**BONUS SHEBA overall goals and expected final results**

BONUS SHEBA’s main goal is to perform a holistic assessment of impacts of operational shipping on the environment of the Baltic Sea region. Through analyses of the drivers for shipping and their impacts on future ship traffic volumes and emission factors, current and scenario emissions to water, to air, and of underwater noise are calculated. This is done using and extending the currently most advanced emission model which is based on Automatic Identification System (AIS) ship movement data combined with both the state-of-the-art emission factors as well as new emission factors developed within the project. Atmospheric, oceanic and noise propagation models in combination with ecotoxicology studies are used to assess spatio-temporal distributions, fates and effects of these stressors in the Baltic Sea region. The project assesses the impact of different pollutants on the water quality indicators of the EU Marine Strategy Framework Directive (MSFD) and Water Framework Directive (WFD) and on air quality indicators. Further, the project will provide an integrated assessment of policy options to mitigate pressures linked to shipping by quantifying as far as possible anticipated changes in ecosystem services, compared to an established baseline. This will include an analysis of the marginal changes in costs and benefits of options to reduce environmental pressures from shipping. BONUS SHEBA is supported by a wide group of stakeholders, including harbours, shipping industry and authorities, who have been consulted in a series of stakeholder meetings. In fall 2017 the project will organise jointly with International Surface Ocean - Lower Atmosphere Study (SOLAS) the 2nd BONUS symposium named ‘Shipping and the environment - From Regional to Global Perspectives’, where the project results will be communicated and aligned with international research in the field.

**Work performed since the beginning of the project**

The project has now been running for 2 years and while work in the first year was focused on the development of tools, the project is now producing results needed for the assessments. After completing the report ‘Drivers for the shipping sector’ containing a summary of relevant key international and national policies affecting shipping for the countries participating in BONUS SHEBA, work carried out on policies, activity data and scenarios has been focusing on the shipping scenarios through stakeholder consultations, literature reviews and project meetings. The work contains the development of a business as usual scenario where current trends are used to project shipping in 2030 and 2040. Scenarios are also being developed for the development of shipping within shared socio-economic pathways (SSPs). This work has been done for the Baltic region by BONUS SHEBA in collaboration with other BONUS projects looking at other sectors. Datasets for commercial shipping that contain gridded data on shipping in the Baltic Sea for 2011, 2012 and 2014 and for the North Sea for 2011 has been produced during the first year. The data covers emissions to air (NOX, CO, CO2, SOX, and particulate matter) and transport work. The data is produced using AIS data combined with the Ship Traffic Emission Assessment Model (STEAM). In addition to the gridded data, summaries are available with emissions and ship statistics divided into different ship types and months of the year. During the second year a database with leisure boat activity has been delivered together with a spatial distribution of the activity and fuel consumption.

For assessment of air pollution from shipping, atmospheric chemistry transport model runs on 4 km resolution were performed for year 2012. They give a detailed picture of the current contribution of shipping to air pollution in the Baltic Sea area. This and other future products, such as indicators for health effects and effects on land ecosystems, were described in the midterm work package report.
(Deliverable 2.2). First scenario calculations for 2040 were started. They focus on effects of the implementation of a nitrogen emission control area in the Baltic Sea in 2021. The city scale simulations for Gothenburg were completed for 2012. For the other Baltic Sea cities in focus, emission inventories that cover all relevant sources including ships have been prepared for the respective local scale simulations.

To assess impact of shipping on the marine environment, load factors for pollutants from black water, grey water, food waste, bilge water, scrubber water, ballast water, stern tube oil, operational oil discharges and antifouling paints have been produced. These load factors have been implemented into the emission model STEAM and a spatio-temporally resolved of pollutants for the entire Baltic Sea has been produced. The first simulations with the coupled 3-d hydrodynamic-biogeochemical General Estuarine Transport Model (GETM) and Ecological Regional Ocean Model (ERGOM) utilizing the spatial resolved emissions and deposition of pollutants from air have been performed. Furthermore, a field sampling campaign in the Baltic Sea has been finalised, where both atmospheric and water pollutants were measured.

The work package on underwater noise has finalised development of the noise source model. The BOUNDS SHEBA approach calculates the noise energy (Joules) emitted from ships at specific frequency bands and the noise source maps have thus far been produced for 2014. Noise propagation studies in two selected pilot areas, first near southern Gotland and second the entry to Gulf of Finland, are in progress. The experimental campaign concerning tracking of fish behaviour as a function of underwater noise level was completed during the summer 2016 and analysis of the data is underway.

‘Report on development of analytical framework for assessment of shipping and harbours in the Baltic Sea’ was published during the reporting period. It provides the evolution and an assessment of the Drivers Pressures State Impact Response (DPSIR) framework and presents how the framework was adapted to shipping in the Baltic Sea. Finally, the interlinkages of the BONUS SHEBA DPSIR for shipping in the Baltic Sea and potential indicators are included. In the second year of the project the main focus has been on further development of the framework, including stakeholder consultation.

The project has organised 2 stakeholder meetings. The first, hosted by Helmholtz Zentrum Geesthacht in Hamburg, Germany, in September 2015, was organized in form of World cafés facilitating collaborative dialogue and the sharing of knowledge and ideas on topics of air, water and underwater noise pollution from shipping, technical and socioeconomic future developments as well as shipping policies. The second was an expert elicitation workshop, using a quantitative method, which has been conducted to support the scenario building and development of the assessment framework in the project.

Several dissemination activities took place; among them were a discussion panel and an exhibition during the Almedalen politicians’ week on Gotland, Sweden. The project has produced 4 newsletters which can be downloaded at www.sheba-project.eu. The concept of the SHEBA data portal was finalized and the actual interactive portal was activated. First concepts of the educational material based on BONUS SHEBA results have been developed. These activities have established a close contact of the project with stakeholders, the project has been supporting both HELCOM and several national authorities with expertise for their policy work at IMO and EU.

BONUS SHEBA project has received funding from BONUS (Art 185), funded jointly by the EU, Innovation Fund Denmark, Estonian Research Council, Academy of Finland, Forschungszentrum Jülich Beteiligungsgesellschaft mbH (Germany), Research Council of Lithuania, National Centre for Research and Development (Poland) and Swedish Environmental Protection Agency.
BONUS SHEBA is a flagship project of the EU Strategy for the Baltic Sea Region (EUSBSR) and regularly participates on meetings of the international steering board of EUSBSR Policy Area Ship. BONUS SHEBA is a part of the Baltic Earth (www.baltic-earth.eu).

Main results achieved during the reporting period, including potential impact and use envisaged by the results noted (including the socio-economic impact and the wider societal implications)

1. The work on scenarios has produced predictions of emissions to air and water as well as underwater noise for present times, 2030 and 2040 for shipping in the Baltic Sea.
2. A database with leisure boat activity has been delivered together with a spatial distribution of the activity and fuel consumption.
3. Load factors of shipping-related water contaminants have been implemented into the Ship Traffic Emission Assessment Model (STEAM) and a spatio-temporally resolved emission inventory of pollutants for the entire Baltic Sea has been produced. First simulations with the coupled 3-d hydrodynamic-biogeochemical marine model GETM-ERGOM utilizing the spatial resolved emissions and deposition has been produced.
4. Project has finalized a field sampling campaign in the Baltic Sea shipping lanes, where both atmospheric and water pollutants were measured.
5. The BONUS SHEBA approach calculates the noise energy (Joules) emitted from ships at specific frequency bands. This additive quantity can be used not only as a noise map visualisations, but also as an indication of annual changes of shipping noise emissions in various parts of the Baltic Sea.
6. The experimental campaign concerning tracking of fish behaviour as a function of underwater noise level was completed during the summer 2016. Preliminary analysis revealed that upon exposure to loud shipping noise, a cautious defensive reaction was observed. However, clear panic reaction or physical injury were not observed.
7. BONUS SHEBA has organised exhibition and seminar of cluster of 5 BONUS shipping projects on Swedish politicians’ week in Almedalen. For the seminar, the BONUS projects invited Swedish politicians and representatives of authorities and industry to take part in a panel discussion attended by some 50 participants at the West Swedish Arena on 3 July 2016. For three days, the research sailing vessel Hrimfare was open for visitors and an exhibition tent provided further possibilities to discuss with BONUS experts cleaner and safer shipping and view sea videos, posters and demonstration of equipment related to the BONUS projects.

BONUS SHEBA project has received funding from BONUS (Art 185), funded jointly by the EU, Innovation Fund Denmark, Estonian Research Council, Academy of Finland, Forschungszentrum Jülich Beteiligungsgesellschaft mbH (Germany), Research Council of Lithuania, National Centre for Research and Development (Poland) and Swedish Environmental Protection Agency.