SHEBA NEWS

// Dear Reader ...

Welcome to the 3rd SHEBA newsletter, which aims to inform project collaborators, stakeholders affected by Baltic shipping and interested scientists on the content and development of SHEBA.

SHEBA is running now for more than a year. The work packages are proceeding with their research programmes. During a project meeting in May in Helsinki the consortium members exchanged information on the status of their specific tasks and discussed the upcoming steps (see summary under "Inside SHEBA"). As the development of relevant scenarios is crucial for the project at this stage, scenarios and their role within SHEBA are introduced following these introductory lines. The featured topic of this newsletter is underwater noise, an evolving subject with importance in marine ecology.

We hope you enjoy reading this issue, and welcome any feedback via the contact information given on the last page,

Jana Moldanova (IVL) and Markus Quante (HZG)

// "On SHEBA"

Scenarios and their role in SHEBA

By Erik Fridell (IVL) and Benjamin Boteler (Ecologic)

Scenario development is central in the research of SHEBA in order to understand how shipping could potentially impact the environment and society in the Baltic Sea region in the future as well as how technologies or policies could be used to address these impacts. This note describes the scenario development in SHEBA and which scenarios will be developed.

For a systematic analysis of potential futures it can be very helpful to develop scenarios. For example, climate research depends on scenarios to describe the changes in climate depending on the development of emissions of greenhouse gases, development of technology for mitigations and to illustrate the uncertainties in the development. Scenarios can also be used to illustrate the effect of specific changes, which may or may not be realistic, such as how the climate would change if nuclear power is quickly phased out. Scenarios are also used to assess economic or social development in different futures and how these might impact activities that affect the environment and vice versa.

Knowledge about the current state of the global system but also of regional systems is incomplete. There also exist many uncertainties regarding the drivers of change and how they influence these systems. But even if all information were available, there are still turbulent behaviours, extreme sensitivity, and tipping points. Human behaviour and choices strongly influence the future, and it is impossible to know how actors will behave in the future and what consequences this might have.

Using scenarios provides an opportunity to explore a variety of long-term alternatives. They provide a way of making a very complex, highly uncertain picture of the future understandable by narrowing down the range of variables that affect these alternatives. The risk that scenarios do not adequately capture the range of possible alternatives increases the further into the future they seek to look. Kosow and Gaßner (2008) define a scenario as an outline of a possible future alternative that includes the development paths that led to this situation. Aside from a simple picture of the future, scenarios include developments, dynamics, and drivers to picture a possible future situation. Rather than telling the story of one particular future status quo, a scenario should display relevant key factors in the field and their potential influence.

Scenarios for shipping in the Baltic Sea for the years 2030 and 2040 are developed in SHEBA. They are used to assess the impact of shipping on the Baltic Sea area environment and the ecosystem services on which humans depend. In SHEBA scenarios were developed after a literature survey and stakeholder consultations, mainly during a physical meeting, in order to elucidate trends for shipping and what possible future alternatives would be relevant for further studies. A workshop within the consortium was also arranged where it was decided which scenarios to investigate within SHEBA.

A Business As Usual (BAU) scenario is constructed as a reference scenario for all other scenarios. It is based on current trends in shipping and takes into account already decided policy measures and technologies as well as economic and social factors. This includes, for example, the Energy - Efficiency

Index (EEDI) regulations and the grey water regulations for the Baltic Sea. The trends in shipping are analysed from Automatic Identification System (AIS) data from many years and combined with an analysis of the different shipping sectors to obtain the development regarding transport work, ship size, ship speed and number of ships for different ship types. In combination with assumptions on ship age distribution and upcoming regulations this gives the possibility to calculate emissions to air and water and underwater noise.

A number of single scenarios are constructed in order to delve further into specific questions that arose during the stakeholder consultations and within the consortium discussions. The following questions are studied to understand the possible impact of shipping on the Baltic Sea region on air quality, water pollution, under water noise emissions and on society:

- What is the effect of further extension of slow steaming in the Baltic Sea?
- What is the effect of a modal shift from land to sea?
- What is the impact of an introduction of a Nitrogen Emission Control Area (NECA) by 2021?
- What would be the effect if emissions to water from shipping are eliminated?
- What would a large introduction of Liquid Natural Gas (LNG) as a marine fuel imply?
- What can be done with further environmental regulations for leisure boats?
- What can be achieved with measures in ports that restrict the use of auxiliary engines?

Cumulative scenarios are also being developed where alternative futures built on the interaction of a number of different factors are analyzed. So called Shared Socioeconomic Pathways (SSP) that were developed for the climate community have been adapted and the outcome for shipping in the Baltic Sea is assessed. Three SSPs are chosen: SSP1 “Sustainability” with concern for the environment and high degree of technical development; SSP2 “Middle of the road” here interpreted as the same as the BAU scenario; SSP3 “Fragmentation” with regional development, fossil fuel dependence and low degree of environmental concern. For each of these three SSPs the characteristics and volumes of shipping have been analyzed to make it possible to calculate emissions to air and water, underwater noise, and socioeconomic effects. The scenarios described above will be used in BONUS-SHEBA to analyse emissions to air, emissions to water, impact on under water noise, influence on ecosystem services and socioeconomic effects as well as the effects of different policy options. Depending on the nature of the scenarios, and the changes vs. BAU that are expected, some scenarios will be selected for detailed analysis of emissions to air, emissions to water and underwater noise, respectively. Air pollution will be studied with dispersion modeling, emissions to water with detailed modeling of the distribution of pollutants within the Sea, and underwater noise with a model developed in SHEBA for underwater noise distribution.

In addition, scenarios will be used to understand the potential effect of shipping on ecosystem services and human wellbeing, and ultimately the policy options available to tackle environmental challenges. Towards the end of BONUS-SHEBA the results of these studies will be summarised.

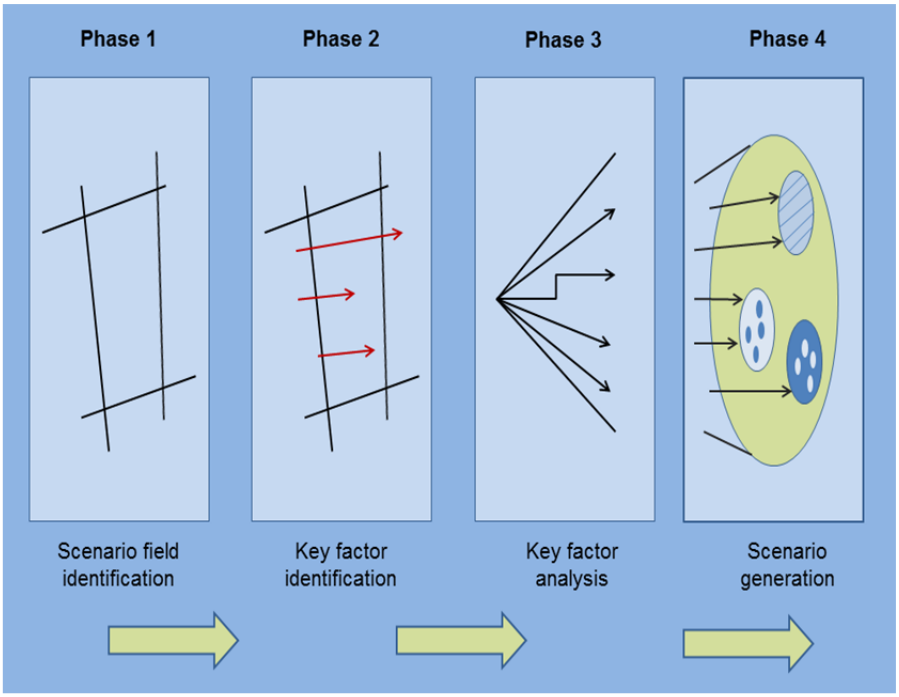


Figure 1 Four Phases of the general scenario process. After Kosow and Gaßner, 2008.

Furthermore, the information obtained will be used to construct a Sustainable Shipping Scenario. This is a back casting scenario were the boundary conditions are that externalities from shipping should not have adverse effects on the Baltic Sea region and will thus aim at describing what we want shipping to be in the future.

Cited references

Kosow, H., and R. Gaßner, 2008: Methods of Future and Scenario Analysis: Overview, Assessment, and Selection Criteria. Bonn, (DIE Studies 39).

// “Featured Topic”

Underwater noise produced by ships

By Jukka-Pekka Jalkane (FMI)

General

There are several sources of underwater noise ranging from natural (seismic, wind, rain, sea ice) to anthropogenic, man-made sounds (construction work, explosions, boating, sonars, ships). SHEBA concentrates on the continuous underwater noise produced by ships. Propeller, machinery and flow noise are generated during a vessel voyage and sound source levels have clear dependence on vessel speed. The faster you go, the noisier you tend to be. This depends on the propeller features of the vessel, though.

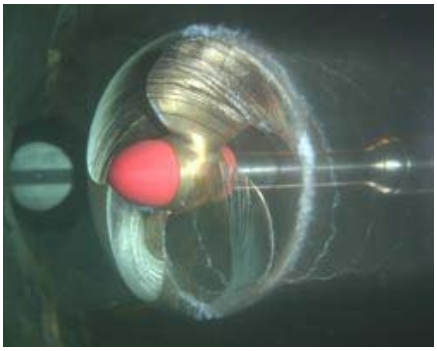


Figure 2 Propeller testing in the cavitation laboratory of the Norwegian University of Science and Technology. Image by NTNU.

In SHEBA, a recent sound source model was chosen (Wittekind, 2014) which is a kind of “engineer’s approach” shipping noise modeling. In this approach, the noise comprises of three primary contributions, low and high frequency propeller cavitation and machinery noise. Fast rotating propeller in water makes air bubbles and as they collapse, cavitation occurs. The propeller design, one of the key factors affecting the energy efficiency of a ship, plays a very important role also in underwater noise. With military vessels, sound has always been a matter of life and death, but with civilian shipping this has not been the case. Lacking the regulatory actions, designs of quiet commercial ships have not been a priority. Further, if silent designs increase the cost of the vessel, not many would voluntarily pay the higher price.

Modeling

In SHEBA, vessel noise is modeled combining ship technical data in conjunction with signals from vessel navigation equipment (AIS; Automatic Identification System). With this combination, it is possible to identify each vessel and study its movement every minute in the Baltic Sea, which helps us to understand how high the continuous shipping noise under the sea surface really is.

Just like the traditional air pollutants, like NO_X, SO_X and PM which behave differently in the atmosphere, noise dispersion will change depending on the signal frequency. High frequency sound does not travel very far from the vessel, but low frequency sound can be heard far away from the source. The continuous noise from ships is loudest in the 10Hz-1kHz range which is also relevant to many fish species. Ship source levels as high as 190 dB have been recorded under water. In air, this would be painful for human ears too, corresponding to almost 130 dB.

Impacts

Not all fish are the same, however, when sensitivity to sound is considered. Species like herring, sprat and cod have excellent ability to detect pressure changes (hear), whereas salmon, sharks and flounder mostly detect changes in kinetic energy of particle motion. This is because if air filled cavities (swim bladder, air bubbles) exist close to the ear, sound, or pressure changes, will be detected.

Higher frequency sounds can be heard by many marine mammals, like seals and porpoises, which use sound as a means of communication. In these cases, shipping noise can mask the sound based underwater communication and make it more difficult to find a mate. Loud enough noise can cause a temporary hearing loss or even physical injury, but indirect effects may include habitat loss or decrease in population size. Long term monitoring of fish and underwater noise

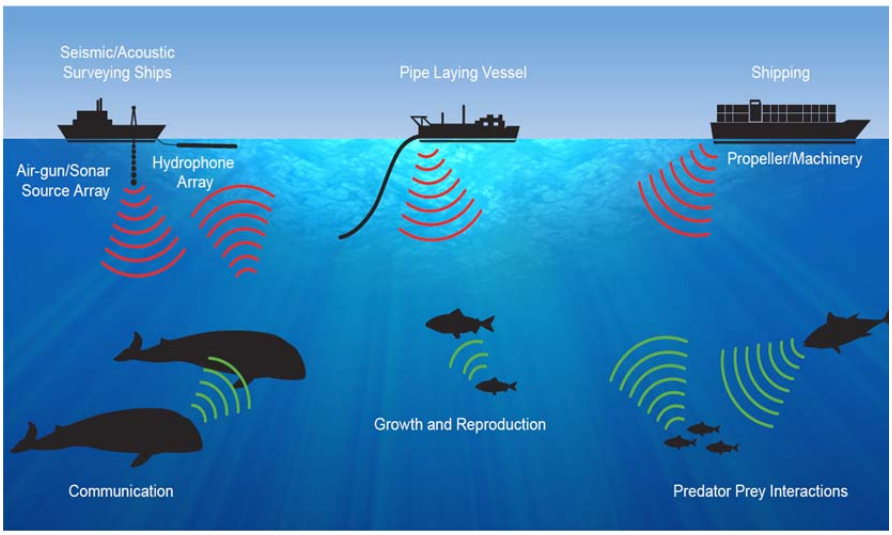


Figure 3 Underwater sound. Image from SSPA highlights, 61/2015.

would be required to determine changes over time in fish habitats and spawning areas.

In SHEBA, we will conduct controlled experiments with playback of recorded shipping noise and observations of fish behavioral changes. Previously recorded vessel noise from previous projects, like the Baltic Sea Acoustic Soundscape (BIAS), will be played back to fish. This will be done in a natural environment and fish will be monitored with special sonar equipment which allows us to see fish movements. These field studies will take place during the summer of 2016 and it will tell us whether shipping noise causes observable changes in fish behaviour.

Policy outreach

Currently, EU Marine Strategy Framework Directive (MSFD) requires that the member states also include noise monitoring in their activities to mitigate harmful impacts on the environment. However, there are some aspects of underwater noise, like recreational boating, which have not been considered by the directive. Also, the frequency range required by the directive may be too narrow since the hearing ability of marine mammals extends beyond the MSFD noise monitoring requirements. At the IMO level, technical recommendations to reduce underwater noise levels of ships have been agreed, but thus far noise has not been regulated at a global level. Possible options to mitigate the impact of underwater noise include vessel design changes, speed reductions and better maritime spatial planning. The modeling tools developed in SHEBA will give us new insight in the effectiveness of these options.

Cited references:

D. K. Wittekind, 2014: A simple model for the underwater noise source level of ships. *Journal of Ship Production and Design*, 30(1):1–8.

// "Inside SHEBA"

This rubric will briefly introduce over the set of newsletters the partner of SHEBA as well as key personnel. Last time we introduced Chalmers University of Technology and Helmholtz Centre Geesthacht– now we continue with the Finnish Meteorological Institute and the Swedish Research Defence Agency.

Finnish Meteorological Institute

The Magnetic Observatory of the University of Helsinki, from which the Finnish Meteorological Institute (FMI) started, was founded in 1838 by the Russian emperor Nicholas I. Nowadays FMI is a national weather service under the Finnish Ministry of Traffic and Communications. The foundations of all FMI activities are anchored in extensive research and development as well as modern observation and IT technologies. FMI provides innovative and user-driven weather, climate, maritime, ice and environment services for a wide variety of public and private sector customers in Finland and worldwide. FMI employs 720 people, half of which work in research and development.

The Finnish Meteorological Institute

- observes the physical state, chemical composition and electromagnetic phenomena of the atmosphere
- observes the physical state of the Baltic Sea and the Arctic sea areas
- produces high-quality information and services about the past, present and future states of the atmosphere and seas
- conducts high-standard research and development in the fields of meteorology, marine sciences, air quality, space physics and earth observation
- plays an active role in national and international cooperation
- actively distributes information to decision makers, the business world and the general public about matters related to the atmosphere, seas and near space
- predicts changes and responds quickly to environmental changes and changing conditions.

The research group involved in SHEBA is the Atmospheric Dispersion Modelling, which concentrates on the modelling of atmospheric compounds in micro to global scales. The group develops and evaluates the full range of air pollution dispersion, exposure, and emission models, and other mathematical modelling techniques (such as Computational Fluid Dynamics). The models are used in international and national projects as well as operational air pollution forecasting.

FMI people involved in SHEBA are:

Adj. Prof, Mikhail Sofiev, Atmospheric dispersion modelling, WP2

Dr. Jukka-Pekka Jalkanen, Ship Emissions, WPs 1-4

Dipl. Eng. Lasse Johansson, Ship emissions, WPs 1-4

The Swedish Research Defence Agency

The Swedish Research Defence Agency (FOI) is one of Sweden's largest research facilities in the field of applied marine research. About 40 people are employed working solely with underwater research. FOI underwater research is focused on developing marine surveillance and warning systems, which are often based on advanced sensor technology. The underwater activities are focused on sensor systems, underwater communication and ship signatures. FOI has established a unique experience by combining experimental research with an advanced understanding of the underwater environment, underwater sensors, acoustic and electromagnetic wave propagation, hydrodynamics and signal processing.

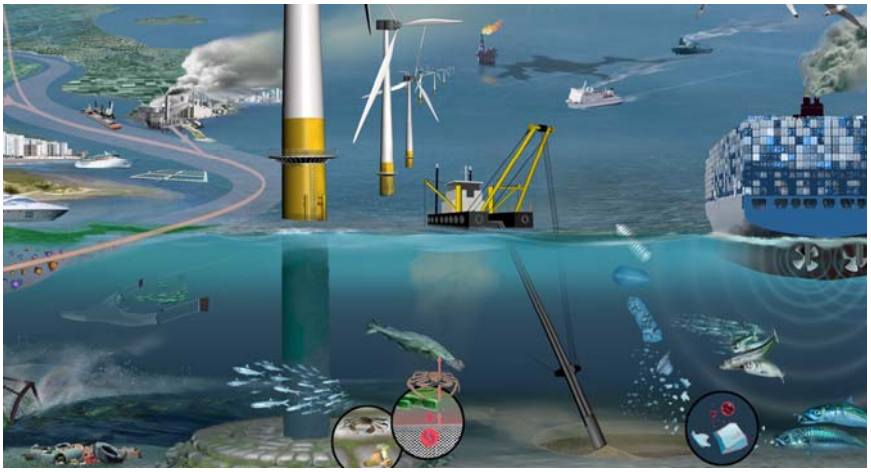
FOI has been involved in several commercial applications as well as environmental investigations such as pipeline inspection, energy exploration and studies of effects of acoustic noise on the marine environment. The last years FOI has been a major European actor in environmental studies focused on impact of underwater noise. FOI has been coordinating and participating in several EU-projects studying the impact of noise on the marine environment and one of them is SHEBA.

FOI people involved in SHEBA are:

Dr. Peter Sigray, Research Director FOI, Adjunct Professor at Stockholm University, WP 4

Dr. Martin Östberg, Researcher at FOI, WP 4

Dr. Ilkka Karasalo, Emeritus Research Director at FOI, Adjunct Emeritus Professor at KTH, WP 4



Graphic: Glynn Gorick

SHELF – Stakeholder elicitation

By Lena Granhag (Chalmers)

A course in the Sheffield Elicitation Framework (SHELF) took place on the 25th- 27th of May 2016 in Sweden at Chalmers University of Technology in Gothenburg.

Elicitation and SHELF

Elicitation is the process where expert knowledge about one uncertain quantity can be captured together with a probability distribution. The idea of the course is to learn and start using a formal procedure in the gathering of expert judgements to ensure the quality of the results.

The **SH**effield **EL**icitation **F**ramework is a method to carry out the elicitation of probability distributions for uncertain quantities from a group of experts and stakeholders. Elicitation is important for quantifying expert knowledge in situations where exact data are sparse. This is often the context in which policy decisions are made. It is generally important to elicit from a group of experts in order to synthesize the range of knowledge and opinions of the expert community.

In SHEBA the skills in expert elicitation achieved during the training course will be used in the three upcoming stakeholder workshops which will be held back to back with the SHEBA project consortium meetings.

Photo: M. Quante

The Course in May

On the course in May Anthony O´Hagan (University of Sheffield), one of the developers of the SHELF method, held lectures about the

framework and the method for expert elicitation (day 1) followed by demonstrations (day 2) and practical exercises (day 3). The course had participants from HZG, IVL and Chalmers. The course participants from among the SHEBA consortium were trained in the method and during the practices acted as elicitation session's facilitators, recorders or experts with given roles. The recorders were trained in how to use the SHELF software. In the practices we worked with three cases or dossiers, targeting the following questions.

- What is the number of scrubber-installations on ships trading in the Baltic Sea in 2030?
- Who is the phosphorous content in cruise ship generated sewage in the Baltic Sea?
- And how big are particle emissions from Anti-Fouling (AF) paint during hull cleaning outside Helsinki?

Financing and Future use

The financing of the course and parts of the coming stakeholder workshops where expert eliciting will be used are granted from Swedish Institute, Baltic Sea Unit: https://eng.si.se/

On the SHEBA stakeholder-workshop in Talinn, Estonia in October 2016 we will start using the method for certain questions. Further will the method be used in Gdansk, Poland in spring 2017 and at the final SHEBA meeting in Gothenburg in autumn 2017.

Photo: M. Quante

The material from the SHELF course is available to all SHEBA participants and available via the author of this article.

// "Meetings/Events"

SHEBA project meeting in Helsinki

By Ingrid Mawdsley (IVL)

One year into the three-year SHEBA project, a project meeting took place on 18-20 May in Helsinki. It was hosted by the Finnish Meteorological Institute.

Photo: M. Quante

On Wednesday May 18, the project discussions started with work package meetings for all six operative work packages. One year into the project, the work packages are at different stages, with several deliverables behind them and much to discuss for the work ahead. This was also a good opportunity to discuss interactions between different work packages, such as scenarios and the assessment framework.

The second day started with the invited speaker of the meeting, Jorma Kämäräinen, Chief Advisor at the Finnish Transport Safety Agency, presenting the current state of emission regulations for ships. Thereafter, Andris Andrusaitis from the BONUS secretariat summarized the project progress in terms of deliverables and reports. This was followed by an overview of the project progress as presentations on each work package were given. The presentations provided an overview of the results that have been achieved so far, what obstacles have come up and how these have been resolved, as well as what lies ahead. The presentations also put the different work packages in correlation to each other and helped shedding light on the links and interactions between work packages.

After a full day of interesting presentations and discussions, dinner was held at Suomelinna fortress just off the coast of Helsinki. After a short boat trip and walk through the picturesque surroundings, the fortress offered beautiful views of the coast of Helsinki. Dinner was inspired by traditional Finnish cuisine and was served in the historical settings of the fortress.

The second day of the meeting continued with more interesting work package presentations. Among other things, the status of the noise experiments on fish was presented and the audience was treated to samples of underwater noise.

Photo: M. Quante

All in all, the project meeting was successful and a good opportunity for the project members to meet and discuss issues in detail as well as get a good overview of the project progress.

Photo: M. Quante

SHEBA shipping cluster outreach and sailing campaign in summer 2016

By Jana Moldanová (IVL)

During June-July 2016, the SHEBA project organised a combined measurement and outreach campaign on the research sailing ship Hrimfare of Ranrike.

Taking water samples on Hrimfare. Photo: J. Moldanová

During the first part of the campaign, en route from Gothenburg to Visby, Gotland, researchers from the BONUS SHEBA and PINBALL projects, sampled water and air on several transects crossing the main shipping lines in Kattegat and in the Baltic proper. Researchers were looking for fingerprints of the shipping in the water column and in the air, performing continuous measurements of water and air composition, taking water samples as well as samples of water- and air-born particles for further analyses.

Among the parameters which were analysed were temperature, salinity, pH, alkalinity, concentration of metals, nutrients, oil residuals, PAHs, elemental composition and microstructure of particles, and atmospheric concentrations of NO_X, CO_2, SO_2, size-resolved particulate matter and soot. The campaign crew proved their dedication to the science, having successfully managed the sampling, sometimes in harsh weather conditions, and combining the intensive scientific programme with non-stop sailing.

Discussing the safe and clean shipping in the Baltic Sea infront of the Bonus projects' exhibition tent on Swedish politicians' week in Almedalen. Photo: J. Moldanová

In Visby, Gotland, Hrimfare switched from expedition research vessel into a floating exhibition and hotel during the Swedish politicians' week in Almedalen. Researchers from BONUS SHEBA were joined by colleagues from other BONUS projects CHANGE, ZEB, BALTSPACE and ESABALT.

BONUS shipping cluster organised panel discussion, 3 July 2016. Photo: Stjepan Budimir

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. The topic of the discussion was about how citizens, boat owners, harbour operators, shipping partners, authorities and politicians can help to decrease undesired environmental impact caused by shipping and boating in the Baltic Sea.

For three days, Hrimfare was also 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.

SHEBA presented during 1st Baltic Earth Conference

By Markus Quante, (HZG)

The first Baltic Earth Conference took place from 13 to 17 June 2016 in Nida, Curonian Spit, Lithuania. It was devoted to multiple drivers for Earth system changes in the Baltic

Sea region and as such also shipping in the Baltic Sea was of interest. SHEBA was introduced to the participants by Jana Moldanová during this well attended meeting.

Jana Moldanová presenting SHEBA at Nida. Photo: Baltic Earth

Many of the talks presented in Nida were of relevance for different SHEBA topics ranging from basic physical oceanography and biogeochemical processes (like marine acidification) and feedbacks to environmental hazards. During the discussions and social events contacts to researchers interested in shipping and environment could be established or fostered, even leading to ideas for common activities.

SHEBA presented during the „Forschung vor Anker“ tour of Helmholtz-Zentrum Geesthacht

By Volker Matthias (HZG)

Since 2009, scientists from Helmholtz-Zentrum Geesthacht (HZG) present their research to the German public during the „Forschung vor Anker“ tour of the HZG-owned research vessel “Ludwig Prandtl”. This year, the ship went between 4 and 8 July to the Baltic Sea ports Wismar and Heiligenhafen as well as Rendsburg at the Kiel Canal. SHEBA was one of the foci of the presentations on board of the ship. HZG scientist Matthias Karl showed results of atmospheric chemistry transport model simulations and explained what SHEBA is about.

The visitors could listen to underwater noise and watch a presentation on shipping emissions and their impact on air quality at the Baltic Sea coast. Typically, a few hundreds of people are attracted by the tour and visit the ship.

Photo: M. Quante

Besides the exhibition on board, scientists also gave evening talks and discussed their findings with the audience. SHEBA was presented in a 30 minutes talk by Volker Matthias in Rendsburg. The tour will be repeated in other German harbours next year. Certainly, the impact of shipping on the environment in the Baltic Sea region will again be one of the topics that gains high interest from the public.

Progress of SHEBA presented during EUSBSR-Steering Committee meeting

SHEBA is a flagship project of EUSBSR PA Ship (EU Strategy for the Baltic Sea Region – Policy Area on Clean Shipping). The 6th international Steering Committee meeting of EUSBSR PA Ship took place on 14 and 15 April 2016 in Copenhagen. During this meeting Markus Quante (HZG) reported on progress that SHEBA has made since the last meeting and discussed common issues with other clean shipping related projects present at the meeting. Among many other topics presented in Copenhagen were presentations highlighting news from the European Commission of relevance to the Baltic Sea region and the Interreg Baltic Sea Region Programme 2014 to 2020.

Upcoming:

Fehmarn Belt Days 2016

The Fehmarn Belt Days 2016 will take place between 20 and 22 of September at the HafenCity University in Hamburg, Germany. More than 450 participants have already registered for this event. During the scientific section of the program SHEBA will be part of presentations given by Erik Ytreburg, Chalmers University, and Markus Quante, HZG.

Green Cruise Port- BSR Interreg Project meeting in Hamburg

The opening conference of the BSR Interreg project “Green Cruise Ports – sustainable development of Cruise Port Locations” will be held on 27 September 2016 in Hamburg (contact: m.thom@uniconsult-hamburg.de).

SHEBA Consortium and Stakeholder Meeting in October 2016

The next SHEBA project meeting and stakeholder consultation will take place on the 12th and 13th of October 2016 in Tallinn, Estonia. Dedicated working package gatherings will precede the meeting on the 11th of October.

BONUS
SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

SHEBA

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