and of underwater noise using and extending the currently most advanced emission model based on AIS ship movement data. Atmospheric, oceanic and noise propagation models in combination with ecotoxicology studies will then be used to assess spatiotemporal distributions, fates and effects of these stressors in the Baltic Sea region.

The project will assess the impact of different pollutants to the water quality indicators of the Marine Strategy Framework Directive and Water Framework Directive and to air quality indicators. Further, the project will provide an integrated assessment of policy options to mitigate pressures linked to shipping, quantifying as far as possible anticipated changes in ecosystem services compared to an established baseline. This will include an analysis of trade-offs between options as well as synergies, and the marginal changes in costs and benefits of options to reduce environmental pressures from shipping and support the achievement of Good Environmental Status as prescribed by the Marine Strategy Framework Directive.

SHEBA is supported by a wide group of stakeholders, including harbours, shipping industry and authorities, who will be consulted about the input of data, feedback and results of the project. A stakeholder workshop and a conference on the impact of shipping on environment in the Baltic Sea region will be organised by the project as well as a number of activities and products aiming to rise the public awareness in this issue.

Project partners

Sweden

IVL, Swedish Environmental Research Institute, Stockholm
Chalmers University of Technology, Gothenburg
Swedish Defence Research Agency, Stockholm

Denmark

University of Southern Denmark, Odense

Estonia

Marine Systems Institute, Tallinn University of Technology

Finland

Finnish Meteorological Institute, Helsinki
Finnish Environment Institute, Helsinki

France

Centre National de la Recherche Scientifique, Marseille Interdisciplinary Centre for Nanoscience

Germany

Helmholtz Zentrum Geesthacht, Centre for Materials and Coastal Research
Ecologic Institute, Berlin

Poland

Maritime Institute in Gdansk

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

3.2 Assessing the effects of air and water pollution and introduction of energy (including noise) by shipping activities on the marine environment and integrated water management in harbours

Supplementary themes

4.1 Governance structures, policy performance and policy instruments
4.3 Maritime spatial planning from local to Baltic Sea region scale

BONUS SHEBA is a flagship project in the policy area SHIP of the EU Strategy for the Baltic Sea Region (EUSBSR).

BONUS INSPIRE

INtegrating SPatial pRocesses into Ecosystem models for sustainable utilisation of fish resources

Estonian Marine Institute, University of Tartu

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BONUS funding: EUR 3.6 million

Duration: 4 years, 01.02.2014-31.01.2018



The publishable summary of the BONUS INSPIRE final report, including the main results achieved during the project, is available online at www.bonusportal.org/inspire

Introduction to the project as first published in BONUS in Brief December 2013

*Written by **Henn Ojaveer**, Coordinator of BONUS INSPIRE*

Process-based understanding of changes in spatial distributions of commercial fish, disentangling the role of natural drivers and various human induced impacts form the challenging topic for the research project INSPIRE. The project sets out to fill in the most persistent gaps in knowledge of the spatial ecology of the major commercial fish and thereby support the effectiveness of the relevant policies and ecosystem based management of the Baltic Sea. The project aims to serve as a "framework axis project" to which other Baltic Sea research could link to.

INSPIRE is designed to substantially advance our knowledge on the major commercial fish species in the Baltic Sea (cod, herring, sprat and flounder). These fish form more than 95% of the commercial catches, and represent key elements of the Baltic Sea ecosystems.

The objectives of the INSPIRE project are to:

1. Quantify processes generating heterogeneity in spatial distributions of cod, herring, sprat and flounder.
2. Quantify and map potential hazards to the connectivity between identified key habitats, and assess the impact of human induced and climatic environmental changes on habitat connectivity.
3. Quantify the population dynamics and interactions of the fish species in a spatially explicit context.
4. Develop spatially explicit advice for ecosystem-based fisheries management of Baltic cod, herring, sprat and flounder, accounting for the spatial heterogeneity in fish distributions.

To accomplish these objectives, INSPIRE will answer the following fundamental research questions:

1. What are the marine habitat conditions that characterise the spatial distributions of cod, herring, sprat and flounder?
2. To what extent do fishing and species interaction affect the local and basin-scale distribution of commercially exploited stocks?
3. What drives spatial connectivity and migrations of different fish species/populations?
4. How does stock structure and separation of natural populations impact stock assessment outcomes?

INSPIRE proposes pilot ecosystem field surveys to resolve the habitat requirements of different life-stages of fish species by combined use of traditional methods and application of modern advanced analysis techniques, for example otolith microchemistry and biochemical techniques. The surveys are conducted in close collaboration with local fishermen. Their inclusion will strengthen their participatory spirit in the implementation of INSPIRE results into ecosystem-based fisheries management, and improve the data collection.

INSPIRE will generate new data and operational models that allow making projections on spatial distributions of key commercial fish species of the Baltic on different spatial and temporal scales, and their integration in analytical assessments and ecosystem-based fisheries management. Moreover, as main providers of management advice on Baltic fish stocks, INSPIRE partners are also able to translate these model outputs into urgently needed advice on how to move best beyond spatially homogeneous approach of current fishery and ecosystem assessments, and adopt spatially explicit ecosystem-oriented management. The INSPIRE project is addressing major research objectives set forth by the revised EU Common Fisheries Policy, the EU Marine Strategy Framework Directive, the EU Marine and Maritime Research Strategy and the HELCOM Baltic Sea Action Plan.

Stakeholder involvement starts already at the data generation phase and continues till the end of the project. The major stakeholders include Baltic Sea Regional Advisory Council, International Council for the Exploration of the Sea and the Baltic Marine Environment Protection Commission. In addition, INSPIRE will closely cooperate with national fisheries management bodies and ministerial authorities.

Project partners

Estonia

Estonian Marine Institute, University of Tartu (coordinating partner)

Denmark

National Institute of Aquatic Resources, Technical University of Denmark, Kongens Lyngby

Finland

Natural Resources Institute Finland, Helsinki

Germany

Thünen Institute for Baltic Sea Fisheries, Rostock

Institute for Hydrobiology and Fisheries Science, University of Hamburg

Helmholtz Centre for Ocean Research Kiel

Latvia

Institute of Food Safety, Animal Health and Environment, Riga

Poland

National Marine Fisheries Research Institute, Gdynia

Sweden

Lund University

Stockholm University

Swedish University of Agricultural Sciences, Uppsala

Uppsala University, Campus Gotland, Visby

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

3.3 Improving stock assessments and resolving spatial heterogeneity and temporal dynamics of the Baltic Sea fish stocks

Supplementary themes

1.2 Causes and consequences of changing biodiversity

1.3 Food web structure and dynamics

3.4 Evaluation framework for fisheries management

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS CLEANAQ

Innovative removal of N, P and organic matter in effluents from recirculating aquaculture systems

Technical University of Denmark, National Institute of Aquatic Resources

pbp@aqua.dtu.dk

BONUS funding: EUR 1 million

Duration: 2,75 years, 1.4.2017-30.12.2019



The publishable summary of the BONUS CLEANAQ final report, including the main results achieved during the project, is available online at www.bonusportal.org/cleanaq

Introduction to the project as first published in BONUS in Brief October 2017

*Written by **Per Bovbjerg Pedersen**, Coordinator of BONUS CLEANAQ*

To sustain the development of nutrient-balanced aquaculture in the Baltic area, BONUS CLEANAQ sets out to develop innovative solutions for cost-efficient end-of-pipe treatment by removing nitrate and phosphorus. The project aims to contribute to the development of a sustainable aquaculture production in the Baltic area that provides many possibilities for aquaculture industry to thrive and grow.

Aquaculture is an efficient way of producing fish for the growing human population. It is already providing 50% of the fish used for human consumption (FAO 2017). However, the huge growth in aquaculture has largely happened outside the Baltic Sea region as existing eutrophication in Baltic waters limits the possibilities of getting licenses for traditional cage farming.

Recirculation is a potential solution for farming fish with minimum environmental impact. The technology has developed rapidly in recent years, and recirculating aquaculture systems (RAS) are now build worldwide to support further increase in aquaculture production in a sustainable manner.

Fish farming in RAS provides possibilities for optimized food production for the benefit of the environment, and farming in closed confinements virtually eliminates the risk of escapees and diseases spreading to the environment. Within the recirculation loop in RAS, nutrients are mainly converted and subsequently removed from the farming system through particle separation and water replacement. Hence, current RAS technology uses much less make-up water than classical aquaculture systems allowing nutrients to accumulate within the system. From the concentrated effluent, these nutrients might be removed in subsequent processes termed end-of-pipe treatment.

However, although recirculation technology has reached a fully commercial scale, practical and cost-efficient solutions for removing or retrieving the concentrated nutrients from the RAS discharge are still missing, in particular for brackish and salt-water farming. To sustain the development of nutrient-balanced aquaculture in the Baltic area, BONUS CLEANAQ will develop innovative solutions for cost-efficient end-of-pipe treatment by removing nitrate and phosphorus.

We will investigate the applicability of removing nitrate through single-sludge denitrification using the fish waste as a carbon source for nitrogen removal. Also, with the use of woodchip-beds for nitrogen removal we will investigate carbon-free woodchip denitrification, and we will study non-microbial nutrient removal methods. For all methods,

we seek to identify the optimal conditions and the most feasible process design applicable for the different salinities prevailing in the Baltic Sea area.

As for concomitant phosphorous removal, we will examine the most cost-efficient and environmentally sustainable treatment method or combination of treatment methods available. We will also explore the biogas potential of the retained sludge and thus examine the potential of integrating RAS end-of-pipe treatment and energy production.

Through the project, we anticipate to contribute to the development of a sustainable aquaculture production in the Baltic Sea area. Rural areas and water access combined with good infrastructure, skilled labour, technical skills and supply-industries all provide a solid base for recirculating aquaculture. If the challenges of cost-efficient nutrient removal can be solved we foresee great possibilities for the region to participate in the fast growing aquaculture sector.

Project partners

Denmark

Technical University of Denmark, National Institute of Aquatic Resources, Kongens Lyngby (coordinating partner)

Billund Aquakulturservice A/S

KSK Aqua Aps., Skive

Sashimi Royal A/S, Bedsted Thy

Finland

Gala Mare Oy, Turku

Natural Resources Institute Finland, Helsinki

University of Jyväskylä

Sweden

KTH Royal Institute of Technology, Stockholm

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

3.5 Sustainable aquaculture in the Baltic Sea

Supplementary themes

2.3 Integrated approaches to coastal management

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

BONUS FLAVOPHAGE

Bacteriophage based technology for pathogen control in aquaculture

University of Copenhagen, Department of Biology, Denmark

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BONUS funding: EUR 2,2 million

Duration: 3,6 years, 1.4.2017-31.10.2020



The publishable summary of the BONUS FLAVOPHAGE final report, including the main results achieved during the project, is available online at www.bonusportal.org/flavophage

Introduction to the project as first published in BONUS in Brief October 2017

Written by **Mathias Middelboe**, Coordinator of BONUS FLAVOPHAGE

The aim of the BONUS FLAVOPHAGE project is to go beyond the currently used medical approaches for disease treatment in rainbow trout aquaculture in the Baltic Sea, and develop alternative environment-friendly approaches based on natural microbial warfare, with the help of bacteriophages. Ultimately, the project aims to produce a series of prototype 'phage-based' applications with the potential for global commercialization.

Fish production in aquaculture is a fast growing industry which supports an increasing global demand for high quality protein and healthy food. In the Baltic Sea region, rainbow trout is the most important farmed fish species, with an annual production of >200.000 tons. However, diseases caused by bacterial pathogens at the larval and fry stages of trout production are a major bottleneck in trout farming and cause economic losses to the industry. Especially the bacteria *Flavobacterium psychrophilum* and *Flavobacterium columnare* cause serious disease outbreaks in most rainbow trout hatcheries throughout the Baltic Sea, with mortalities of up to 80-90% if left untreated. Currently, antibiotics are used to treat infections with these important pathogens, despite serious concerns about the development of bacterial antibiotic resistance. Resistance against some of the approved drugs has been found, and because of the environmental reservoir of these pathogens, fish are repeatedly challenged and often re-infected.

Hence a strong demand for alternatives to the traditional chemical treatment exists. BONUS FLAVOPHAGE utilises the infective properties of bacteriophages to prevent and control *Flavobacterium* pathogens in trout farming. Bacteriophages are viruses that infect bacteria. Like all other organisms, bacteria become infected and killed by viruses. Viral infections can rapidly spread among bacterial populations, and by lysing the cells bacteriophages can efficiently destroy specific bacterial pathogens.

Bacteriophages are naturally present in the aquaculture environments and in BONUS FLAVOPHAGE these will be isolated, purified and characterised and subsequently proliferated in large scale bioreactors. The purified bacteriophages will be coated onto fish feed using a novel immobilization technology that stabilises the bacteriophages and increases shelf life of the product. Finally, the bacteriophage-coated feed will be administered to rainbow trout fry to prevent and control *Flavobacteria* infections.

While there is a very strong potential in using bacteriophages to control pathogens in aquaculture, the technology is still in the early stage of development. The project's goal is to develop industrially relevant bacteriophage applications which contribute to future's sustainable and productive aquaculture by improving fish health and reducing antibiotic use. By combining expertise on fish diseases and bacteriophage biology with expertise on biotechnological application of bacteriophages and representatives from the aquaculture industry, BONUS

FLAVOPHAGE aims at exploring the biological and commercial potential for developing this biotechnological use of bacteriophages. Ultimately, the expected outcome of the project is a series of prototype phage-based applications with the potential for global commercialization. This research will thus help to fulfil public expectations via identifying new sustainable practices to achieve good environmental status in the Baltic Sea aquaculture.

Project partners

Denmark

University of Copenhagen, Department of Biology (coordinating partner)

Technical University of Denmark, National Veterinary Institute, Frederiksberg

Finland

University of Jyväskylä

Åbo Akademi University, Turku

Poland

Phage Consultants Marcin Łoś, Gdansk

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

3.5 Sustainable aquaculture in the Baltic Sea

Supplementary themes

1.2 Causes and consequences of changing biodiversity

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

BONUS OPTIMUS

Optimisation of mussel mitigation cultures for fish feed in the Baltic Sea

Technical University of Denmark, National Institute of Aquatic Resources

jekjp@aqua.dtu.d

BONUS funding: EUR 2,9 million

Duration: 3 years, 1.4.2017-31.3.2020



The publishable summary of the BONUS OPTIMUS final report, including the main results achieved during the project, is available online at www.bonusportal.org/optimus

Introduction to the project as first published in BONUS in Brief October 2017

*Written by **Jens Kjerulf Petersen**, Coordinator of BONUS OPTIMUS*

Aquaculture of extractive species, such that derive nutrition from their natural surroundings and do not require any external feeding, can be of critical means in maintaining long-term sustainability of blue growth. In particular mussel farming provides an extractive aquaculture crop that is widely recognised to possess the largest potential in relation to production volume, economic viability, and ecological sustainability in nutrient rich systems. By harvesting the farmed mussels, nutrients – captured as mussel tissue – are removed from the aquatic environment, thereby creating a truly circular economy. In addition, mussel filtration improves water clarity by reducing concentrations of particles like phytoplankton. The BONUS OPTIMUS project will investigate mussel production potential in the Baltic Sea. By exploring the possibilities of using payment schemes for ecosystem goods and services from mussel farming in Baltic contexts, new incentives for mussel production can open doors for a different perspective to both mussel production and blue economy.

As the Baltic Sea is already heavily exploited and subject to multiple human induced stressors, the ambition of the EU to boost blue economy must in the Baltic be aligned with long-term sustainability. For a variety of reasons, mussel farming in the Baltic Sea area is not very well developed compared to the rest of the European waters. For example, producing mussels in the central part of the Baltic is challenged by low salinities not favoring mussel growth.

In BONUS OPTIMUS, existing mussel production units in Sweden and Denmark as well as a new pilot unit established in Germany will be followed. Different production methods will be tested with the aim to optimise nutrient removal. Special focus will be placed on applying relevant methods for low salinity areas and on transferring knowledge on mussel farming techniques. By employing advanced monitoring technologies and through dynamic multi-scale modelling, the impact of mussel farms on key indicators of water quality used in the EU Water Framework Directive will be demonstrated. The models will provide maps of impact and will be used to demonstrate the feasibility of using mussel farming to mitigate effects of excess load of nutrients to the coastal environment. Together with the analysis of different schemes for the payment of ecosystem services of the mussel farming, calculations of total costs and profits for mussel farms will be delivered to promote and support profitable and sustainable blue growth.

Noteworthy is that mussels produced in low salinity conditions may not be suited for the market for human consumption. BONUS OPTIMUS will provide documentation for the use of mussel meal as an ingredient in fish feed, thereby providing an alternative sustainable protein source to imported soybean or fishmeal. Furthermore, the

project will address the important issue of social acceptance. If mussel farming or other blue growth activities generate local hostility, blue growth will fail in feasibility. In BONUS OPTIMUS, we will investigate and promote social acceptance through various mapping and survey activities.

Project partners

Denmark

Technical University of Denmark, National Institute of Aquatic Resources, Kongens Lyngby (coordinating partner)

Aarhus University

GRAIN Wood A/S, Erslev

Hjarnø Havbrug A/S, Juelsminde

Germany

EUCC - Die Kuesten Union Deutschland e.V., Rostock

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

Poland

Institute of Oceanology of the Polish Academy of Sciences, Sopot

Sweden

Swedish University of Agricultural Sciences, Uppsala

University of Gothenburg

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

3.5 Sustainable aquaculture in the Baltic Sea

Supplementary themes

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

4.2 Linking ecosystem goods and services to human lifestyles and well-being

4.3 Maritime spatial planning from local to Baltic Sea region scale

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

BONUS CHANGE

Changing antifouling practices for leisure boats in the Baltic Sea

RISE Research Institutes of Sweden

mia.dahlstrom@ri.se

BONUS funding: EUR 3.9 million

Duration: 4 years, 1.1.2014-31.12.2017



The publishable summary of the BONUS CHANGE final report, including the main results achieved during the project, is available online at www.bonusportal.org/change

Introduction to the project as first published in BONUS in Brief December 2013

*Written by **Mia Dahlström**, Coordinator of BONUS CHANGE*

A staggering 3.5 million leisure boats have their homeports in the Baltic Sea. Eighty per cent of these boats have paints containing toxic heavy metals and organic booster biocides that prevent growth of benthic organisms, so called biofouling, on their hulls. These toxins pose a serious threat to the sensitive coastal waters of the Baltic Sea. Biofouling makes boats run slower, increases fuel consumption and impairs maneuverability.

Biofouling is combated by toxic heavy metals used in paint formulations that, in order to be effective, will leak its content to the marine environment. What is left of the paint at the end of the boating season is scraped off at the boat yard. Toxic heavy metals in the scraped off paint ends up on the ground and is further transported to the ground water or to the sea close to the marina. This procedure is repeated year after year. Thus, it is an unacceptable risk to the Baltic Sea ecosystem, including humans in the region, to allow the continued use of toxic heavy metals in antifouling paints.

Highly promising solutions, that in an environmentally safe way combat biofouling, are emerging. However, for these to make it into eco-innovations, changes are needed on all levels of society – from the outline of the regulatory framework to changes in market actors including leisure boating cultures and institutions.

The CHANGE project brings together scientists from natural science, business administration and environmental law to develop entirely new ways of solving an environmental problem. The CHANGE project sets out to map changes needed to reduce the supply of toxic antifouling compounds to the Baltic Sea environment and provide new powerful instruments for Baltic Sea policies.

The most important and urgent challenges in the field of antifouling toxins are that consumer antifouling needs are currently met through a) conventional toxic products and b) boating practices embedded in various Baltic boating cultures. The current legal framework and the influence of conventional market actors mean eco-innovations are not seen as the necessary or preferred option to combat marine biofouling. The performance of eco-innovations or paints with low biocide content has low credibility with consumers. The most commonly used toxin in marine paints is copper. To date what is known about the effects of copper on non-target organisms is minimal. CHANGE will, during the next four years, study the performance of available products and the effect of copper on sensitive ecosystemshaping behaviours in marine organisms such as mate search and homing. We will also map the legal framework and perform in-depth studies to thoroughly understand consumer practices related to boating behaviour and boating use. Understanding boat owners' patterns of behaviour is essential for the policy and regulative aspects

of CHANGE. Bans or legal restrictions alone might not result in the desired effect. The CHANGE project includes building communication networks and developing strategies for stakeholder collaboration and training. The CHANGE project has a strong regional aspect and similar studies and collaborative processes will be performed in Sweden, Finland and Germany.

Project partners

Sweden

RISE Research Institutes of Sweden, Borås (coordinating partner)
(Chalmers University of Technology, Gothenburg – *until 31.12.2016*)
(SIK – the Swedish Institute for Food and Biotechnology, Gothenburg – *merged with RISE*)
Stockholm University
University of Gothenburg

Denmark

University of Copenhagen, Frederiksberg

Finland

Aalto University, Espoo

Germany

Laboratory for Freshwater, Marine Research and Comparative Pathology, Hamburg

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.1 Governance structures, policy performance and policy instruments

Supplementary themes

1.4 Multilevel impacts of hazardous substances

2.2 The role of the coastal systems in the dynamics of the Baltic Sea

BONUS CHANGE is a flagship project in the policy area HAZARDS of the EU Strategy for the Baltic Sea Region (EUSBSR).



BONUS GO4BALTIC

Coherent policies and governance of the Baltic Sea ecosystems

Aarhus University, Denmark

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BONUS funding: EUR 2 million

Duration: 3,75 years, 1.4.2015-31.12.2018



The publishable summary of the BONUS GO4BALTIC final report, including the main results achieved during the project, is available online at www.bonusportal.org/go4baltic

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Berit Hasler**, Coordinator of BONUS GO4BALTIC*

Eutrophication is one of the most critical environmental problems of the Baltic Sea. HELCOM has set ambitious targets for nutrient reductions to the Baltic Sea in the Baltic Sea Action Plan (BSAP). The ultimate impact of efforts to reduce the eutrophication of the Baltic Sea is tightly linked to design and stringency of agricultural and climate policies. Coherence between these policy areas is therefore necessary, as improved synergies would most likely increase efficiency of them all.

Agriculture is an important source of nutrient loading to the Baltic Sea. The development of the agricultural sector and its technologies for nutrient management, and the level of environmental concern among farmers, affect nutrient loads to the sea. In the same way, greenhouse gas emissions are influenced by agricultural and environmental policy actions – some actions to reduce nutrients also reduce greenhouse gases, but others have the opposite effect.

BONUS GO4BALTIC will:

- analyse how the BSAP can be implemented cost-effectively throughout the Baltic Sea region,
- measure the effectiveness of existing policies in terms of creating incentives for technological innovation and development to reduce nutrient losses from agriculture,
- analyse how future agricultural and climate policy developments influence the achievement of nutrient load reductions to the Baltic Sea, and
- analyse how farmers adapt to the current and future policies in different parts of the Baltic Sea region.

We anticipate that the analysis of these problems in BONUS GO4BALTIC will produce relevant results and recommendations for the implementation of the BSAP, the EU Water Framework Directive and the Marine Strategy Framework Directive which are implemented in the member states. We also anticipate that the results will be useful for recommendations on future adjustment of agricultural and climate policies. The aim is to find solutions where policies can be coherently developed while taking advantage of potential synergies.

Specific focus will be put on the incentives for technological development for fertiliser use and handling of manure. As there is little quantitative knowledge and data about fertiliser use and handling of manure in the countries around the Baltic, the BONUS GO4BALTIC project will make a comprehensive farmer survey where we will ask farmers about their practice and also about how they will adapt to hypothetical, but realistic, future policy changes in environmental, climate and agricultural policies. A specific focus will be on farmers handling of manure (amounts,

timing, application methods etc.). The survey will be submitted to representative samples of farmers in Denmark, Sweden, Poland and Estonia. Contrary to former studies of nutrient handling and measures to reduce nutrient losses in agriculture, we will retrieve information from farmers on their decisions and trade-offs between agricultural production and environmental protection. We will pay attention to their choices of subsidy schemes and how they respond to other policy instruments.

The BONUS GO4BALTIC project research approach is social science-oriented and involves close cooperation with natural scientists. We build on former BONUS projects as well as the cooperation within the Baltic Stern network and with the Baltic Nest Institute. Recommendations from the research will be presented as a “Baltic Sea Socioeconomic Action Plan” (BASAP), proposing policy improvements in both the short- and long-term.

Project partners

Denmark

Aarhus University (coordinating partner)

Estonia

Stockholm Environment Institute Tallinn Centre

Finland

University of Helsinki

Natural Resources Institute Finland, Helsinki

Poland

University of Warsaw

Sweden

Swedish University of Agricultural Sciences, Uppsala

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.1 Governance structures, policy performance and policy instruments

Supplementary themes

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of e.g. agriculture, forestry and urbanisation

2.4 Eco-technological approaches to achieve good ecological status in the Baltic Sea

4.2 Linking ecosystem goods and services to human lifestyles and well-being

BONUS GOHERR

Integrated governance of Baltic herring and salmon stocks involving stakeholders

University of Helsinki, Finland

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BONUS funding: EUR 1.9 million

Duration: 3,25 years, 1.4.2015-30.6.2018



The publishable summary of the BONUS GOHERR final report, including the main results achieved during the project, is available online at www.bonusportal.org/goherr

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Päivi Haapasaari**, Principal investigator, University of Helsinki*

*(Coordinator of BONUS GOHERR **Sakari Kuikka**)*

Baltic salmon and herring provide a rich source of Omega3 fatty acids and vitamin D for seafood consumers. However, they also absorb high concentrations of dioxin and dioxin-like PCBs, which accumulate in the food-chain and are harmful to human health. The EU has banned the selling of food items containing dioxins above the defined maximum levels. Therefore, salmon and herring with high levels of dioxins are not allowed to be marketed within the EU. Only Finland and Sweden have an exemption for marketing them without restrictions, within their national boundaries. Latvia has an exemption for salmon. The permits oblige the states to inform their citizens about the negative health impacts of the fish, by recommendations on their maximum intake.

Inevitably, the toxins decrease the attractiveness of the Baltic fish for consumers. This may have impacts on consumer choice, the fisheries management decisions, fishing, the fish populations, and thereby the whole Baltic Sea ecosystem.

A decrease in dioxin concentration would likely raise the socio-cultural and economic value of Baltic salmon and herring. Healthy, safe fish would be more desired by people favouring local ecological food, seafood with ethnic flavours such as sushi, or other modern food trends. Increased use of local fish could replace imported fish and other less sustainable or less ethical food resources in the Baltic Sea area, and open new export market. This would create a more stable basis for a viable fishing industry, and provide employment and better opportunities for coastal communities. Improving the image of Baltic Sea fish might boost the image of the whole Baltic Sea.

In BONUS GOHERR, fisheries scientists, social scientists, and public health scientists, will put concerted effort into solving the dioxin problem by building a holistic map that consists of ecological, social, and human health-related pieces. The main question is whether a more comprehensive understanding of the social-ecological system around salmon and herring can influence decision-making that results in reduced toxicants in these fish species, simultaneously considering the sustainable use of the resources. GOHERR will produce new knowledge inter alia on the following issues:

- the predator-prey interrelationship between salmon and herring
- the accumulation mechanisms of dioxin in fish, and the potential of selective fishing to reduce dioxin concentration in salmon and herring
- consumers' fish eating habits today and in the future, and the impact of this on the fish stocks

- impacts of the consumption of Baltic salmon and herring on human health
- the socio-cultural importance, values, and use of Baltic salmon and herring, and the impact of these on the governance, policies and policy performance of these fisheries, today and in the future
- ecosystem-based management.

GOHERR involves stakeholders in designing and evaluating novel nested and regionalised participatory governance structures for the integrated management of salmon and herring. The final output of the project will be a decision support model that informs about the optimal decisions to reach social, human health-related and ecological aims, and about the optimal type and structure of governance. The project combines the health of the Baltic Sea with the health of humans, and the dynamics of the ecosystem with human values.

Project partners

Finland

University of Helsinki

University of Oulu

National Institute for Health and Welfare, Helsinki

Denmark

Aalborg University

Sweden

Swedish University of Agricultural Sciences, Uppsala

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.1 Governance structures, policy performance and policy instruments

Supplementary themes

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

4.2 Linking ecosystem goods and services to human lifestyles and well-being

BONUS MIRACLE

Mediating integrated actions for sustainable ecosystems services in a changing climate

Linköping University, Sweden

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BONUS funding: EUR 1.9 million

Duration: 3,3 years, 1.4.2015-31.7.2018



The publishable summary of the BONUS MIRACLE final report, including the main results achieved during the project, is available online at www.bonusportal.org/miracle

Introduction to the project as first published in BONUS in Brief May 2015

Written by **Karin Tonderski**, Coordinator of BONUS MIRACLE

More than 85 million people live in the Baltic Sea catchment area, and around 60–70 % of the land is farmland. Thus the agriculture and wastewater treatment sectors are key actors in combating eutrophication. The problem is, however, that there are insufficient incentives within these sectors to further reduce their contributions to nutrient enrichment of aquatic ecosystems. The hypothesis underpinning the MIRACLE project is that more effective approaches to 'nutrient governance' cannot focus solely on the nutrient issue itself. Real changes will require bringing on board new constellations of stakeholders with issues that are interconnected with nutrient enrichment. We will seek win-win models for governance by emphasising synergies between aligned policy communities, such as the flood control sector, downstream urban communities vulnerable to flooding, biodiversity conservation interests, and the human health and biosecurity sector.

In this transdisciplinary project, social scientists work with economists and hydrologists in a social learning process with stakeholders. The aim is to identify new configurations for governance (conceptual, institutional and practice based) to reduce nutrient enrichment and flood risks in the Baltic Sea region. An example could be how to reform farming practices in a way that measures such as flood control and biodiversity conservation become new 'agricultural products' which also impact emissions of nutrients.

A set of workshops will be organised in four case areas, the Berze (Latvia), Reda (Poland), Helgeån (Sweden), and Selke (Germany). Cross-case and regional workshops will facilitate scaling up the results to the Baltic Sea region level. The workshops will identify innovative actions and plans that offer multiple ecosystem service benefits to diverse stakeholders. The social learning process will be supported by interactive hydrological modelling of what impacts the suggested measures will have on nutrient transport and flooding risks. Here, uncertainty assessments and the need for adaptation to climate change scenarios are key features. Economists will assess the cost and benefits of selected governance features and policy instruments in the environmental mitigation and flood prevention scenarios. The goal is to identify the most socioeconomically efficient measures and governance features to deliver multiple ecosystem service benefits.

In the project, an interactive visualisation platform will be used where stakeholders will guide the use of input data sets and the development of visualised scenarios. The aim is to facilitate their understanding of suggested governance actions' consequences and assist identification of novel actions. Policy analyses will be done to identify how institutional settings have shaped governance structures in the Baltic Sea region. In the next step, opportunities for greater integration of agricultural and environmental policy actions at different scales will be identified. A

particular focus will be on identifying prospects for introduction of payments for ecosystem services as a key governance approach. Finally, emerging from the social learning process, the project aims to support development of road maps that integrate agricultural, environmental and risk management governance in the Baltic Sea region.

Project partners

Sweden

Linköping University (coordinating partner)
Stockholm Environment Institute
Swedish Meteorological and Hydrological Institute, Norrköping
Uppsala University

Denmark

University of Copenhagen

Germany

Johann Heinrich von Thünen-Institut, Braunschweig
Helmholtz Centre for Environmental Research, Leipzig

Latvia

University of Latvia, Riga
Latvia University of Agriculture, Jelgava

Poland

Institute of Meteorology and Water Management, Warsaw
POMinnO Sp. Zo.o., Gdynia

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.1 Governance structures, performance and policy instruments

Supplementary themes

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of e.g. agriculture, forestry and urbanisation

2.3 Integrated approaches to coastal management

4.2 Linking ecosystem goods and services to human lifestyles and well-being

BONUS DESTONY

Decision support tool for management of the Baltic Sea ecosystem

Finnish Environment Institute

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BONUS funding: EUR 0,45 million

Duration: 1,75 years, 1.10.2018-30.6.2020



The publishable summary of the BONUS DESTONY final report, including the main results achieved during the project, is available online at www.bonusportal.org/destony

Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Vivi Fleming-Lehtinen**, Coordinator of BONUS DESTONY*

Successful environmental management relies on an enormous amount of complex information that is processed further to interpret or predict potential changes and responses. A number of decision support tools (DST) have already been developed to support this process. The aim of BONUS DESTONY is to evaluate these tools and propose the direction of further development.

Decision support tools represent various compartments from the pressure-state-impact-response -chain of actions, cover a wide field of disciplines, and vary in the degree of their availability and use – all these properties characterise them as well as enable investigating their successfulness.

During the coming 1.5 years, BONUS DESTONY will develop definitions and criteria to help evaluate the performance of DST. Furthermore, the tools will be analysed against the current and anticipated future needs. Finally, an internet-based catalogue will be created as an information base.

A common feature to successful DST is that they are developed in close collaboration with end-users, or even by end-users themselves, and constantly updated along with increasing knowledge or changing requirements. BONUS DESTONY has gathered together a core group of end-users to be interactively involved in the project implementation.

Project partners

Finland

Finnish Environment Institute (coordinating partner)

Denmark

Aarhus University

Germany

Leibniz University for Baltic Sea Research Warnemünde

Sweden

Stockholm University

Themes from the BONUS strategic research agenda, update 2014 covered

4.1 Governance structures, performance and policy instruments

1.1 Dynamics of biogeochemical processes

4.2 Linking ecosystem goods and services to human lifestyles and well-being



BONUS TOOLS2SEA

Policy tools for Baltic Sea nutrient management

Aarhus University, Denmark

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BONUS funding: EUR 0,45 million

Duration: 1,5 years, 1.10.2018-31.3.2020



The publishable summary of the BONUS TOOLS2SEA final report, including the main results achieved during the project, is available online at www.bonusportal.org/tools2sea

Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Mikael Skou Andersen**, Coordinator of BONUS TOOLS2SEA*

From the end of the 20th century and up to 2014 nutrient loads to the Baltic Sea declined by 13% for nitrogen and 19% for phosphorus. Despite this relief, virtually the entire Baltic Sea (97%) remains eutrofied, according to HELCOM's second holistic assessment, and deep emissions reductions are required as agreed under the Baltic Sea Action Plan. In this context, the BONUS TOOLS2SEA project will provide much needed knowledge about the history and performance of governance approaches and policy instruments for nutrient management.

Aims

BONUS TOOLS2SEA will focus its work on three fronts. Firstly it sets out to assess how national regulatory traditions, individual attitudes and human behaviour shape nutrient management policies, in order to understand countries' policy performance around the Baltic Sea and beyond. Secondly, we will provide a synthesis of the most reliable cost and benefit estimates, identifying socioeconomically suitable policy instruments for spatially targeted nutrient management. It will take into account distributional implications, regional disparities and possible win-win approaches. Thirdly, to facilitate accomplishment of Baltic Sea Action Plan targets, we will provide an outlook on possible future directions in emissions abatement. Critical gaps in current knowledge will be identified and translated into practice to provide suggestions for pilot experiments and innovations. The project will thus provide support to deliberations in HELCOM and in individual countries, including with relevance to the planned 2020 revision of the EU Water Framework Directive.

Methods

BONUS TOOLS2SEA will screen and synthesise results from previous BONUS funded projects (MIRACLE; GO4BALTIC; GOHERR; BALTICAPP; COCOA; SOILS2SEA) as well as summarise research results and insights from a broader array of studies, projects and publications available in the international literature and in national languages of the Baltic Sea region. Stakeholders from farming, NGO's and government agencies are invited to provide input early on of the project, as well as at a policy scenario workshop scheduled for Fall 2019, where preliminary findings will be presented and reviewed.

Outputs

Results will be subject to peer review under the high standards of scientific publications. They will be available in a condensed version as policy briefs accompanied by infographics, with summaries in national languages of the Baltic

Sea region. Three sets of brochures will target farmers, water planners and investors respectively. Lessons with regard to the coordination of rural development funds with targeted water quality measures will be highlighted.

Project partners

Denmark

Aarhus University (coordinating partner)

Finland

Finnish Environment Institute

Latvia

Baltic Study Centre

Sweden

Swedish University of Agricultural Sciences

Themes from the BONUS strategic research agenda, update 2014 covered

4.1 Governance structures, performance and policy instruments

1.1 Dynamics of biogeochemical processes

4.2 Linking ecosystem goods and services to human lifestyles and well-being

BONUS BALTICAPP

Well-being from the Baltic Sea – applications combining natural science and economics

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BONUS funding: EUR 2.0 million

Duration: 3 years, 1.4.2015-31.3.2018



The publishable summary of the BONUS BALTICAPP final report, including the main results achieved during the project, is available online at www.bonusportal.org/balticapp

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Kari Hyytiäinen**, Coordinator of BONUS BALTICAPP*

The Baltic Sea provides us with a precious flow of marine ecosystem services that are important for our wellbeing. However, some of these services are at stake due to the sensitivity of the young Baltic Sea ecosystem to human pressures and changes in the environmental conditions. Looking back the past 50 years, many cultural and provisioning services, such as opportunities for recreation and fish fit for food, have alarmingly decreased due to overconsumption and polluting uses of the sea. Looking forward, attaining and maintaining the good environmental status of the sea may become even more challenging, in particular if some of the more resource-intensive socio-economic developments, driving the future uses of the sea, will take place.

Will future generations be able to enjoy from an equally rich mixture of marine ecosystem services that ours and earlier generations have been fortunate to enjoy? How much additional efforts in terms of nutrient abatement and fisheries management would be needed to reach and to maintain the good environmental status of the sea? Should we commence clearly more substantial and costly actions immediately, or can we afford to wait a bit longer? How might the costs and benefits from securing a sustained flow of marine ecosystem services evolve in the future?

The BALTICAPP project addresses these questions by exploring the long-term prospects for the demand and supply of marine ecosystem services. To this end, the project combines state-of-the-art models and recently collected ecological and economic data to create a coherent and causal chain of interactions between the natural and human systems.

The modelling framework will describe the joint impacts of climate change and socio-economic trends on human induced pressures (nutrient loading and fishing effort), and impacts of these pressures on biogeochemical processes and the food web structure of the sea. As the next step, altered functioning and structure of the marine ecosystem services will be translated in terms of indicators describing the flows of cultural and provisioning ecosystem services. Finally, the importance of changes in the ecosystem services for human wellbeing will be described in monetary terms when relevant, and with quantitative or qualitative measures otherwise.

After these steps, the project will conduct a cost-benefit analysis to explore whether the current and planned efforts are adequate to reach and maintain the desired health of the marine ecosystem during this century.

Citizen science is a growing field in research, where volunteers collect and process data as part of a scientific inquiry. As the second key task, the project will pilot a mobile application. The aims are to allow end-users of marine ecosystem services to share spatially and temporally explicit information on the state of the sea, and simultaneously,



to provide policy makers, researchers and any other interested parties valuable information about the demand and hotspot areas of cultural ecosystems services.

Project partners

Finland

University of Helsinki (coordinating partner)
Natural Resources Institute Finland, Helsinki

Denmark

Aarhus University

Germany

Kiel Institute for the World Economy

Poland

University of Warsaw

Sweden

Swedish Meteorological and Hydrological Institute, Norrköping
Stockholm University

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.2 Linking ecosystem goods and services to human lifestyles and well-being

Supplementary themes

1.3 Food web structure and dynamics

4.1 Governance structures, policy performance and policy instruments

4.3 Maritime spatial planning from local to Baltic Sea region scale

5.3 User-driven new information and communication services for marine environment, safety and security in the Baltic Sea area

BONUS MARES

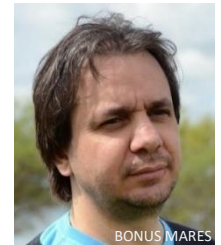
Multi-method assessment for resilient ecosystem services and human-nature system integration

Pellervo Economic Research PTT, Finland

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BONUS funding: EUR 0,45 million

Duration: 1,75 years, 1.10.2018-30.6.2020



The publishable summary of the BONUS MARES final report, including the main results achieved during the project, is available online at www.bonusportal.org/mares

Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Maurizio Sajeva**, Coordinator of BONUS MARES*

BONUS MARES will set out to identify possible future scenarios of best practices in the knowledge transfer and generate a geospatial tool to represent ecosystem goods and services, as well as their impact on human lifestyles and well-being. This in turn will contribute to efficient and sustainable use of natural resources.

An idea of natural capital has emerged to identify the potential and actual benefits that humans derive from nature. Economic research and various monetary and nonmonetary methods have also been developed to reintroduce environmental goods into economic evaluations, generating the concept of ecosystem services. However, the issue is under debate within the scientific community, and a general agreement on the validity of evaluation methods is often missing: not all methods are adequate to evaluate all kinds of environmental goods. Moreover, much about ecological processes and the amount of resources that can be used in a sustainable way is still unknown.

Understanding the interactions between biodiversity, humans and geophysical processes are of primary importance in BONUS MARES: Economics is approached as an open system that is intertwined with other environmental and human systems. In this light, the BONUS MARES project will:

- observe and monitor ecosystem goods and services in the Baltic Sea region, and more specifically of its coastal system threatened by multiple pressures and climate change (macroalgae, seagrass beds and mussel reefs)
- analyse the adequacy of existing methods to transfer this scientific knowledge for practitioners (combination of 'ecosystem service-evaluation method')
- provide an interface that brings science closer to society and policy, and thereby supports policy makers with scientific evidence, upon which critical decisions can be made, and the principle of accountability adequately implemented.

A highly participatory research process will involve experts, stakeholders and decision-makers from the Baltic countries and possibly from other regions where similar experiences can be found. BONUS MARES' work will be captured in newsletters, policy briefs and a final popular publication that will pull together findings, lessons learned, and gaps identified in current practices. BONUS MARES will inform and interface in this way with the concerned stakeholders and the general public, thereby pursuing the objective of concretely reducing the distance between the scientific community, decision making and the overall society.

Project partners

Finland

Pellervo Economic Research PTT (coordinating partner)
Edistysmielisen tutkimuksen yhdistys ry (e2)

Estonia

University of Tartu

Germany

GEOMAR Helmholtz Centre for Ocean Research Kiel

Themes from the BONUS strategic research agenda, update 2014 covered

4.2 Linking ecosystem goods and services to human lifestyles and well-being

2.2 The role of coastal systems

3.4 Evaluation framework for fisheries management



BONUS ROSEMARIE

Blue health and wealth from the Baltic Sea – a participatory systematic review for smart decisions

Finnish Environment Institute

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BONUS funding: EUR 0,45 million

Duration: 1,5 years, 1.10.2018-31.3.2020

The publishable summary of the BONUS ROSEMARIE final report, including the main results achieved during the project, is available online at www.bonusportal.org/rosemarie



Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Soile Oinonen**, Coordinator of BONUS ROSEMARIE*

When sustainable blue growth is the target, what are the burning questions of the decision makers? How can they balance the current uses of the Baltic Sea ecosystem services with the future uses? BONUS ROSEMARIE aims to act as a 'research broker': By meeting policy advisors and decision makers we set out to identify their knowledge needs, and then search for the answers through the existing scientific works.

The answers will be summarised in three separate evidence syntheses. The first synthesis focuses on the state and future of the Baltic Sea ecosystem services and what is now known about the synergies and trade-offs that link different usages of these services. The second sheds light on the impacts these ecosystem services have on human mental and physical health and well-being. The third synthesis will help decision makers navigate through the different non-monetary and monetary valuations methods used to capture full spectrum of values attached to the marine ecosystem services.

We will also highlight our main findings in policy briefs and an animation. To reach the wider public we will publish the animation in German, Estonian, Finnish, Swedish and English. To ensure high-quality, the work will follow the guidelines and standards of Collaboration for Environmental Evidence.

This means that we separate the wheat from the chaff: Evidence is searched following predetermined rules, findings are listed transparently and their quality will be checked. This will help us also find the gaps in knowledge. Such a systematic method allows for repeating similar analyses later on when new research is available.

BONUS ROSEMARIE engages with stakeholders throughout the project implementation. Both the systematic reviews and the policy briefs will be produced in dialogue with the end-users. This way, new and even unexpected results are hopefully easier to assimilate and apply in the daily work of decision makers. Moreover, it will add to the researchers' understanding of the ways that practitioners use scientific outputs. This can pave the way for increased societal impact of research.

Project partners

Finland

Finnish Environment Institute (coordinating partner)

Estonia

Estonian University of Life Sciences

Germany

Gottfried Wilhelm Leibniz Universität Hannover

Sweden

Royal Institute of Technology

Themes from the BONUS strategic research agenda, update 2014 covered

4.2 Linking ecosystem goods and services to human lifestyles and well-being

2.2 The role of coastal systems

3.4 Evaluation framework for fisheries management

BONUS BALSPACE

Towards sustainable governance of Baltic marine space

Södertörn University, Sweden

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BONUS funding: EUR 2.0 million

Duration: 3 years, 1.4.2015-31.3.2018



The publishable summary of the BONUS BALSPACE final report, including the main results achieved during the project, is available online at www.bonusportal.org/baltSPACE

Introduction to the project as first published in BONUS in Brief May 2015

*Written by **Michael Gilek**, Coordinator of BONUS BALSPACE*

Maritime Spatial Planning (MSP) – the process of planning when and where human activities take place at sea – has gained increasing prominence during recent years. In times of increasing pressures upon the seas and resulting tensions between different interests, policy makers have high expectations from MSP. It is seen as a central policy for delivering economic development in maritime sectors while at the same time achieving environmental policy targets.

The Baltic Sea region has been dealing with MSP for more than 10 years now and is often perceived as a model region. Realising the ambitions of MSP in the Baltic Sea region and beyond depends on how well different forms of integration can be achieved. The key challenges on the path of achieving MSP are the integration of different maritime sectors (such as transport, fisheries and tourism), public policy, integrating of MSP across national borders in conjunction with terrestrial planning and the integration of stakeholder knowledge, values, interests and critique in MSP processes. Nevertheless, it should be remembered that MSP is still in its infancy, and to overcome these challenges new methods and tools will need to be developed. This is what BALSPACE wants to achieve: the project aims to clarify and improve the capacity of MSP as a policy integrator by providing science-based approaches and tools.

BONUS BALSPACE will start off by developing a framework for analysing integration in MSP in the Baltic Sea region. BONUS BALSPACE partners will then apply this analytical framework to identify different kinds of concrete integration shortcomings and inefficiencies in one pan-Baltic and two transboundary case studies (see map). This, in turn, will go hand in hand with evaluating existing MSP processes and developing new policy approaches and tools that can support integration goals in planning. The effectiveness and applicability of these selected tools in different MSP situations will then be tested and verified in the case study areas. As a result, BALSPACE partners will have produced a handbook for practitioners on when and how to use the developed tools in future MSP processes.

BONUS BALSPACE partners will also make sure that input, advice and critique from those involved in MSP is reflected and taken into account in all parts and phases of the project. This is even more important, since BALSPACE takes place at a time when all member states in the Baltic Sea region need to implement the new EU MSP Directive and are working towards developing their own maritime spatial plans. We will seek continuous exchange with a broad range of planners, scientists and sectorial stakeholders. For this purpose, a series of dialogue meetings will be organised to discuss and review the BONUS BALSPACE approach, results and conclusions. Similarly, we will also discuss the BONUS BALSPACE approach and results with leading scientists based in various academic disciplines to

make sure that knowledge from other relevant sectors in the Baltic Sea region and beyond is integrated in BONUS BALTSAPCE.

Stay tuned on upcoming dialogue meetings and other BONUS BALTSAPCE developments at www.baltspace.eu.

Project partners

Sweden

Södertörn University (coordinating partner)

Swedish Institute for the Marine Environment, University of Gothenburg

Denmark

Aarhus University

Germany

Helmholtz-Zentrum Geesthacht, Centre for Materials and Coastal Research

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

s.Pro - sustainable projects GmbH, Berlin

Lithuania

Coastal Research and Planning Institute, Klaipėda

Poland

Maritime Institute in Gdansk

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.3 Maritime spatial planning from local to Baltic Sea region scale

Supplementary themes

2.3 Integrated approaches to coastal management

4.1 Governance structures, policy performance and policy instruments

BONUS BASMATI

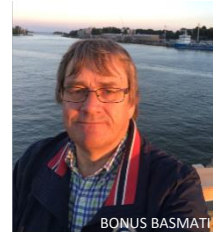
Baltic Sea maritime spatial planning for sustainable ecosystem services

Aalborg University, Denmark

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BONUS funding: EUR 2,8 million

Duration: 3,25 years, 1.7.2017-30.9.2020



The publishable summary of the BONUS BASMATI final report, including the main results achieved during the project, is available online at www.bonusportal.org/basmati

Introduction to the project as first published in Brief October 2017

*Written by **Henning Sten Hansen**, Coordinator and **Lise Schrøder**, Co-coordinator of BONUS BASMATI*

The overall objective of BONUS BASMATI is to develop integrated and innovative solutions for maritime spatial planning from the local to the Baltic Sea Region scale. This is to be realised through multi-level governance structures and interactive information technology aiming at developing an ecologically and socio-economically sound network of protected marine areas covering the Baltic Sea.

New ways of exploiting the sea, such as aquaculture, marine mineral resources, marine biotechnology, cruise tourism and recreational activities in coastal areas are rapidly growing and supported by the EU Strategy for growth and jobs in coastal and maritime tourism. In order to do this sustainably, the European Commission adopted a directive on establishing a framework for maritime spatial planning in 2014. Thus, through the allocation of marine space that is based on ecosystem-based approach and integrating different interests, maritime spatial planning has become an important basis for decision-making.

Based on the results of former maritime spatial planning projects, the BONUS BASMATI project sets out to analyse governance systems and their information needs regarding maritime spatial planning in the Baltic Sea region in order to develop an operational, transnational model for maritime spatial planning, while maintaining compliance with existing governance systems. It also develops methods and tools for assessments of different plan-proposals based on an approach including spatially explicit pressures and effects on maritime ecosystem services. Furthermore, it creates a spatial data infrastructure for the Baltic Sea region to facilitate broad access to information. The project's work is carried out in close cooperation with relevant stakeholders in the Baltic Sea region.

To achieve all its goals, BONUS BASMATI will design and develop an innovative web-based decision support system providing easy access to information through intelligent discovery. The 'Baltic Explorer'-decision support tool will be developed and built on interactive information technology. It will support an ecosystem-based and integrated approach to maritime spatial planning and take advantage of the interdisciplinary partnership in the project team, combining competences from natural, social and technical sciences. While the 'Baltic Explorer' –tool will support the collaborative setting of values for different uses of marine space, it will also facilitate the negotiations between the regional stakeholders.

During its implementation until 2020, new data will be produced and tested in assessments corresponding to policy goals to support the combined analysis of the four elements of the concept of ecosystem services: provisioning,

regulating, cultural and supporting services. The impact of the project will be facilitated and assessed in transnational case studies, where integrated solutions are required. At the local scale, this will include case study areas in the Fehmarn Belt and the Gulf of Finland, and also a pan-Baltic case study.

Project partners

Denmark

Aalborg University (coordinating partner)
Aarhus University

Latvia

Latvian Institute of Aquatic Ecology, Riga

Finland

National Land Survey of Finland, Helsinki
University of Turku

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

Sweden

Nordregio, Stockholm

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

4.3 Maritime spatial planning from local to Baltic Sea regional scale

Supplementary themes

2.3 Integrated approaches to coastal management

4.1 Governance structures, policy performance and policy instruments



BONUS BLUEPRINT

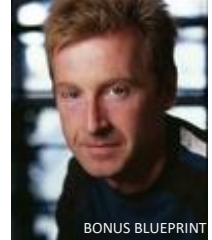
Biological lenses using gene prints - Developing a genetic tool for environmental monitoring in the Baltic Sea

University of Copenhagen, Denmark

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BONUS funding: EUR 3.9 million

Duration: 4,3 years, 1.1.2014-30.4.2018



The publishable summary of the BONUS BLUEPRINT final report, including the main results achieved during the project, is available online at www.bonusportal.org/blueprint

Introduction to the project as first published in BONUS in Brief December 2013

Written by Lasse Riemann, Coordinator of BONUS BLUEPRINT

With the exception of filamentous cyanobacteria, microbes and the fundamental processes they are driving are generally ignored as environmental indicators in the Baltic Sea. However, in aquatic systems, the numerous microorganisms, bacteria and archaea, generally process more than half of the carbon fixed by local photosynthesis and mediate most transformations in the cycling of nitrogen, phosphorus, and other nutrients (Fig. 1). In addition, microorganisms react sensitively and rapidly to any environmental change. Due to differences in growth requirements and high turnover rates of microorganisms, microbial communities are dynamic assemblages that promptly respond to environmental change. Therefore, the combined gene-pool maintained and expressed by the microbes (the microbial genetic blueprint) reflects contemporary nutrient fluxes mediated by the microbes and this is intimately linked to local environmental conditions.

The EU Marine Strategy Framework Directive puts new demands on the member states to monitor and assess the state of the Baltic Sea through an ecosystem-based approach. The Directive underlines that zooplankton and phytoplankton should be included in the assessment of environmental state but the microorganisms are strangely omitted from the regulatory documents. Moreover, the importance of functional aspects and energy flow is acknowledged; yet, the good environmental status indicators that the Directive proposes are focusing on the abundance of higher organisms. Thus, this new and ambitious directive with a holistic perspective on the ecosystem is disappointingly leaving out microorganisms – despite of their pivotal role for status and function of the Baltic Sea.

In the past, analysis of microbes was time-consuming, expensive and inaccurate. This situation has changed in the last 10 years by the development and application of novel cultivation-independent molecular techniques for analysing complex microbial communities, allowing for a significantly improved understanding of microbial metabolic processes and pathways. Indeed, it has become evident that abundant microorganisms, and their genes and transcripts, can be used as sensitive and immediate markers for contemporary environmental conditions and the occurrence of certain stress conditions that may alter nutrient fluxes, e.g., changed nutrient ratios, pollution, hypoxia and climate change. Thus, assessment of environmental status and the associated monitoring may be dramatically improved using genetic (metagenomic or metatranscriptomic) approaches directed at microorganisms.

The goal of the BONUS BLUEPRINT project is to demonstrate the functionality of a publicly available resource with the capacity to deduce environmental status and dominant biogeochemical pathways from the biodiversity and genetic functional profiles of microbes, the blueprint, in a seawater sample. This resource will be established as an operational virtual Blueprint Competence Centre, where blueprints are generated and analysed, followed by an evaluation of the environmental status. Finally, the genomic information will be used to validate and improve biogeochemical models of the Baltic Sea. The project includes small- and largescale experimental approaches, cruises, genomic analyses and modelling, and discussion forums with stakeholders, end-users, and experts involved in monitoring and environmental legislation.

Project partners

Denmark

University of Copenhagen, Helsingør (coordinating partner)

Estonia

Institute of Technology, University of Tartu

Finland

University of Helsinki

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

Sweden

KTH Royal Institute of Technology, Stockholm

Linnaeus University, Kalmar

Stockholm University

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures

1.2 Causes and consequences of changing biodiversity

1.3 Food web structure and dynamics

BONUS INTEGRAL

Integrated carbon and trace gas monitoring for the Baltic Sea

Leibniz Institute for Baltic Sea Research Warnemünde, Germany

gregor.rehder@io-warnemuende.de

BONUS funding: EUR 2 million

Duration: 3,25 years, 1.7.2017-30.9.2020



The publishable summary of the BONUS INTEGRAL final report, including the main results achieved during the project, is available online at www.bonusportal.org/integral

Introduction to the project as first published in BONUS in Brief October 2017

*Written by **Gregor Rehder**, Coordinator of BONUS INTEGRAL*

BONUS INTEGRAL seeks to demonstrate and exploit the potential added value of the marine stations of ICOS and similar instrumentation for the ecosystem state monitoring of the Baltic Sea as an important contribution to a state-of-the-art improved HELCOM monitoring.

Currently, twelve European nations are national partners of the Integrated Carbon Observation System (ICOS), the pan-European research infrastructure (RI) to provide high-precision data on Greenhouse Gas fluxes and budgets. Four of the Baltic countries (Finland, Sweden, Germany, Denmark) are already partners in the ICOS RI with partly or fully established infrastructure, other countries like Poland and Estonia are currently in the process of developing their strategy towards ICOS. The overall aim of ICOS with its large investments is to provide European-wide CO₂ and – to a lesser extent – non-CO₂ (i.e. methane and nitrous oxide) greenhouse gas concentration and flux data.

BONUS INTEGRAL seeks to demonstrate and exploit the potential added value of the marine stations of ICOS and similar instrumentation for the ecosystem state monitoring of the Baltic Sea. This will serve as an important contribution to a state-of-the-art improved HELCOM monitoring. In direct response to the requirements of the European Marine Strategy Framework Directive, BONUS INTEGRAL will provide new approaches for the monitoring of marine eutrophication and acidification, and explore the integrated greenhouse gas flux as a potential new indicator for the good environmental status of the Baltic Sea.

Integrating the different components and data streams of ICOS, related infrastructure, and pre-existing related data in the pan-Baltic Sea area will be in the core of BONUS INTEGRAL. In order to maximise innovation and obtained knowledge, field studies will be conducted. One major aim of the project is to provide best possible experimentally based seasonal surface concentration charts of carbon dioxide, methane and nitrous oxide over the Baltic Sea.

Within BONUS INTEGRAL, the carbon system implementation in an existing high resolution, physical-biogeochemical model will be scrutinised and improved, and the model results will be evaluated against observations of the carbon system (and other variables). This approach is based on the strong, scientifically underpinned belief that the cycling of carbon is the key variable of marine biogeochemistry, is linking the effects of eutrophication and deoxygenation, and determines the magnitude of coastal acidification.

In order to strengthen the Baltic Sea ecosystem monitoring, the project will advise the implementation of ICOS in the south-eastern countries of the Baltic, and actively promote the implementation of an ocean (sea) component. The aim is also to demonstrate the added value of using greenhouse gas data in combination with carbon system data, and promote project's findings towards a better, cost effective ecosystem based monitoring of the Baltic Sea.

Project partners

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock (coordinating partner)
Helmholtz Centre for Ocean Research Kiel

Estonia

Tallinn University of Technology

Finland

Finnish Meteorological Institute, Helsinki

Poland

Institute of Oceanology of the Polish Academy of Sciences, Sopot

Sweden

Swedish Meteorological and Hydrological Institute, Norrköping
Uppsala University

United Kingdom

University of Exeter

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures

2.2 The role of the coastal systems in the dynamics of the Baltic Sea

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques



BONUS FUMARI

Future marine assessment and monitoring of the Baltic

Finnish Environment Institute

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BONUS funding: EUR 0,4 million

Duration: 1,5 years, 1.10.2018-31.3.2020



The publishable summary of the BONUS FUMARI final report, including the main results achieved during the project, is available online at www.bonusportal.org/fumari

Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Kristian Meissner**, Coordinator of BONUS FUMARI*

BONUS FUMARI will explore gaps in current Baltic Sea monitoring and the possibility of using novel monitoring methods to address these shortcomings. The recommendations aim to enhance future coverage, comparability, sensitivity and cost effectiveness of Baltic Sea monitoring. Given the complexity of this task, stakeholder involvement will be critical to project success and will be integrated at all stages of the project.

BONUS FUMARI builds on past evaluations of relevant directives and combines these with the insights and lessons learned from both freshwater EU-projects led by the project partners (such as EU FP7 WISER, MARS and the COST action DNAqua-Net) and marine projects (such as BONUS BLUEWEBS, EU-LIFE MARMONI, EU FP7- ODEMM, and DEVOTES). The combined experience from both marine and closely related freshwater monitoring will be a valuable basis for the evaluation and recommendation for a renewed monitoring system of the Baltic Sea environment. BONUS FUMARI will coordinate actions with the project BONUS SEAM, which also aims to provide recommendations for a renewed monitoring of the Baltic.

Outputs of the project will include review papers and related policy briefs that address current monitoring and its gaps in relation to legislative requirements, shortcomings and improvements of data management, and novel monitoring methods that could be applied in Baltic marine monitoring.

In particular BONUS FUMARI sets out to answer the following questions:

- Does the current monitoring sufficiently address the requirements set by the EU data collection regulation, Baltic Marine Environment Protection Commission's (HELCOM) Baltic Sea Action Plan, EU Water Framework Directive (WFD), and EU Marine Strategy Framework Directive (MSFD)?
- What are the most critical shortcomings of the current marine monitoring programs regarding the requirements set by relevant EU directives?
- Which novel methods could efficiently enhance the Baltic marine monitoring through improving its coverage, cost effectiveness, and reliability?
- What is the state-of-the-art of these methods related to their use in operational monitoring?
- How could the monitoring system be rearranged and complemented to achieve improved coverage, sensitivity, and cost effectiveness?

Project partners

Finland

Finnish Environment Institute

Germany

University Duisburg-Essen

Sweden

Swedish University of Agricultural Sciences

Halmstad University

Swedish Meteorological and Hydrological Institute

Themes from the BONUS strategic research agenda, update 2014 covered

5.1 Integrated monitoring programmes

1.1 Dynamics of biogeochemical processes

1.4 Impacts of hazardous substances

3.3 Improving stock assessments, spatial heterogeneity of stocks

4.1 Governance structures, performance and policy instruments



BONUS SEAM

Towards streamlined Baltic Sea environmental assessment and monitoring

University of Gothenburg, Sweden

mats.lindegarh@marine.gu.se

BONUS funding: EUR 0,45 million

Duration: 1,5 years, 1.11.2018-30.4.2020



The publishable summary of the BONUS SEAM final report, including the main results achieved during the project, is available online at www.bonusportal.org/seam

Introduction to the project as first published in BONUS in Brief November 2018

*Written by **Mats Lindegarh**, Coordinator of BONUS SEAM and **Richard Emmerson**, BONUS SEAM*

A safe, secure and sustainable society needs good information on the state of the sea. Monitoring of the marine environment and its biodiversity generates this valuable information describing how the marine environment and marine ecosystems vary through time. The objective of the BONUS SEAM project is to propose recommendations for a more efficient monitoring system to ensure that the information generated can be used by policymakers, scientists and wider society to inform and guide policies and actions for the sustainable management of the Baltic Sea.

A key challenge for the organisation of monitoring activity at Baltic Sea scale is to ensure that it can serve the required information needs in a streamlined way while delivering comparable and consistent data transnationally. In parallel, innovations for data collection and interpretation may offer possibilities for further refining approaches for marine monitoring and assessment to provide an increased return of information on present investments in monitoring.

To achieve this objective BONUS SEAM will follow a threefold approach: Firstly, BONUS SEAM will critically analyse the adequacy of current Baltic Sea environmental monitoring to support assessment requirements under different environmental policies, e.g. the assessment of status and trends, identify gaps and mismatches in relation to policy and science, and identify potential routes for improvement. A particular focus will be given to the monitoring of hazardous substances and the habitats and communities of the seafloor and water column.

Secondly, BONUS SEAM will review recent innovative approaches for a more cost effective collection of data and evaluate their potential application in an operational monitoring programme.

Building on these two steps BONUS SEAM will develop a proposal for a revised monitoring system for the Baltic Sea. We will communicate and test with key policy and technical stakeholders, including those authorities in charge of the monitoring nationally, to ensure that there is a close fit with possible implementation routes. The outcome of BONUS SEAM will be a realistically applicable proposal for how the current system of monitoring in the Baltic Sea can be revised. BONUS SEAM will also identify priority research needs to contribute to the further development of Baltic Sea assessments over the longer term.

Project partners

Sweden

Swedish Institute for the Marine Environment/University of Gothenburg (coordinating partner)

Denmark

Technical University of Denmark

Estonia

Tallinn University of Technology

Finland

Finnish Environment Institute

Germany

Leibniz-Institut für Ostseeforschung Warnemünde

Themes from the BONUS strategic research agenda, update 2014 covered

5.1 Integrated monitoring programmes

1.1 Dynamics of biogeochemical processes

1.4 Impacts of hazardous substances

3.3 Improving stock assessments, spatial heterogeneity of stocks

4.1 Governance structures, performance and policy instruments



BONUS AFISMON

Development of the current Automatic Flow Injection Sampler to monitor microbially driven biogeochemical processes in the Baltic Sea water

Leibniz Institute for Baltic Sea Research Warnemünde, Germany

matthias.labrenz@io-warnemuende.de

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.4.2014-31.3.2017



The publishable summary of the BONUS AFISMON final report, including the main results achieved during the project, is available online at www.bonusportal.org/afismon

Introduction to the project as first published in BONUS Briefing 29

*Written by **Matthias Labrenz**, Coordinator of BONUS AFISMON*

Through development of the autonomous *in situ* fixation multi-sampler AFISsys, BONUS AFISMON 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.

Project partners

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock (coordinating partner)
HydroBios GmbH, Kiel

Denmark

University of Copenhagen, Helsingør

Sweden

KTH Royal Institute of Technology, Stockholm

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures

1.2 Causes and consequences of changing biodiversity

1.3 Food web structure and dynamics

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS ECOMAP

Baltic Sea environmental assessments by opto-acoustic remote sensing, mapping, and monitoring

Christian-Albrechts-Universität zu Kiel

jschneider@geophysik.uni-kiel.de

BONUS funding: EUR 2,5 million

Duration: 3 years, 1.9.2017-31.8.2020

The publishable summary of the BONUS ECOMAP final report, including the main results achieved during the project, is available online at www.bonusportal.org/ecomap



Introduction to the project as first published in BONUS in Brief October 2017

*Written by **Jens Schneider von Deimling**, Coordinator of BONUS ECOMAP*

BONUS ECOMAP sets out to acquire the physical and technical fundamental understanding needed for better and more reliable habitat mapping and monitoring feasible in the future. Therefore, it contributes to better assessments of the marine health status of the seabed.

On 1 September 2017, the first day of the project, an airplane took off to acquire first airborne data on seagrass meadow distribution with a modern bathymetric laser device. This survey of coastal shallow water near Kiel in Germany was made possible through the close collaboration between BONUS ECOMAP and the German authority Schleswig-Holstein Agency for Coastal Defence, National Park and Marine Conservation, who are all involved in ECOMAP as stakeholders. A subsequent survey on 4 September of the same area was conducted by the project members with modern hydroacoustic swath system. Benthic vegetation deduced from this data was subsequently ground truthed by divers, who are involved in the project through citizens science (www.tauchmonitor.de). With this start, we are happy to have completed comprehensive and likely synergistic surveys right in the beginning and eager to research on it within the upcoming three years.

The Earth's surface and environment is remotely monitored since decades via satellites and airplane imagery with great success. Health status of terrestrial ecosystems, their spatial distribution and natural variations, and human impacts thereon, can therefore be assessed on a global scale. In the marine realm, the water of the sea highly obfuscates the seabed in regard to remote sensing via satellites or airplanes. Therefore, our knowledge about the seabed itself and the associated life thereon is limited to a few dedicated locations that have been researched in situ.

Today, the technical progress has opened new pathways to remotely sense area wide seabed information from space, airplane, and ship vessels. So far, it is rather unknown how each individual sensing interacts with the benthic life on the seabed. Our main objective is to make benthic life visible with innovative remote sensing techniques. BONUS ECOMAP concentrates on how to best remotely sense seagrass and seaweed meadows, mussel and stone reefs, and other benthic fauna in the Baltic Sea. One final goal of the project is to produce a catalogue listing which remote sensor works in the Baltic Sea for which purpose.

BONUS ECOMAP's approach is in line with the European aim to implement digital transformation across disciplines. We will foster innovations by applying airborne LiDAR and drone technology, machine learning to multispectral techniques, by evaluating satellite images for very shallow seabed analysis and by surveying the seabed with customised acoustic systems. By this integrative approach we foresee to achieve a more holistic understanding of the seabed.

Project partners

Germany

Christian-Albrechts-Universität zu Kiel (coordinating partner)
EOMAP GmbH, Seefeld
Helmholtz Centre for Ocean Research Kiel
INNOMAR Technologie GmbH, Rostock
Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

Denmark

Geological Survey of Denmark and Greenland, Copenhagen
University of Copenhagen - Department of Geosciences and Natural Resource Management

Poland

NORBIT-POLAND, Sopot
University of Gdansk

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

Supplementary themes

1.2 Causes and consequences of changing biodiversity
2.2 The role of the coastal systems in the dynamics of the Baltic Sea
4.3 Maritime spatial planning from local to Baltic Sea region scale
5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS FERRYScope

Bridging the divide between satellite and shipborne sensing for Baltic Sea water quality assessment

Brockmann Consult GmbH, Germany

martin.boettcher@brockmann-consult.de

BONUS funding: EUR 0.5 million

Duration: 2 years, 1.7.2014-30.6.2016



The publishable summary of the BONUS FERRYScope final report, including the main results achieved during the project, is available online at www.bonusportal.org/ferryscope

Introduction to the project as first published in BONUS Briefing 29

*Written by **Martin Böttcher**, Coordinator of BONUS FERRYScope*

The applied open-source technology developed by BONUS FERRYScope 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.

Project partners

Germany

Brockmann Consult GmbH, Geesthacht (coordinating partner)

Finland

Finnish Environment Institute, Helsinki

Estonia

Estonian Marine Institute, University of Tartu

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

Supplementary themes

1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures

2.3 Integrated approaches to coastal management

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS FISHVIEW

Assessing fish passages by the use of a robotic fish sensor and enhanced digital imaging

Tallinn University of Technology, Estonia

maarja.kruusmaa@ttu.ee

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.4.2014-31.3.2017



The publishable summary of the BONUS FISHVIEW final report, including the main results achieved during the project, is available online at www.bonusportal.org/fishview

Introduction to the project as first published in BONUS Briefing 29

*Written by **Maarja Kruusmaa**, Coordinator of BONUS FISHVIEW*

BONUS FISHVIEW 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.

Project partners

Estonia

Tallinn University of Technology (coordinating partner)

Finland

Tampere University of Technology

Germany

Ecohydraulic Engineering GmbH, Stuttgart

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

Supplementary themes

1.2 Causes and consequences of changing biodiversity

2.1 Natural and human-induced changes in catchment land cover patterns, including the role of e.g. agriculture, forestry and urbanization



BONUS HARDCORE

Harnessing coastal radars for environmental monitoring purposes

Finnish Meteorological Institute

mikko.lensu@fmi.fi

BONUS funding: EUR 0.3 million

Duration: 3 years, 1.6.2014-31.5.2017



The publishable summary of the BONUS HARDCORE final report, including the main results achieved during the project, is available online at www.bonusportal.org/hardcore

Introduction to the project as first published in BONUS Briefing 29

Written by Mikko Lensu, Coordinator of BONUS HARDCORE

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 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.

Project partners

Finland

Finnish Meteorological Institute, Helsinki (coordinating partner)

Image Soft Oy, Helsinki

Finnish Transport Agency, Helsinki

Estonia

Marine Systems Institute at Tallinn University of Technology

Poland

Institute of Meteorology and Water Management – National Research Institute, Warsaw

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

Supplementary themes

2.2 The role of the coastal systems in the dynamics of the Baltic Sea

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS PINBAL

Development of a spectrophotometric pH-measurement system for monitoring in the Baltic Sea

Leibniz Institute for Baltic Sea Research Warnemünde, Germany

gregor.rehder@io-warnemuende.de

BONUS funding: EUR 0.5 million

Duration: 3 years, 1.4.2014-31.3.2017



The publishable summary of the BONUS PINBAL final report, including the main results achieved during the project, is available online at www.bonusportal.org/pinbal

Introduction to the project as first published in BONUS Briefing 29

*Written by **Gregor Rehder**, Coordinator of BONUS PINBAL*

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. 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.

Project partners

Germany

Leibniz Institute for Baltic Sea Research Warnemünde, Rostock (coordinating partner)
CONTROS Systems & Solutions GmbH, Kiel

Sweden

University of Gothenburg

Poland

Institute of Oceanology of the Polish Academy of Sciences, Sopot

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ remote sensing and laboratory techniques

Supplementary themes

1.2 Causes and consequences of changing biodiversity

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures

BONUS SEAMOUNT

New innovative underwater vehicles for studying submarine groundwater discharge and associated nutrient fluxes

EvoLogics GmbH, Germany

info@evologics.de

BONUS funding: EUR 2,9 million

Duration: 3,3 years, 1.4.2017-31.7.2020



The publishable summary of the BONUS SEAMOUNT final report, including the main results achieved during the project, is available online at www.bonusportal.org/seamount

Introduction to the project as first published in BONUS in Brief October 2017

*Written by **Joonas Virtasalo**, Partner Project Scientist and **Rudolf Bannasch**, Coordinator of BONUS SEAMOUNT*

Although the main nutrient supply routes into the Baltic Sea are well known, nutrient flows to the Baltic Sea by submarine groundwater discharge are poorly understood. BONUS SEAMOUNT develops innovative technologies for complex real-time sea survey, analysis and monitoring and sets out to test and apply these new technologies for the detection and monitoring of submarine groundwater discharge in the Baltic Sea.

Submarine groundwater discharge is understood as the flow of groundwater, or quite often a mixture of groundwater and seawater, from the seabed to the coastal sea. The volume of submarine groundwater discharge is generally viewed to be small compared to rivers. However, groundwater seeping from the seabed often carries high amounts of nutrients and other potentially harmful substances. Therefore, even a small submarine groundwater flux may have considerable effects on the coastal environment.

In the Baltic Sea, submarine groundwater discharge has been documented in the Eckernförde Bay (Germany), Laholm Bay (Sweden) and Puck Bay (Poland).

The discharge to the sea may be focused or diffuse, with scale lengths of meters to kilometers. As a result, quantifying submarine groundwater discharge and associated fluxes of nutrients and other substances is not easy.

BONUS SEAMOUNT develops innovative technologies for complex real-time sea survey, analysis and monitoring. These technologies integrate sensors in remotely operated or fully autonomous underwater vehicles, adaptable to the survey objectives and site characteristics. The vehicles will be equipped with an efficient bionic communication system for the remote transmission of collected data. The vehicles will also be equipped with an innovative squid drive bionic propulsion system.

BONUS SEAMOUNT will test and apply these new technologies for the detection and monitoring of submarine groundwater discharge in the Baltic Sea, both at previously known localities as well as at new sites found in the course of the project. Important submarine groundwater discharge sites will be characterised by marine geological surveys, and continuously monitored by seabed moored sensors to determine nutrient and pollutant fluxes. Hydrogeological modeling will be carried out for the adjoining coastal aquifers.

Revealing the occurrence of submarine groundwater discharge in the Baltic Sea area, and understanding the associated fluxes and variability with seasons and, more importantly, the human influence on their nutrient and pollutant composition will be valuable information. The findings of BONUS SEAMOUNT will be communicated to the scientific community and policy makers, in order to support informed decisions with regard to environmental management and planning the sustainable use of the sea.

Project partners

Germany

EvoLogics GmbH, Berlin (coordinating partner)
Christian-Albrechts-Universität zu Kiel, Institute of Geosciences
Leibniz Institute for Baltic Sea Research Warnemünde, Rostock

Denmark

Geological Survey of Denmark and Greenland, Copenhagen

Finland

Geological Survey of Finland, Espoo

Poland

Maritime Institute in Gdansk
NOA Sp. z o.o., Krakow

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.2 Developing and testing innovative in situ, remote sensing and laboratory techniques

Supplementary themes

- 1.1 Ecosystem resilience and dynamics of biogeochemical processes, including cumulative impacts of human pressures
- 2.2 The role of the coastal systems in the dynamics of the Baltic Sea
- 4.3 Maritime spatial planning from local to Baltic Sea region scale
- 5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures



BONUS ANCHOR

The captain assistant system for navigation and routing during operations in harbor

Astri Polska Sp. z o. o., Poland

karol.brzostowski@astripolska.pl

BONUS funding: EUR 0.4 million

Duration: 2,25 years, 1.4.2014-30.6.2016



The publishable summary of the BONUS ANCHOR final report, including the main results achieved during the project, is available online at www.bonusportal.org/anchor

Introduction to the project as first published in BONUS Briefing 29

*Written by **Karol Brzostowski**, Coordinator of BONUS ANCHOR*

BONUS ANCHOR 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.

Project partners

Poland

Astri Polska Sp. z o. o., Warsaw (coordinating partner)
Polish Naval Academy, Gdynia

Germany

Automotive & Rail Innovation Center, Aachen
RWTH Aachen University, Aachen

France

University of Montpellier 2, Nimes

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.3 User-driven new information and communication services for marine environment, safety and security in the Baltic Sea area

Supplementary themes

2.3 Integrated approaches to coastal management
4.3 Maritime spatial planning from local to Baltic Sea region scale



BONUS ESABALT

Enhanced situational awareness to improve maritime safety in the Baltic

National Land Survey of Finland, Finnish Geospatial Research Institute

heidi.kuusniemi@nls.fi

BONUS funding: EUR 0.4 million

Duration: 2 years, 1.3.2014-28.2.2016



The publishable summary of the BONUS ESABALT final report, including the main results achieved during the project, is available online at www.bonusportal.org/esabalt

Introduction to the project as first published in BONUS Briefing 29

*Written by **Heidi Kuusniemi** Coordinator of BONUS ESABALT*

A novel citizens' crowdsourcing solution has been developed for increased sharing of and access to the maritime information by BONUS ESABALT. 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.

Project partners

Finland

National Land Survey of Finland, Finnish Geospatial Research Institute, Kirkkonummi (coordinating partner)
Furuno Finland Oy, Espoo

Poland

Maritime University of Szczecin

Sweden

SSPA, Gothenburg

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.3 User-driven new information and communication services for marine environment, safety and security in the Baltic Sea area

Supplementary themes

2.3 Integrated approaches to coastal management

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

4.3 Maritime spatial planning from local to Baltic Sea region scale

BONUS ESABALT is a flagship project in the policy area SAFE of the EU Strategy for the Baltic Sea Region (EUSBSR).





BONUS GEOILWATCH

Geopositional Early Warning System Integration for Disaster Prevention in the Baltic Sea

Tallinn University of Technology, Estonia

heidi.pihlak@ttu.ee

BONUS funding: EUR 0.5 million

Duration: 2 years, 1.5.2014-30.4.2016



The publishable summary of the BONUS GEOILWATCH final report, including the main results achieved during the project, is available online at www.bonusportal.org/geoilwatch

Introduction to the project as first published in BONUS Briefing 29

*Written by **Heidi Pihlak**, Coordinator of BONUS GEOILWATCH*

BONUS GEOILWATCH 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.

Project partners

Estonia

Tallinn University of Technology (coordinating partner)
Flydog Solutions LCC, Tallinn
Marine Systems Institute, Tallinn University of Technology

Finland

Finnish Meteorological Institute, Helsinki

Latvia

Latvian Coast Guard Service
Ventspils University College

Sweden

Swedish Meteorological and Hydrological Institute, Norrköping

Themes from the BONUS strategic research agenda, update 2014 covered

Key theme

5.3 User-driven new information and communication services for marine environment, safety and security in the Baltic Sea area

Supplementary themes

2.3 Integrated approaches to coastal management

3.1 Enhanced, holistic cross-sector and cross-border maritime risk analysis and management, including effects of new technologies, human element, climate change effects in open water and in ice, and interaction with onshore activities

5.1 Developing and improving scientific basis for integrated monitoring programmes for continuous assessment of ecological status and human pressures



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