D4.2 REPORT ON WORKSHOP ON SCENARIOS

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PREFACE

The aim of the BONUS Pilot Scenario Workshop, organized 6-7 April 2016 in Helsinki, was to develop harmonised regional storylines of socio-ecological futures in the Baltic Sea region. Based on the background material (Part 1 of this publication) and plenary and panel sessions (see Part 2 of this publication for workshop agenda), the workshop participants worked in three groups through three themes: eutrophication, marine traffic, and biodiversity (Part 3 of this publication).

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Background Material

BONUS Pilot Scenario Workshop 6-7/4 2016

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BOX 1. List of abbreviations / vocabulary

AR5 – 5th Assessment Report of the IPCC

Pathways – conditions that describe specific components of the future, e.g. climate change (RCPs) or socio-economic circumstances (SSPs).

RCP – Representative Concentration Pathway describing a consistent trajectory of future climate development and land use change.

Scenarios – plausible, comprehensive, integrated and consistent description of how the future might unfold; integrating climate change, societal developments and possibly also policy assumptions.

Socio-economic - covers socio-ecological systems including demographics, political, social, cultural, institutional, life-style, economic & technological aspects and the conditions of ecosystems and ecosystem services that have been affected by human activity such as air, water quality, biodiversity and ecosystem form and function.

Storyline/narrative - are qualitative descriptions of the relationships among different trends and socio-economic developments assumed in a scenario.

SPA – Shared climate policy assumption capturing the goals, instruments and obstacles of mitigation and adaptation measures. Constitutes the link between RCP and SSP.

SSP – Shared Socio-economic Pathway describing possible socio-economic futures without climate change and climate impacts.

1 Aim of scenario workshop

Welcome to the BONUS pilot workshop on scenarios. We look very much forward to constructive and inspiring debates, exchanges and collaboration over the 2 days.

The aim of the workshop is to take the first steps to explore and develop harmonized scenarios for future developments of multiple regional drivers and pressures that affect the Baltic Sea and that can be associated with readily available global climate and socioeconomic pathways (RCPs and SSPs). The focus of the workshop is the expansion of the basic Shared Socio-economic Pathways (SSPs) for the Baltic Sea Region.

The workshop serves the purpose of:

- debating a conceptual framework of regional storylines for the Baltic Sea up to 2100;
- exchanging ideas on plausible future sectoral developments; and
- exploring possibilities of further collaboration between ongoing BONUS projects and stakeholders.

For use in analyses in several Bonus projects, there would be clear benefits of working together to:

- Extend the SSPs to the sectors of interest and for the Baltic Sea region up to 2050 and 2100; and
- Develop the narrative and quantitative scenarios that integrate emissions (both climate and nutrients), climate impacts, socio-ecological systems including consumption/management patterns for relevant sectors (fisheries, agriculture, tourism…), projections of water quality, and policy assumptions.

Based on the workshop, a collaborative journal article on regionalized scenarios for the Baltic Sea could be envisaged. The group work will be built based on environmental problems that the participants have the most interest in. Our intention is to cover several environmental problems.

1.1 Homework before the workshop

In order to speed up the process in the workshop, some homework is recommended:

1. Please take time to familiarize with this document, and in particular the concept of shared socioeconomic pathways;
2. Consider which is the environmental problem/focus and type of questions you are the most interested in working with;
3. Give a thought to the economic sectors that cause the pressure and are main contributors to the environmental problem at hand; and
4. Consider the different likely developments in the sector/environmental problem of your interest and how this could be linked to the different baseline scenario(s) for global climate and socioeconomic outcomes.

Please forward us your thoughts and information on the points above in advance of the workshop to allow for a head-on start at the workshop to mz@envs.au.dk.

This document first provides a brief introduction to the three dimensions in the scenario matrix framework developed in the scenario process for AR5: RCPs, SSPs, and SPAs in Section 2; next, in Section 3, it suggests a conceptual framework based on the scenario matrix framework and the DPSIR framework. Section 4 contains the qualitative storylines or narratives of the five SSPs and Section 5-6 the quantitative narratives at global scale and for the Baltic Sea region. Section 7 suggests a format for discussing the extension of the SSPs to socio-ecological systems of interest to participants in the workshop.

2 Introduction to the Scenario Framework

The Intergovernmental panel on climate change (IPCC) and the research community have prepared a set of global scenarios to support climate change research. The scenarios cover a wide range of plausible futures and elaborate their potential consequences to ecosystems, human welfare, and societal decision making. The goal of scenarios is not to predict, but rather to help us better understand the challenges and uncertainties attributed to alternative futures.

The causal thinking behind the work with climate scenarios goes as follows: socioeconomic factors (our tastes, consumption patterns, etc.) and the technologies available determine the level of anthropogenic greenhouse gas emissions. These emissions increase radiative forcing, warm earth's climate, and reduce the future generations' possibilities to enjoy from multitude of ecosystem services our biosphere produces. This threat gives raise to mitigation policies that aim at slowing down and eventually end warming and its negative consequences, and adaptation policies to make society better prepared for the changes in climate and ecosystems.

In order to allow simultaneous development of models and tools needed in developing integrated scenarios, IPCC has adopted a so-called "parallel approach" in its last Fifth Assessment Report (AR5). It takes alternative developments of global greenhouse gas and aerosol concentrations (representative concentration pathways, RCPs) as a starting point. There are four alternative RCPs that together represent broad range of climate outcomes for the period 2000-2100. Each RCP can be made consistent with alternative socio-economic pathways because different socio-economic futures could give rise to similar changes in atmospheric composition.

The climate change research community has formed an International Committee On New Integrated Climate change assessment Scenarios (ICONICS)[1] to develop SSPs to be used in conjunction with the RCPs. Shared Socioeconomic Pathways consist of qualitative narratives for 5 distinct socio-economic futures. Researchers have also taken steps to use Integrated Assessment Models to prepare quantitative scenarios of socio-economic changes, including changes in demographics, technology, energy and land-use that are consistent for the combinations of SSPs and RCP pathways.

Coherent combinations of climate and socioeconomic scenarios describe the challenge space for mitigating climate change and to adapt to the changes. Coherent combinations of RCPs and SSPs can be also integrated with climate policy assumptions that together scan the potential future developments with new climate policy.

2.1 Representative Concentration Pathways (RCPs)

The Representative Concentration Pathways (RCPs) which represent the anthropogenic interference with the climate system and represent the current reference pathways of climate change. They provide a consistent set of trajectories for future atmospheric composition and land use change up to 2100 for use in climate model analyses.

The information from RCPs include emissions of greenhouse gases and short-lived emissions at 0.5x0.5 degree grid scale as well as five categories of land use and land cover (urban, cropland, pasture land, primary land (pristine land, not altered by humans), and secondary land (nature recovering from human disturbance).

[1] http://sedac.ipcc-data.org/ddc/ar5_scenario_process/parallel_nat_scen.html

The RCPs are each defined in terms of the radiative forcing in the year 2100 relative to pre-industrial conditions and direction of change (Moss et al., 2010; van Vuuren et al., 2011):

- In RCP 8.5 GHG emissions are rising over time reaching a radiative forcing higher than 8.5W m^{-2} by 2100 and concentrations more than 1370p.p.m. in 2100;
- In RCP6.0 the total radiative forcing is stabilized at 6.0 W m^{-2} shortly after 2100 corresponding to a stabilization of concentrations around 850 p.p.m. GHG emissions are gradually curbed.
- In RCP 4.5 the total radiative forcing is also stabilized at 4.5 W m^{-2} shortly after 2100 without overshooting the long-run radiative forcing target level based on an assumption of more rapid reduction of GHGs than under RCP6.0. Concentrations stabilise around 650p.p.m.
- In RCP2.6 low greenhouse gas concentration levels are reached. Its radiative forcing level peaks around 3 W m^{-2} by mid-century and declines to 2.6 W m^{-2} by 2100, corresponding to approximately 1.7ºC temperature increase above pre-industrial levels. This would require net negative CO_2 emissions in the second half of the century.

The RCPs do not incorporate socio-economic and ecological data but were developed using idealized assumption about policy instruments and the timing of participation by the international community (Edenhofer et al., 2010).

The effect of the different RCPs conditions on global future climate is simulated by General Circulation Models (GCMs), which are 3D numerical models that aim to represent physical processes in the atmosphere, ocean, cryosphere and land surface. Their typical horizontal resolution is in the order of hundreds of kilometres (between 250 and 600 km), with 10 to 20 vertical layers in the atmosphere and sometimes as many as 30 layers in the oceans. Their resolution is thus quite coarse to study the impacts on a particular area of the globe. Detailed local features, particularly along complex coastlines, cannot be resolved but also many important processes occur at smaller scales and have to be parameterized in the GCM. Hence, for climate change impact and adaptation studies, as well as for climate-process studies of regional importance, high-resolution regional climate models (RCM) are essential (Wang et al., 2015). Regional climate models use GCM results for a particular region as initial and boundary conditions. They operate at much higher resolution and often, with more detailed topography and physical parameterizations. This way, RCM can be used to enhance the detailed regional model climatology and this downscaling can be extended to even finer detail in local models.

The use of different approaches and parameterizations by GCMs can lead to differences in results for future climate and consequently on RCM projections. This is one cause of uncertainty in climate change impact assessment that can, however, be accounted for if several models are used as an ensemble analysis. As an example, Figure 1 compares the climatology from five different GCMs (1980-2006 period) with a climatology resulting from the SMHI data base (the so-called Lars Meuller data base, e.g. Meier et al., 2011, for Gotland Deep, a particular monitoring station, located in the Baltic proper. Generally, in the Baltic Sea area, and for most of the properties, all models are able to well reproduce the seasonal pattern of atmospheric conditions and results are typically within the standard deviation of observations. However, some differences between the models can be noticed and although it is not quantitatively shown, none of the models can be classified as significantly better than the others.

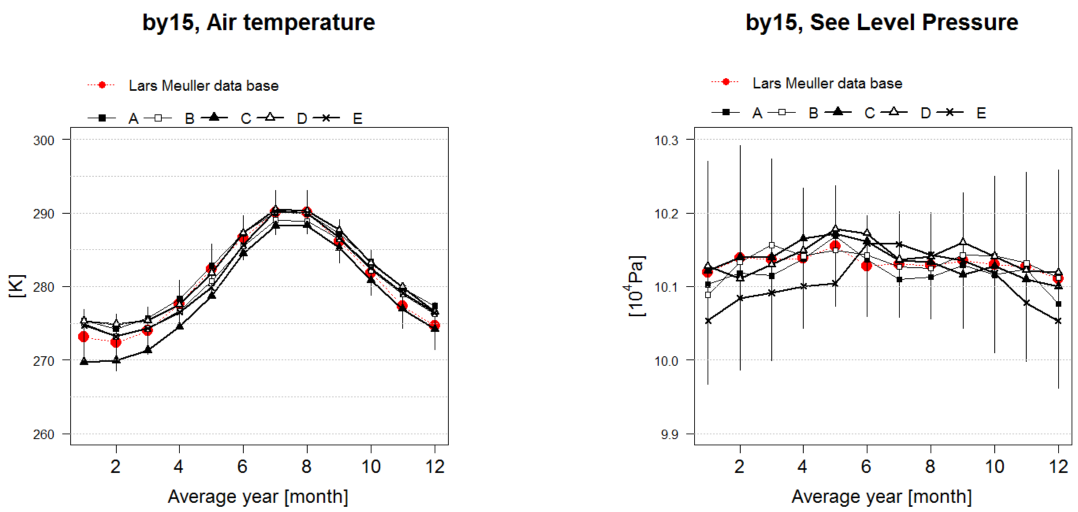
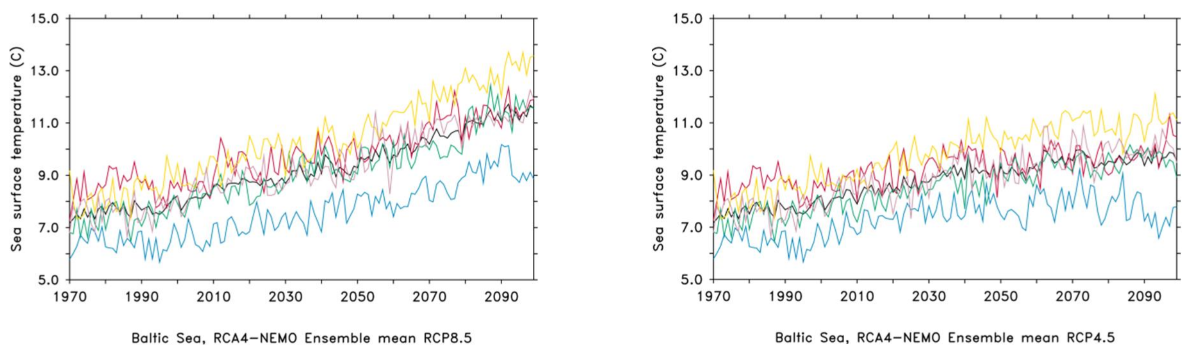


Figure 1. Air temperature and See level pressure: comparison between the climatology computed by five GCMs results and observed climatology for the period of 1980 to 2006. Model A: MPI-ESM-LR (http://www.mpimet.mpg.de/en/science/models/mpi-esm.html); Model B: EC-EARTH (https://www.knmi.nl/kennis-en-datacentrum/achtergrond/ec-earth-goals-developments-and-scientific-perspectives); Model C: GFDL-ESM2M (http://www.gfdl.noaa.gov/earth-system-model); Model D: HadGEM2-ES (http://www.metoffice.gov.uk/research/modelling-systems/unified-model/climate-models/hadgem2); Model E: IPSL-CM5A-MR (http://icmc.ipsl.fr/).

The effect of the different atmospheric scenarios in the Baltic Sea physical conditions can be seen in Figure 2 and 3 below.

Figure 2 presents the mean sea surface temperature and salinity for the whole Baltic Sea obtained with the coupled system consisting of the Rossby Centre regional climate model (RCA4) and the NEMO (Nucleus for European Modelling of the Ocean) ocean model for the RCPs 8.5 and 4.5 using the five different GCMs.

Figure 3 presents the difference between the ensemble mean (the average of all the model results using the different GCM atmospheric forcing) obtained for two periods of 30 years: 2070 to 2099 and 1970 to 1999. The results show significant differences depending on the atmospheric model. For the RCP8.5 scenario, ensemble mean temperature changes would reach a maximum of almost 4ºC and most of the area presents changes above 3 degrees. The RCP 4.5 scenario indicates that the ensemble mean temperature increase would be below 2.5 degrees. In terms of salinity, results point to a maximum decrease of about 2 psu in RCP8.5 and 1.5 psu in RCP4.5.



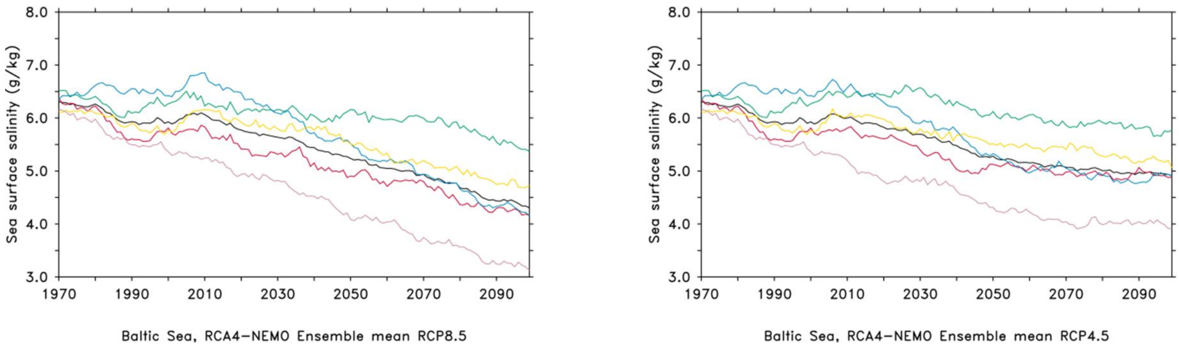


Figure 2. Annual mean sea surface temperature and sea surface salinity mean value in the Baltic Sea using different atmospheric forcing. black line: ensemble mean; red: MPI-ESM-LR; green: EC-EARTH; blue: GFDL-ESM2M; pink: HadGEM2-ES; yellow: IPSL-CM5A-MR.

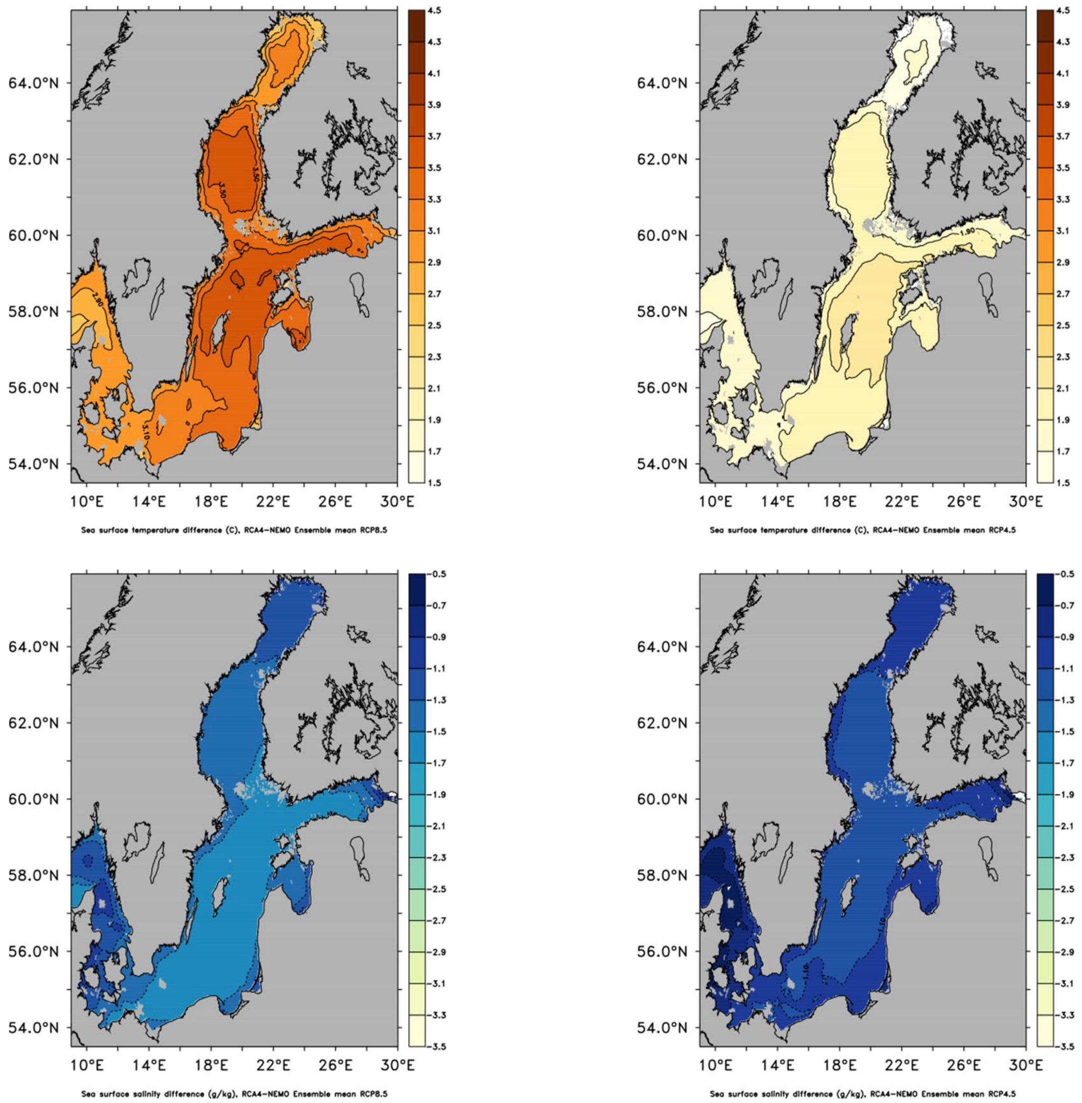


Figure 3. Sea surface temperature (upper panel) and salinity (lower panel): differences of the ensemble mean between the two 30-year climatological annual means 2070 to 2099 and 1970 to 1999 for RCP 4.5 (right panel) and RCP 8.5 (left panel).

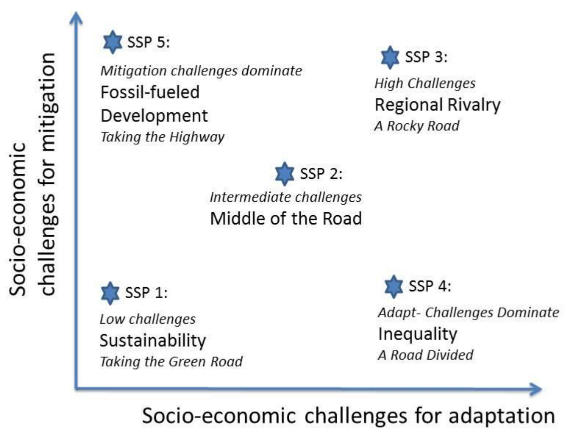
2.2 Shared Socioeconomic Pathways (SSPs)

SSPs are used in the climate research community to explore uncertainty in mitigation, adaptation and impacts associated with alternative climate and socioeconomic futures (O'Neill, 2014) and can be viewed as boundary conditions that provide the framing for more complex assumptions for regions and/or sectors (Edenhofer et al., 2010; O'Neill et al., 2014).

But SSP narratives can also be extended beyond the purpose of studying purely uncertainties with respect to climate adaptation and mitigation to also suit the needs of e.g. impacts of human pressures and mitigation of these pressures on the Baltic Sea. Also, additional quantitative information can be added as needed.

SSPs are quantitative and qualitative narratives of possible socio-economic futures up to the end of the century. They are reference pathways and therefore assume *no* climate change or climate impacts and *no new* climate policies (Kriegler et al., 2012). Near-term future conditions link to ongoing trends and planning horizons while the long-term future conditions provide plausible large-scale divergences in key driving factors (van Vuuren et al., 2014).

SSPs are defined as 'parsimonious narratives capturing the key dimensions of the underlying global scale socio-economic development and a collection of quantitative projection for global socio-economic boundary conditions' (Kriegler et al., 2012). They are constructed to span a range of outcomes that can describe the uncertainty in mitigation, adaptation and impacts by means of two axes: one axis in relation to challenges for adaptation and one axis relating to challenges for mitigation (See Figure 4).



Source: O'Neill, B.C. et al. 2014

Figure 4. Five challenge spaces spanned by SSPs

The term *socio-economic* is interpreted in a broad sense as covering socio-ecological systems including demographics, political, social, cultural, institutional, life-style, economic & technological aspects and the conditions of ecosystems and ecosystem services that have been affected by human activity such as air, water quality, biodiversity and ecosystem form and function (O'Neill, 2014).

The quantifications in the SSPs are limited to *drivers* that lead to outcomes such as population growth, energy system characteristics, urbanization and GDP. The *consequences* of these outcomes on e.g. the Baltic Sea, i.a. through the emissions from agriculture or changes in temperature is left to the *integrated scenarios* produced based on the SSPs (van Vuuren et al., 2014). *Integrated scenarios* combine climate and socio-economic pathways with information such as nutrient emissions, climate projections and policy assumptions.

SSPs are the results of primarily an *inverse* approach, where an outcome space of interest for climate change research is defined and then combinations of socio-economic trends are identified that are hypothesized to lead to those outcomes. They are starting points for developing integrated scenarios of the future (O'Neill et al., 2014). This can of course also be combined with forward approaches.

2.3 Shared Climate Policy Assumptions (SPAs)

SPAs are sometimes used to augment SSPs, depending on whether the analysis requires input assumptions on climate policy in addition to socio-economic reference developments. SPAs are complementary to SSPs, but are also to a certain extent governed by the narrative of the SSPs.

SPAs provide the link that explains how possible socioeconomic development futures (SSPs) can possibly be combined with different climate outcomes (RCPs). Policy assumptions may vary within one SSP and also, different policies can lead to the same climate outcome. SPAs therefore offer a third dimension in the climate scenario matrix (See Figure 5)

Full SPAs describe in quantitative and qualitative terms the key climate policy assumptions in terms of climate goals, policy regimes & instruments and obstacles of mitigation and adaptation measures (Kriegler et al., 2014). Time and space is an important dimension here as well.

Basic or reduced SSPs may only include high level information on the scope of mitigation and adaptation actions at a global level, and may focus on a specific topic such as land use change. They would necessarily need to be flexible and broad enough to allow for more national based SPAs, just as the global SSPs.

The level of detail of information in an SPA necessarily depends on the application.

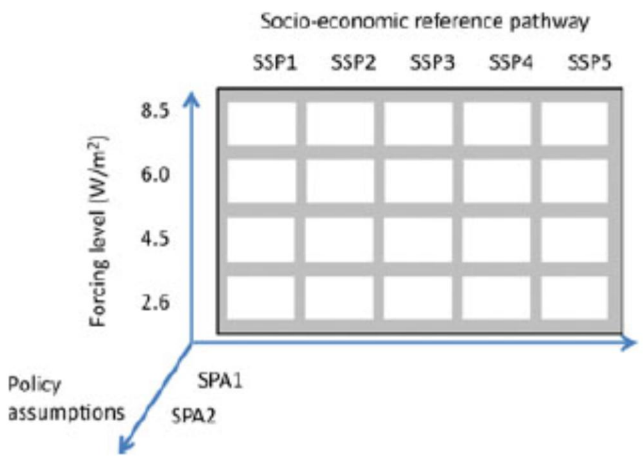


Figure 5 The three dimensions of the climate scenario matrix
Source: van Vuuren et al. (2014).

Climate policies can influence land use change directly and indirectly and subsequently climate policy assumptions may influence the level of nutrient leakage to the marine environment. If a project analyses the impact of land use changes (incl. management practices) on water quality in the Baltic Sea over time, climate policy assumptions may be warranted:

- Will biomass production for energy purposes be a as part of mitigation policies?
- What is the type and stringency of climate mitigation regulation on the agricultural sector?

For more reading on the topic of scenario based policy analysis, pls. refer to Ebi et al., 2014; Kriegler et al., 2014; O'Neill et al., 2014; van Vuuren et al., 2014.

3 Conceptual Framework

3.1 Scenario matrix structure

The scenario matrix architecture is developed as a new scenario framework for climate change research to assess the effectiveness of different adaptation and mitigation strategies and the possible trade-offs and synergies (van Vuuren et al., 2014). The two main axes of the matrix include:

- The level of radiative forcing (RCPs)
- A set of plausible trajectories of future global socio-ecological developments (SSPs)

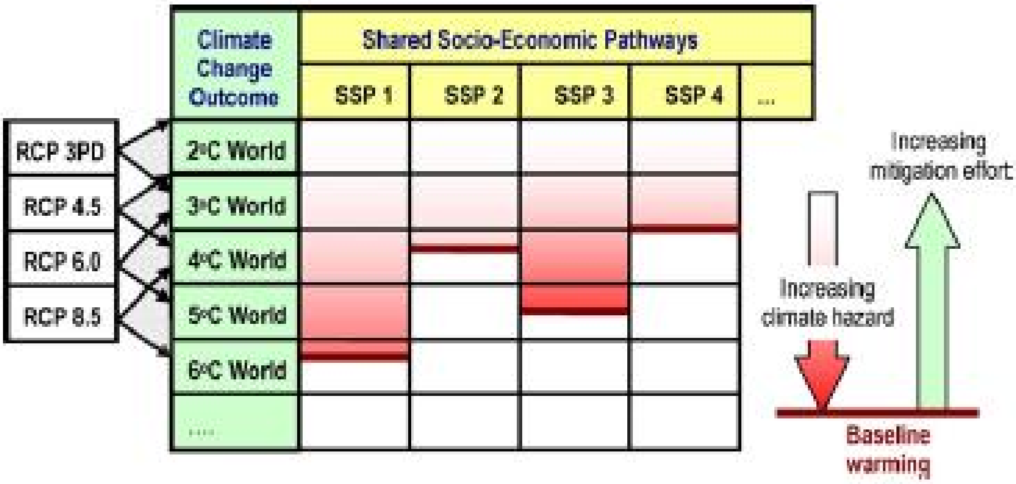


Figure 6 Matrix of socio-economic ''reference'' developments (SSPs) and climate change outcomes (RCPs). Source: Kriegler et al. (2012)

Each row of the matrix summarises the implications of a given level of CC on a range of possible future socio-economic conditions while each column describes the implications of increasing levels of CC (or decreasing levels of mitigation effort for a given set of socio-economic conditions). White cells in Figure 6 indicate that not all combinations may provide a consistent scenario.

Some combinations would not appear consistent – e.g. rapid development of competitive RE, low population growth and environmental orientation does not fit with a 6 degree warming, even without climate policy.

3.2 DPSIR framework

The DPSIR framework is a useful approach to consider in conjunction with the scenario matrix structure when analysing the impacts of climate change and societal development for solving regional environmental problems.

Global socioeconomic developments and the consequent anthropogenic interference with the climate system drive the development of virtually all terrestrial and aquatic ecosystems. At a regional level, these trends drive the development of industries, technologies, land use, governance and all aspects of human life. Many of these aspects are also the driving forces of regional environmental problems and drivers of polluting and consumptive uses of ecosystems.

The Baltic Sea is a fragile marine ecosystem that is sensitive to multiple pressures (nutrient loads, oil spills, hazardous substances, extraction of materials etc). Crucial questions in this respect include:

- How are these pressures likely to develop in the future under alternative climate and socioeconomic futures?; and moreover
- How much effort and what kind of policies would be needed to mitigate the undesirable development in pressures?

These questions can be studied by taking the following steps:

Step 1: Develop one (or several alternative) baseline scenario(s) for global climate and socioeconomic outcomes. This can be done by matching climate projections (RCPs), socioeconomic pathways (SSPs) and climate policies (SPA).

Step 2: Develop harmonized storylines for drivers of selected regional environmental problems that are in line with the underlying assumptions of selected global scenarios (from step 1), taking into account scenario work developed in BONUS projects.

Step 3: Use Integrated Assessment Models to project the (baseline) development of pressures using the storylines of regional drivers (from step 2) and the global developments (from step 1) as an input.

Step 4: Use projections of pressures (from step 3) as inputs to Integrated Assessment Models to describe the consequences to the ecosystem (state in Figure 7); human wellbeing (impact in Figure 1) and the need for new mitigation policies (response in Figure 7).

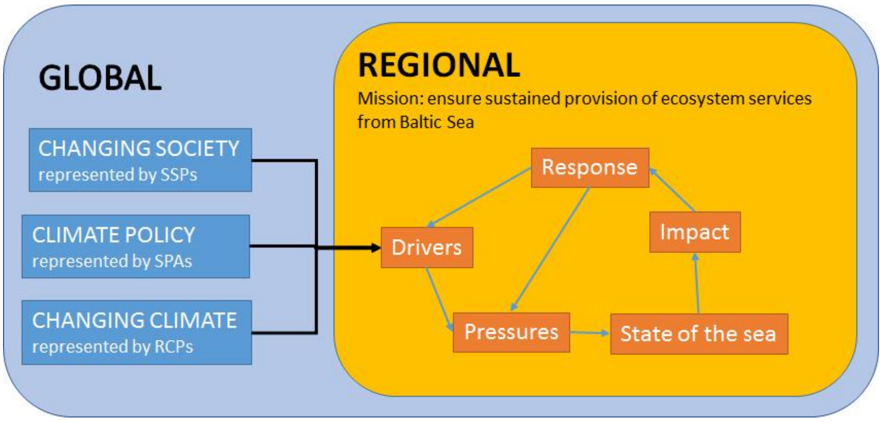


Figure 7. Impacts of changing climate and global socioeconomic development on solving regional environmental problems in DPSIR framework

This workshop focuses on Step 2 described above. The objective is to take the first steps to explore and develop harmonized storylines for future developments of multiple regional drivers and pressures that affect the Baltic Sea and that can be associated with readily available global climate and socio-economic pathways.

3.3 Data Gap

The specific data gap to be considered in this workshop can be visualized as a cube or hexahedron (see Figure 8 below). The axes of the cube are:

1. Global drivers (consisting of five qualitative socioeconomic storylines and the related numerical IAM projections),
2. Regional drivers (e.g. industries and other sectors)
3. Pressure/state descriptors (e.g. the 11 GES descriptors of EU MSFD).

The cube consists of a number of cells – one for each combination of these elements. Each cell is intended to include narrative of the expected future development. The work to be started in this workshop would be to populate the cube, cell by cell or a subset of cells.

Such an approach would allow us to consider:

- multiple impacts of global drivers (SSPs) on a number of sectors
- multiple pressures of sectors to the marine environment

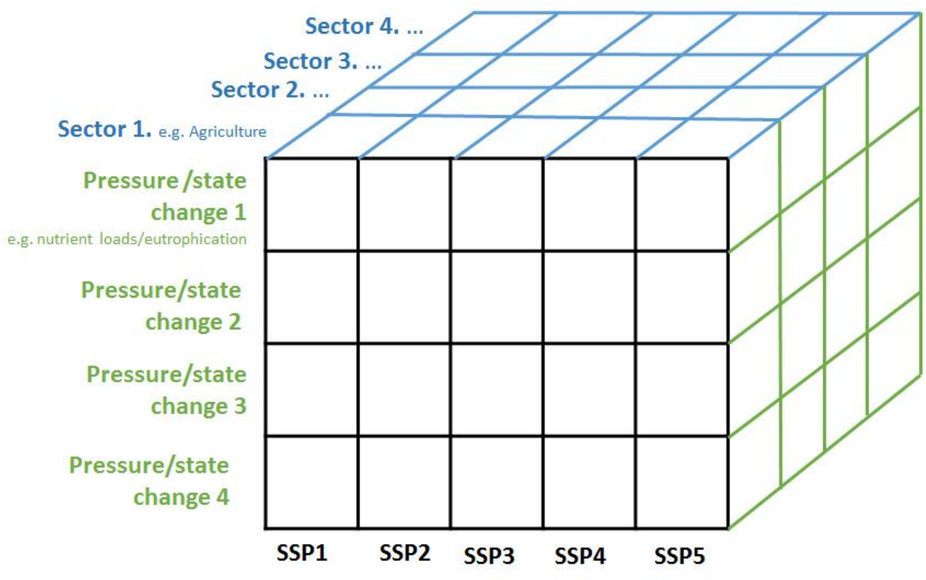


Figure 8. Visualization of the data gap: mutually consistent regional storylines/narratives about the future developments of the Baltic sea for combinations of global drivers (SSP1...SSP5), regional economic sectors and the descriptor of the state.

Steps to be taken to populate the "cube"

1. Select the environmental problem or state change of your interest (e.g. eutrophication)
2. Elaborate the regional drivers of pressures and environmental change (e.g. agriculture, waste water treatment, marine traffic, etc.)
3. Assess, quantify and integrate drivers into regionalised SSPs in a plausible and consistent way. It is of course possible to have different trajectories of the specific drivers within one SSP.

Box 2. Example of the use of scenarios: studying the future challenges in nutrient abatement and fisheries management in the BONUS BalticAPP project

The BONUS BalticAPP-project investigates the challenges to obtain a Good Environmental State of the Baltic Sea by the end of the century. The project conducts cost-benefit analysis of the effort needed to reach that target with respect to eutrophication and fisheries management.

Scenarios will play a central role in that analysis. At first, mutually consistent combinations of RCPs, SSPs, and global climate mitigation effort are elaborated to develop a set of alternative global futures. These global developments are downscaled to the Baltic Sea region, and their impacts on drivers of eutrophication and fisheries are elaborated. Next, the nutrient loads and fisheries management effort are projected. The projections are used as inputs to the biogeochemical model (RCO-SCOBI), and the food-web model (Ecosim/ecopath) to depict the developments of marine ecosystem for the selected baseline scenarios.

The set of baseline projections describe the uncertainties and expected trends in the development of the Baltic Sea biota. They also allow analysing the level of e.g. nutrient mitigation effort and policies needed to reverse the undesired developments, and to develop cost-effective programmes of measures to reach and maintain the good environmental status of the Baltic Sea. The scenarios will also be used as an input to valuation surveys depicting the values people place on meeting the good environmental state of the Baltic Sea.

4 Qualitative descriptions of SSPs

The five narratives of possible socio-economic futures without climate change and climate change impacts

- SSP 1 - Sustainability – taking the green road (commitment to achieving development goals, increasing environmental awareness and gradual move towards less resource intensive lifestyle; policy changes are driven by changing attitudes)
- SSP 2 - Middle of the Road (consistent with typical patterns of past developments re. economic growth, demographic transition etc.)
- SSP 3 – Regional Rivalry – A Rocky Road (globalisation trends can be reversed by a number of events – e.g. regional rivalries – weakening progress towards development goals)
- SSP 4 – Inequality – A Road Divided (across- and within country inequality due to unequal investments in education, skill-based technological development; slow-down of middle class growth)
- SSP 5 – Fossil Fueled Development – Taking the Highway (accelerated globalisation and rapid development of developing countries; improvement in effectiveness of institutions)

Source of main description below: https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf

4.1 SSP1 – Sustainability

This is a world making relatively good progress towards sustainability, with sustained efforts to achieve development goals, while reducing resource intensity and fossil fuel dependency. Elements that contribute to this include a rapid development of low-income countries, a reduction of inequality (globally and within economies), rapid technology development, and a high level of awareness regarding environmental degradation. Rapid economic growth in low-income countries reduces the number of people below the poverty line. The world is characterized by an open, globalized economy, with relatively rapid technological change directed toward environmentally friendly processes, including clean energy technologies and yield-enhancing technologies for land. Consumption is oriented towards low material growth and energy intensity, with a relatively low level of consumption of animal products. Investments in high levels of education coincide with low population growth. Concurrently, governance and institutions facilitate achieving development goals and problem solving. The Millennium Development Goals are achieved within the next decade or two, resulting in educated populations with access to safe water, improved sanitation and medical care. Other factors that reduce vulnerability to climate and other global changes include, for example, the successful implementation of stringent policies to control air pollutants and rapid shifts toward universal access to clean and modern energy in the developing world.

Urbanisation -> Sustainable development is an organizing principle in this pathway, so environmentally friendly living arrangements and human settlement design define the nature of future urbanization processes. This leads to fast urbanization in all countries both because urban centers are attractive to the rural population, and because urbanization is encouraged for environmental reasons. Slower population growth, together with rapid technological change and medium to fast economic growth, enables countries to support well-planned urban development. Cities provide employment opportunities, adequate infrastructure, and convenient services for their residents, therefore attracting in-migrants from rural areas. In addition, in order to reduce impacts on the natural environment, resource-efficient and energy-saving compact cities are promoted by governments and societies, and population concentration in these cities is encouraged

Population projections for rich OECD countries -> education level is high, migration is medium (following UN's medium variant); low mortality and medium fertility.

Urbanisation for rich OECD countries: urbanization is fast.

Economic Growth projections (GDP and GDP/capita) -> Total Factor Productivity (TFP, residual technologial progress) growth at frontier (i.e. most advanced countries): Medium high; TFP growth rate of technology leader: 0.8%/yr; Speed of convergence of other countries towards the frontier: high

4.2 SSP 2 - Middle of the Road

This pathway is also known as Dynamics as Usual, or Current Trends Continue, or Continuation, or Muddling Through. It represents an intermediate case between SSP1 & SSP3.

In this world, trends typical of recent decades continue, with some progress towards achieving development goals, reductions in resource and energy intensity at historic rates, and slowly decreasing fossil fuel dependency. Development of low-income countries proceeds unevenly, with some countries making relatively good progress while others are left behind. Most economies are politically stable with partially functioning and globally connected markets. A limited number of comparatively weak global institutions exist. Per-capita income levels grow at a medium pace on the global average, with slowly converging income levels between developing and industrialized countries. Intra-regional income distributions improve slightly with increasing national income, but disparities remain high in some regions. Educational investments are not high enough to rapidly slow population growth, particularly in low-income countries. Achievement of the Millennium Development Goals is delayed by several decades, leaving populations without access to safe water, improved sanitation, medical care. Similarly, there is only intermediate success in addressing air pollution or improving energy access for the poor as well as other factors that reduce vulnerability to climate and other global changes.

Population projections for rich OECD countries -> education level is medium, migration is medium (following UN's medium variant); medium mortality and medium fertility.

Urbanisation for rich OECD countries: urbanization is central.

Economic Growth projections (GDP and GDP/capita) -> Total Factor Productivity (TFP, residual technologial progress) growth at frontier (i.e. most advanced countries): Medium; TFP growth rate of technology leader: 0.7%/yr; Speed of convergence of other countries towards the frontier: Medium

4.3 SSP 3 - Fragmentation

This pathway is also called Fragmented World. The world is separated into regions characterized by extreme poverty, pockets of moderate wealth and a bulk of countries that struggle to maintain living standards for a strongly growing population. Regional blocks of countries have re-emerged with little coordination between them. This is a world failing to achieve global development goals, and with little progress in reducing resource intensity, fossil fuel dependency, or addressing local environmental concerns such as air pollution. Countries focus on achieving energy and food security goals within their own region. The world has de-globalized, and international trade, including energy resource and agricultural markets, is severely restricted. Little international cooperation and low investments in technology development and education slow down economic growth in high-, middle-, and low-income regions. Population growth in this scenario is high as a result of the education and economic trends. Growth in urban areas in low-income countries is often in unplanned settlements. Unmitigated emissions are relatively high, driven by high population growth, use of local energy resources and slow technological change in the energy sector. Governance and institutions show weakness and a lack of cooperation and consensus; effective leadership and capacities for problem solving are lacking. Investments in human capital are low and inequality is high. A regionalized world leads to reduced trade flows, and institutional development is unfavorable, leaving large numbers of people vulnerable to climate change and many parts of the world with low adaptive capacity. Policies are oriented towards security, including barriers to trade.

Population projections for rich OECD countries -> education level is low, migration is low (following UN's medium variant); high mortality and low fertility.

Urbanisation for rich OECD countries: urbanization is slow.

Economic Growth projections (GDP and GDP/capita) -> Total Factor Productivity (TFP, residual technologial progress) growth at frontier (i.e. most advanced countries): Low; TFP growth rate of technology leader: 0.3%/yr; Speed of convergence of other countries towards the frontier: Low

4.4 SSP 4 - Inequality

This pathway is also known as Unequal World, or Divided World. It envisions a highly unequal world both within and across countries. A relatively small, rich global elite is responsible for much of the emissions, while a larger, poorer group contributes little to emissions and is vulnerable to impacts of climate change, in industrialized as well as in developing countries. In this world, global energy corporations use investments in R&D as hedging strategy against potential resource scarcity or climate policy, developing (and applying) low-cost alternative technologies. Mitigation challenges are therefore low due to some combination of low reference emissions and/or high latent capacity to mitigate. Governance and globalization are effective for and controlled by the elite, but are ineffective for most of the population. Challenges to adaptation are high due to relatively low income and low human capital among the poorer population, and ineffective institutions.

Population projections for rich OECD countries -> education level is medium, migration is medium (following UN's medium variant); medium mortality and low fertility.

Urbanisation for rich OECD countries: urbanization is central.

Economic Growth projections (GDP and GDP/capita) -> Total Factor Productivity (TFP, residual technological progress) growth at frontier (i.e. most advanced countries): Medium; TFP growth rate of technology leader: 0.6%/yr; Speed of convergence of high income countries towards the frontier: Medium

4.5 SSP 5: Conventional Development

This pathway is also known as conventional development first. This world stresses conventional development oriented toward economic growth as the solution to social and economic problems through the pursuit of enlightened self-interest. The preference for rapid conventional development leads to a high energy demand, most of which is met with carbon based fuels. This results in high GHG emissions and challenges to mitigation. Lower socio-environmental challenges to adaptation result from attainment of human development goals, robust economic growth, highly engineered infrastructure with redundancy to minimize disruptions from extreme events, and highly managed ecosystems.

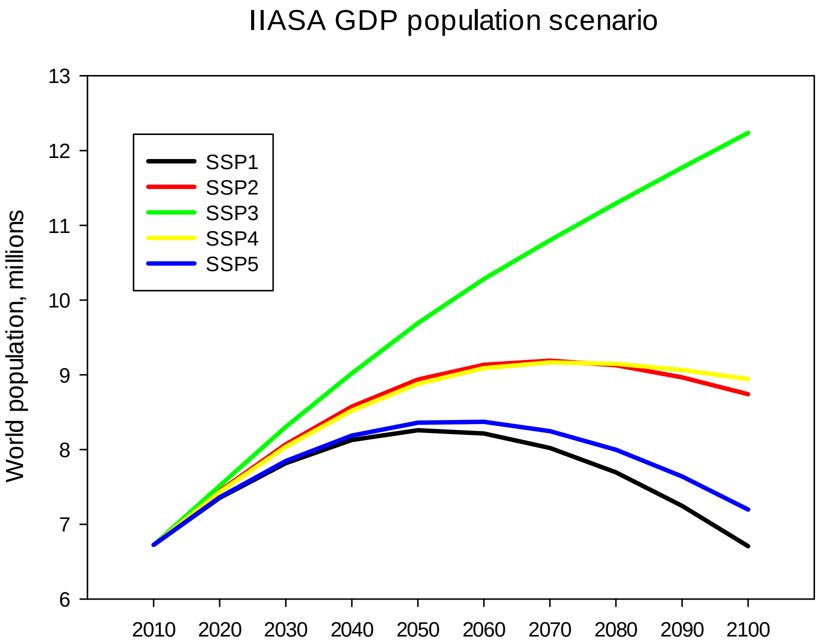
Population projections for rich OECD countries -> education level is high, migration is high (following UN's medium variant); low mortality and high fertility.

Urbanisation for rich OECD countries: urbanization is fast.

Economic Growth projections (GDP and GDP/capita) -> Total Factor Productivity (TFP, residual technological progress) growth at frontier (i.e. most advanced countries): High; TFP growth rate of technology leader: 1.1%/yr; Speed of convergence of other countries towards the frontier: High

5 Global IAM results

The following graphs describe the global developments of numerical results of integrated assessment models, available from the SSP database by IIASA: https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=about. These include global population change, share of urbanization and GDP development.



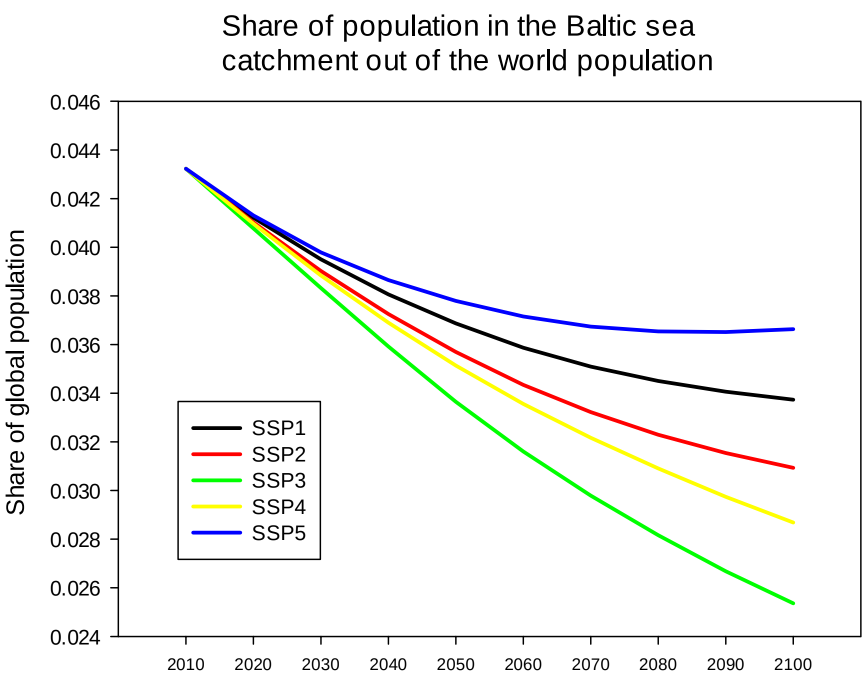


Figure 9. Global population scenarios

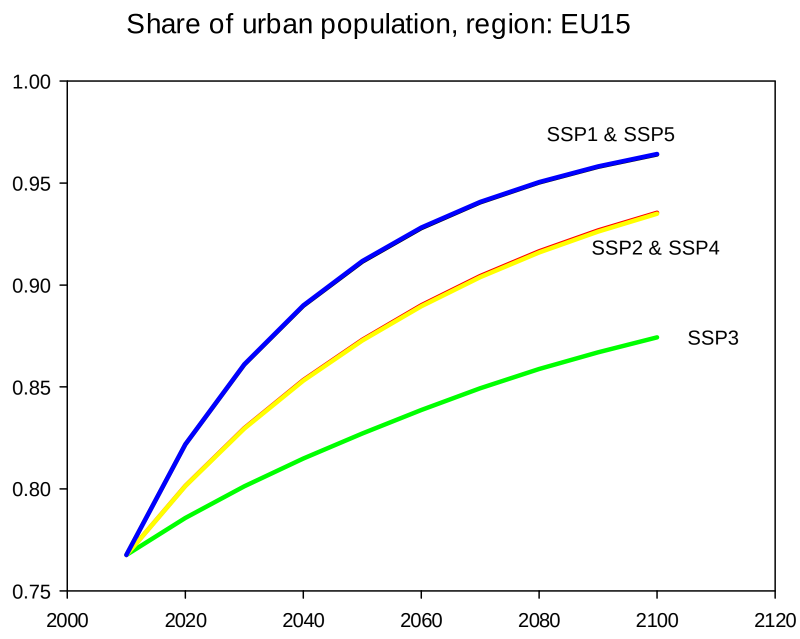


Figure 10. Urbanisation trends in EU15 (model: NCAR)

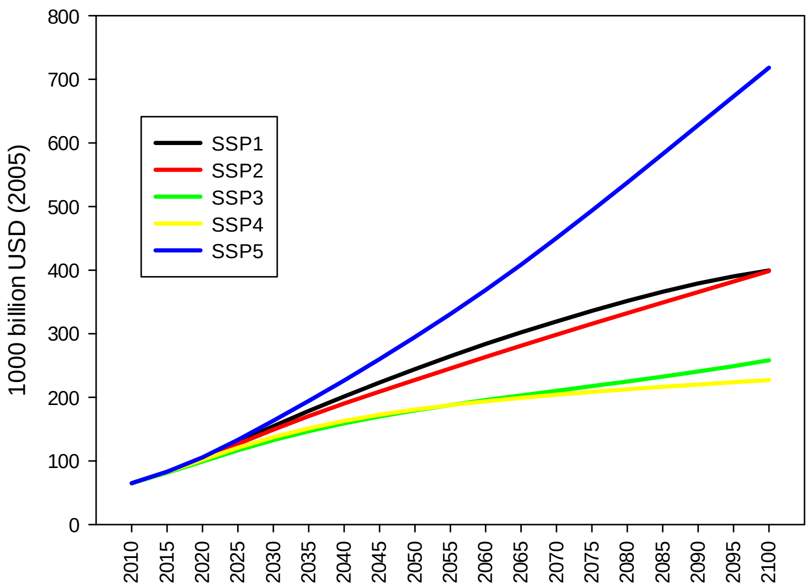


Figure 11. Global GDP development pathways (model: IIASA GDP)

6 Regional IAM results for Baltic Sea riparian countries

General conditions and trends across pathways in Baltic Sea Region

Projections for *population changes* range from a strong decline in populations (-36%) under a fragmented world (SSP3) to almost stable (-1%) under conventional development (SSP5). None of the pathways project an overall population increase in region. However, trends diverge strongly between the nine Baltic Sea countries. Denmark, Finland and Sweden may experience up to strong and very strong increases in population regardless of pathway, while Latvia, Lithuania and Estonia may see their populations halved in several of the pathways.

Urbanisation rates all increase across all pathways but at varying degrees. The sustainability (SSP1) and conventional development (SSP5) pathways share the same projections of a rapid and converging urbanisation reaching 93-96% of populations living in urban areas by the end of the century. In the Middle of the Road Pathway (SSP2), urbanisation follows a central rate while the fragmentation (SSP3) and unequal pathways (SSP4) have slower trends in urbanisation. Countries urbanising the most under the different pathways are predominantly Poland, Latvia and Lithuania as these are also the countries with the lowest urbanisation level at the outset.

Economic growth rates are highest under conventional development (> 177% increase by 2100) and lowest in a fragmented world (> 2%). In a sustainable pathway, growth rates are medium high; in middle of the road medium and low to medium in a fragmented world.

Land use change are available from the IIASA database at a coarse resolution (0.5x0.5 degree) based on Hurtt et al. (2011). Work is underway in the LUC4C project (http://luc4c.eu/) to downscale the RCP land use change trajectories to a finer resolution. Care should therefore be taken in assessing the coarse resolution land use changes by country, especially smaller countries. Compared to the baseline in 2005, there is a general decrease in total agricultural land regardless of future climate, generally due to yield improvements and intensification. The decrease in agricultural land is far more pronounced under RCP4.5 (exception is DK where the predicted trends are fairly the same across RCPs). Total agricultural area seems to be significantly larger under RCP8.5 than under RCP4.5 by 2100 with the exception of Sweden (17% smaller area than under rcp4.5) and Denmark (3% larger area under rcp8.5). Only minor changes in total agricultural area under RCP8.5 are projected by 2100 in Estonia, Latvia and Poland. Large reductions in total agricultural land are projected in DK, FIN, and SWE (22-34%).

At a global scale, cultivated land increases under RCP8.5 in developing countries, driven by the population increase to 12 billion by 2100, but there's a slight decrease of aggregate agricultural land in developed countries. As a result of the expansion of agricultural land (in developing countries), forest cover decreases (Hurtt et al., 2011). Yield improvements and intensification are assumed to cover most of the needed production increases (135% agricultural output increase by 2080 but only 16% expansion of cultivated land compared to 2005).

Under RCP4.5, global mitigation strategies include reductions in land use change carbon emissions as an available mitigation strategy, leading to an expansion in forest land and a slight global decline of agricultural land, while meeting food demand through crop yield improvements, dietary shifts, production efficiency and international trade.

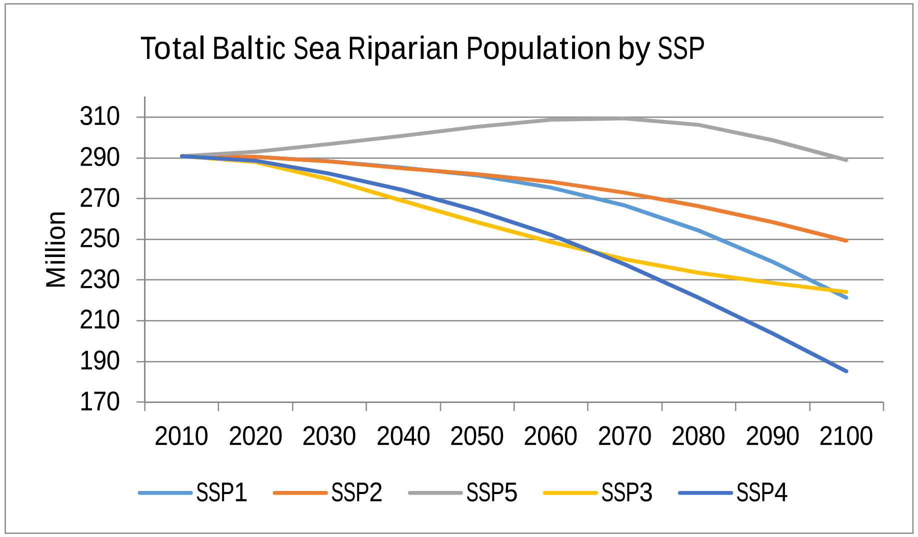
Table 1 Overview of general and country specific development trends by topic and SSP

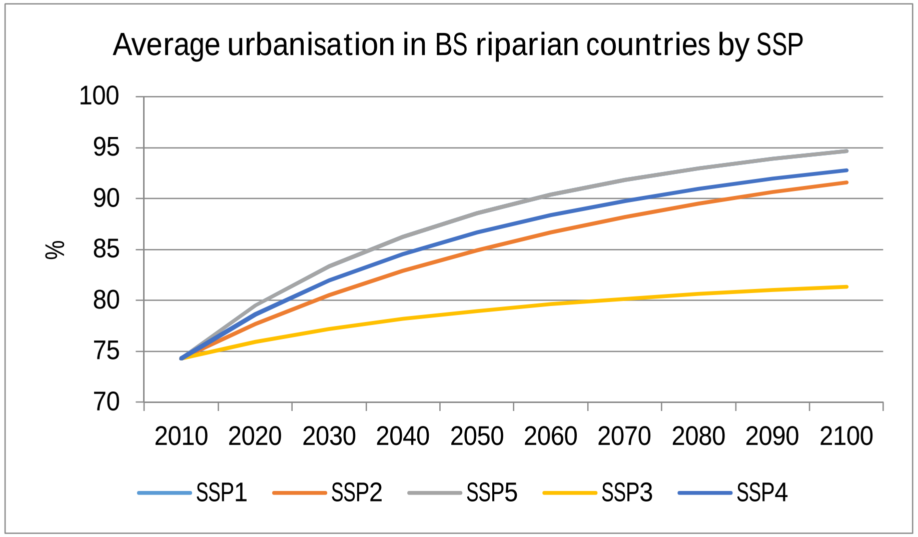
Topic	Pathway	General Trends - Riparian BS countries	Deviations from general trends
Population change	SSP1 – sustainability	Moderate decline (-24%). 291 million in 2010 to 221 by 2100. Up to 2050, the decline is rather modest but accelerates after 2050.	Very strong decline in LVA and LTU (-50%) Very strong increase in SWE (63%) and strong increase in FIN and DK (30-39%)
	SSP2 - Middle of the road	Modest decline (-14%) reaching 249 million by 2100	Very strong decline in LTU & LVA (-40%) Very strong increase in SWE (61%) and strong increase in FIN and DK (27-34%)
	SSP3 - Fragmentation	Moderate decline (-23%) reaching 224 million by 2100.	Very strong decline in EST, DEU and POL (-51-58%) Modest increase in RUS (+4%)
	SSP4 – Inequality	Strong decline (-36%) reaching 185 million by 2100.	SWE only country with population increase (15%) Very strong decline in POL, LVA, LTU (-46-56%)
	SSP5 – Conventional development	Stable (-1%). Moderate increase up to 2070 followed by decrease.	Very strong decline in LVA & LTU (-50-58%) Moderate decrease in RUS (-29%) Moderate increase in DEU & EST (20-28%) Very strong increase in DK (112%)

Topic	Pathway	General Trends - Riparian BS countries	Deviations from general trends
Urbani-sation	SSP1 – sustainability	Rapid (85%-92% by 2050 and 93%-96% by 2100)	Very strong urbanisation trend in POL (+58% from 60% in 2010 to 96% by 2100) Modest urbanisation trends in DEU, EST, LTU, LVA (+29-39%)
	SSP2 - Middle of the road	Central (77%-92% by 2050 and 86%-96% by 2100)	Strong urbanisation trend in POL (+41% from 60% in 2010 to 86% by 2100) Modest urbanisation trends in RUS, DEU, EST, LTU, LVA (+28-33%)
	SSP3 - Fragmentation	Slow (67%-92% by 2050 and 71%-96% by 2100)	FIN, SWE, DK reach urbanization level of 93-96% Very modest increases from 4% (LTA, EST) up to 16% (POL)
	SSP4 – Inequality	Slow (77%-92% by 2050 and 86-96% by 2100)	FIN, SWE, DK reach urbanization level of 93-96% Strong increases in LTU, LVA, POL (39-41%)
	SSP5 – Conventional development	Rapid (Identical to SSP1)	(Identical to SSP1)

Topic	Pathway	General Trends - Riparian BS countries	Deviations from general trends
Econo-mic growth	SSP1 – sustainability	Medium high (approx. between 100% and 580% increase)	Sweden highest growth (233% by 2050 and 578% by 2100) POL & FIN more than double GDP by 2050 (123-136%) and more than 4-doubles by 2100 (230-332%). Slow growth in DEU, LTU & DK (37-71% by 2100)
	SSP2 - Middle of the road	Medium (93-506%)	Sweden highest growth (214% by 2050 and 506% by 2100) LVA, RUS, FIN & POL double GDP by 2050 (96-118%). RUS and FIN have especially strong growth after 2050 (249-279% by 2100). Lowest growth in DEU (27% by 2050; 93% by 2100)
	SSP3 - Fragmentation	Low (1.7-88% by 2050; 2-256% by 2100)	Slowest growth in DEU (2% by 2100) Highest growth in RUS, LVA & LTU (169-256%)
	SSP4 – Inequality	Low medium (6-27% by 2050; 12-363% by 2100)	Slowest growth in DK, SWE & FIN (6-8% by 2050) Highest growth in LTU, LVA. POL & RUS (27%)
	SSP5 – Conventional development	High (77-323% by 2050; 177-1203% by 2100)	Very growth in SWE (323% by 2050; 1203% by 2100); Strong growth in DK, EST, FIN (127-188% by 2050; 745-835% by 2100) Lowest growth in LTU (78% by 2050; 177% by 2100)

Topic	Pathway	General Trends - Riparian BS countries
Land use change	RCP4.5	*Pastureland:* increases only in Poland by 51 % (by 2100). More than halving of pastureland in EST, LVA, LTU. Significant reductions in pastureland are found in Estonia, Lithuania and Latvia under rcp4.5 where pastureland is more than halved by 2100. *Cropland*: more than halved in EST, LTU and LVA (by 2100). More cropland is lost in DK under RCP4.5 than under rcp8.5 (39% under RCP4.5 compared to 25% under RCP8.5). *Total agricultural area* decreases significantly in EST, LTU, LVA by 60-75% by 2050 and 64-76% by 2100). Moderate decrease in DK by 2050 (-11%) and strong decrease by 2100 in DK and FIN (-36%). Stable in DEU, POL, FIN and SWE (+1% to -5%) by 2050 and modest to moderate decline by 2100 (-8% to -18%).
	RCP8.5	*Pastureland*: increases significantly in DEU (+28%) and practically disappears in SWE and DK (by 2100) *Cropland:* decreases by 19-25% in DK, DEU, Fin, and SWE (by 2100). *Total agricultural area* seems to be significantly larger under RCP8.5 than under RCP4.5 by 2100 with the exception of SWE (17% smaller area than under rcp4.5) and DK (3% larger area under RCP8.5)





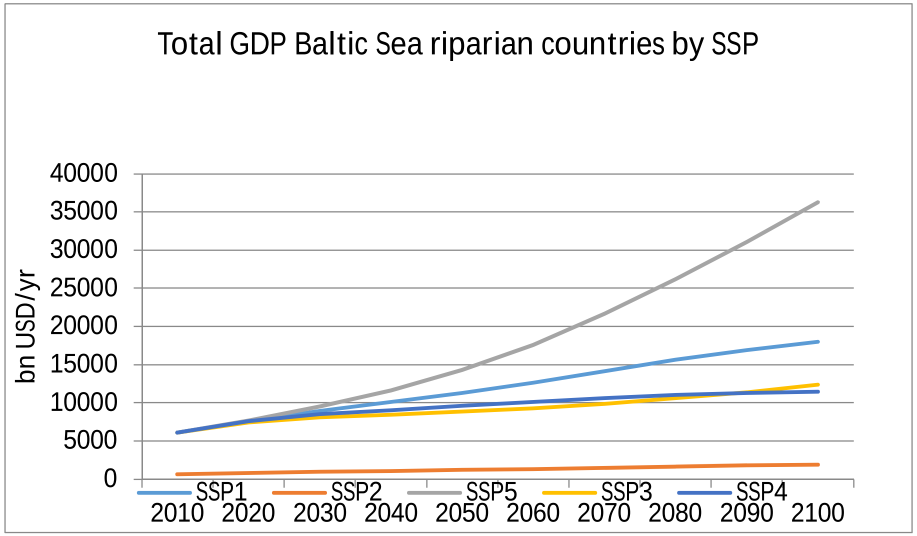


Figure 12. Population, urbanisation & economic growth developments for the Baltic Sea Region by SSP.
Source: SSP database, IIASA
(https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=welcome)

7 Example sectors to populate based on workshop discussions

The pilot scenario workshop is intended as a space for any BONUS project and stakeholders interested in exploring the challenges of securing the future flow of marine ecosystem services in the Baltic Sea.

The RCP and SSP families of pathways and their combination into scenarios can offer valuable frameworks of analysis for studies that are not pure climate research, but where climate impacts and future societal developments represent important drivers in the analysis.

BONUS projects work with different questions of coverage in relation to the marine environment and resolution (space, time and economic sectors). It will therefore be useful at the workshop to discuss the focus and potential type of questions that each of the projects would like to see answered through the scenario work in order to arrive at a common point of view of the scenarios. This would also help narrow down the degrees of freedom.

For use in analyses in several Bonus projects, there would be clear benefits of working together to:

- Extend the SSPs to the sectors of interest and for the Baltic Sea region up to 2050 and 2100; and
- Develop the narrative and quantitative scenarios that integrate emissions (both climate and nutrients), climate impacts, socio-ecological systems including consumption/management patterns for relevant sectors, projections of water quality, and policy assumptions

Examples of sectors could be:

- Management of agriculture and forestry
- Ecosystem management
- Fisheries
- Maritime traffic
- Tourism/recreation

Example Topics	Pathway	General Trends - Riparian BS countries	Deviations from general trends
Management of agriculture and forestry	SSP1 - Sustainability		
	SSP2 - Middle of the road		
	SSP3 - Fragmentation		
	SSP4 – Inequality		
	SSP5 – Conventional development		
Ecosystem management	SSP1 - Sustainability		
	SSP2 - Middle of the road		
	SSP3 - Fragmentation		
	SSP4 – Inequality		
	SSP5 – Conventional development		
Fisheries	SSP1 - Sustainability		
	SSP2 - Middle of the road		
	SSP3 - Fragmentation		
	SSP4 – Inequality		
	SSP5 – Conventional development		
	SSP1 - Sustainability		

Maritime traffic	SSP2 - Middle of the road SSP3 - Fragmentation SSP4 – Inequality SSP5 – Conventional development
Tourism/ recreation	SSP1 - Sustainability SSP2 - Middle of the road SSP3 - Fragmentation SSP4 – Inequality SSP5 – Conventional development
…….	

8 References

Ebi, K. L., Hallegatte, S., Kram, T., Arnell, N. W., Carter, T. R., Edmonds, J., ... Zwickel, T. (2014). A new scenario framework for climate change research: background, process, and future directions. *Climatic Change*, *122*(3), 363–372. http://doi.org/10.1007/s10584-013-0912-3

Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Barros, V., Field B., C., Zwickel, T., ... von Stechow, C. (2010). *No TitleIPCC Workshop on Socio-Economic Scenarios*.

Hurtt, G. C., Chini, L. P., Frolking, S., Betts, R. A., Feddema, J., Fischer, G., ... Wang, Y. P. (2011). Harmonization of land-use scenarios for the period 1500–2100: 600 years of global gridded annual land-use transitions, wood harvest, and resulting secondary lands. *Climatic Change*, *109*(1-2), 117–161. http://doi.org/10.1007/s10584-011-0153-2

Kriegler, E., Edmonds, J., Hallegatte, S., Ebi, K. L., Kram, T., Riahi, K., ... van Vuuren, D. P. (2014). A new scenario framework for climate change research: The concept of shared climate policy assumptions. *Climatic Change*, *122*(3), 401–414. http://doi.org/10.1007/s10584-013-0971-5

Kriegler, E., O'Neill, B. C., Hallegatte, S., Kram, T., Lempert, R. J., Moss, R. H., & Wilbanks, T. (2012). The need for and use of socio-economic scenarios for climate change analysis: A new approach based on shared socio-economic pathways. *Global Environmental Change*, *22*(4), 807–822. http://doi.org/10.1016/j.gloenvcha.2012.05.005

Meier, H. E. M., Höglund, A., Döscher, R., Andersson, H., Löptien, U., & Kjellström, E. (2011). Quality assessment of atmospheric surface fields over the Baltic Sea from an ensemble of regional climate model simulations with respect to ocean dynamics**The work presented in this study was jointly funded by the Swedish Environmental Protection Agency . *Oceanologia*, *53*, 193–227. http://doi.org/10.5697/oc.53-1-TI.193

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., van Vuuren, D. P., ... Wilbanks, T. J. (2010). The next generation of scenarios for climate change research and assessment. *Nature*, *463*(7282), 747–56. http://doi.org/10.1038/nature08823

O'Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., ... van Vuuren, D. P. (2014). A new scenario framework for climate change research: the concept of shared socioeconomic pathways. *Climatic Change*, *122*(3), 387–400. http://doi.org/10.1007/s10584-013-0905-2

van Vuuren, D. P., Isaac, M., Kundzewicz, Z. W., Arnell, N., Barker, T., Criqui, P., ... Scrieciu, S. (2011). The use of scenarios as the basis for combined assessment of climate change mitigation and adaptation. *Global Environmental Change*, *21*(2), 575–591. http://doi.org/10.1016/j.gloenvcha.2010.11.003

van Vuuren, D. P., Kriegler, E., O'Neill, B. C., Ebi, K. L., Riahi, K., Carter, T. R., ... Winkler, H. (2014). A new scenario framework for Climate Change Research: Scenario matrix architecture. *Climatic Change*, *122*(3), 373–386. http://doi.org/10.1007/s10584-013-0906-1

Wang, S., Dieterich, C., Döscher, R., Höglund, A., Hordoir, R., Meier, H. E. M., ... Schimanke, S. (2015). Development and evaluation of a new regional coupled atmosphere–ocean model in the North Sea and Baltic Sea. *Tellus A*, *67*. http://doi.org/10.3402/tellusa.v67.24284

9 Annex 1. IIASA database

The IIASA database (https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=about) includes final projections for population and economic development (posted in March 2013) over the period of 2015-2100. The elements included:

1. population by age, sex, and education
2. urbanization
3. economic development (GDP)

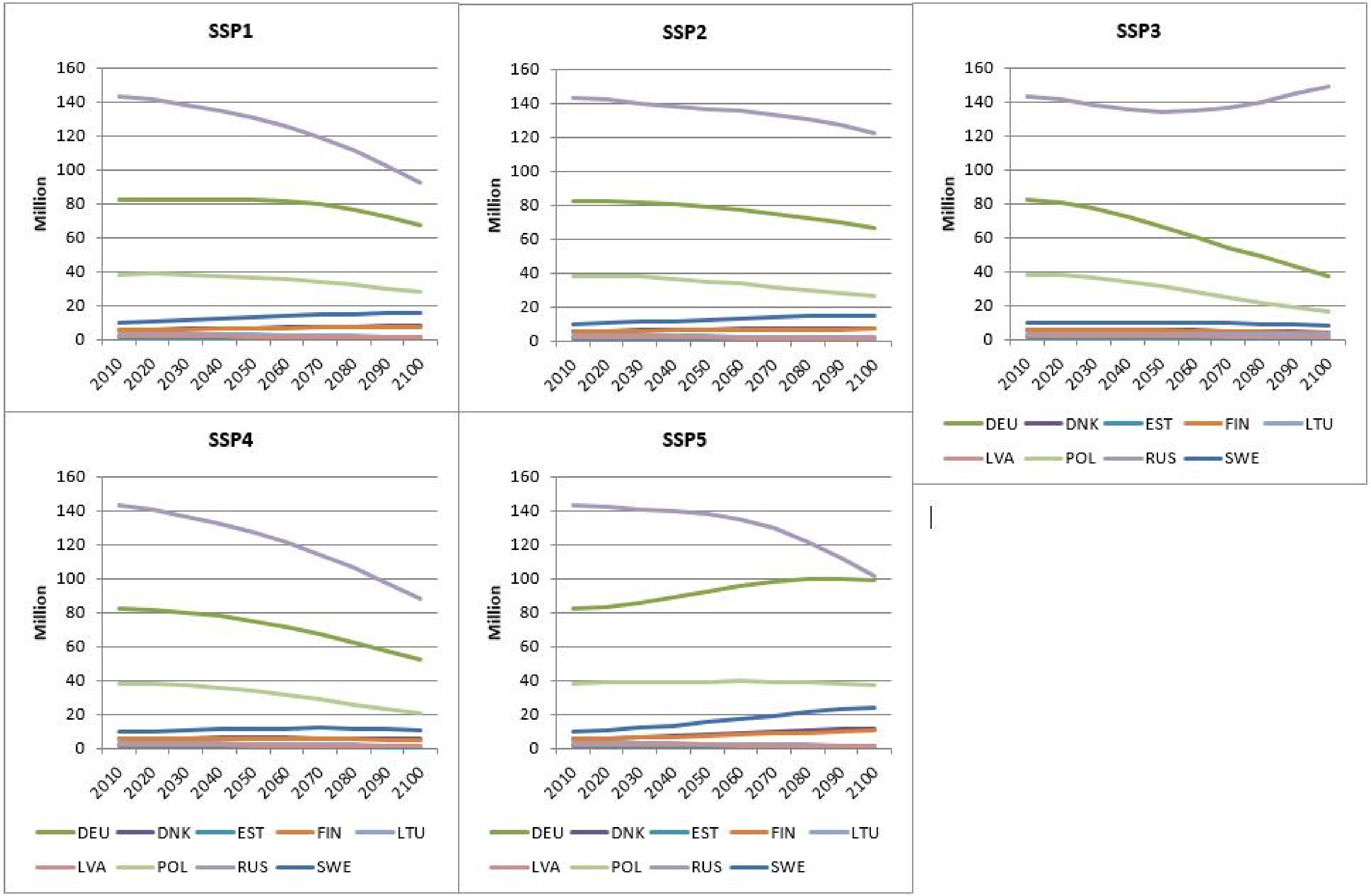
In addition to the basic SSP socio-economic elements, the database includes preliminary SSP-based scenarios by IAMs. The scenarios provide detailed global and regional projections among others for:

4. energy supply and use
    a. Resource
    b. Primary energy (biomass, coal, fossil, gas, oil)
    c. Secondary energy (electricity, liquids, solids
    d. Final energy (electricity, gases, geothermal, heat, hydrogen, liquids, solids) by sectors (industry, residential & commercial and transportation)
5. land-use
    a. Land cover (built-up area, arable land, cropland, forestland, pasture
    b. Food Energy Supply (crops and livestock per capita)
    c. Agricultural production (livestock, energy crops, non-energy crops)
    d. Agricultural demand (crops for food and feed, livestock)
6. GHG and air pollutant emissions
    a. CO2, CH4, N20, CO, NOx, BC, OC, Sulfur, Kyoto Gases, VOC by source (fossil fuels and industry, land use, carbon capture)
7. Climate
    a. concentration (CO2, CH4,N20)
    b. radiative forcing (Kyoto gases, CO2,CH4, N20, Aerosols, F-gases)
    c. global mean temperature change
8. Mitigation costs
    a. Carbon price
    b. consumption
    c. policy cost (area under MAC curve, consumption loss, GDP loss)

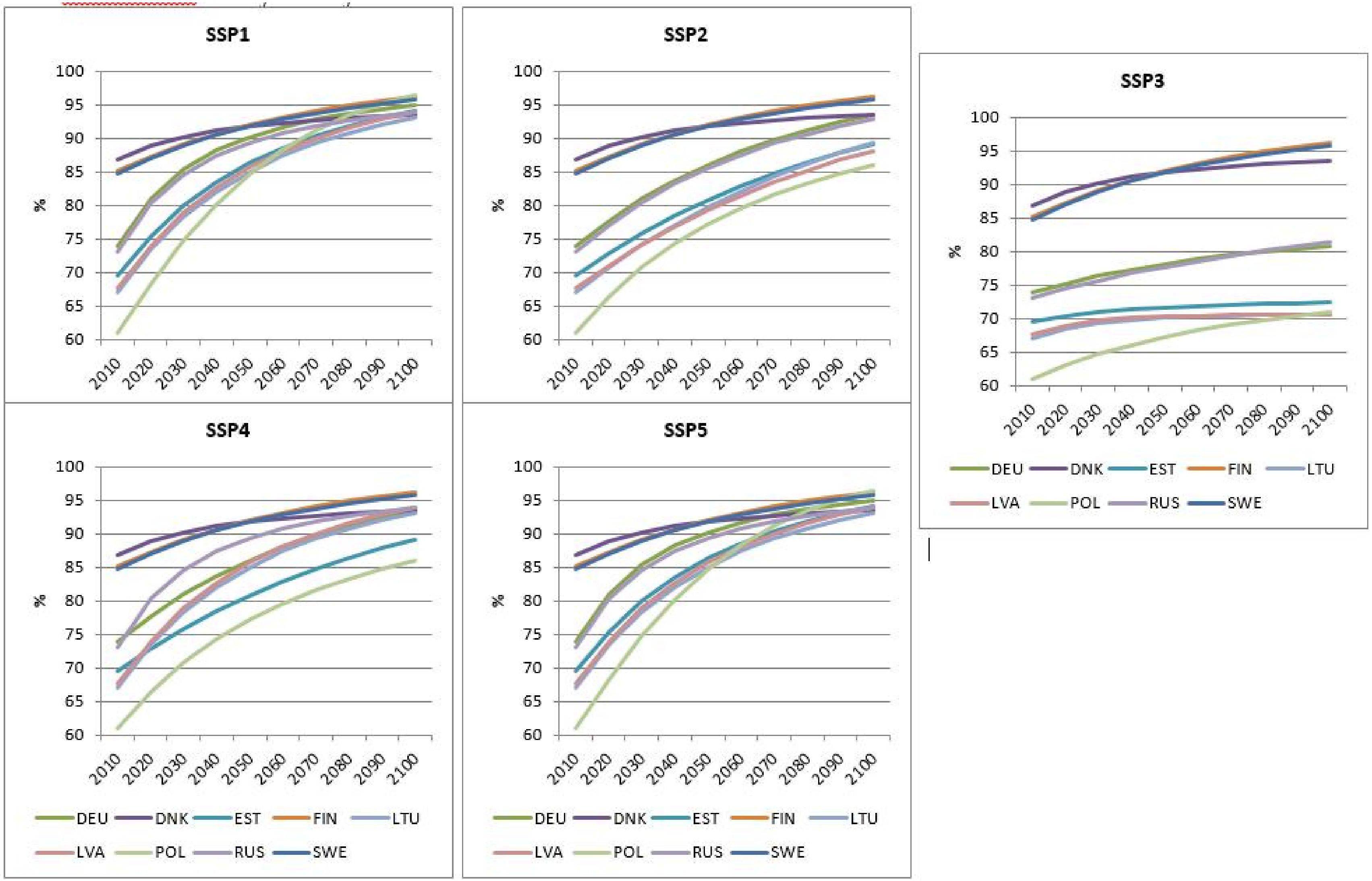
Please note that the quantifications apart from population, urbanization and economic development are still undergoing review and should be considered preliminary.

10 Annex 2. Graphic illustrations of Basic SSP elements by Riparian Baltic Sea countries

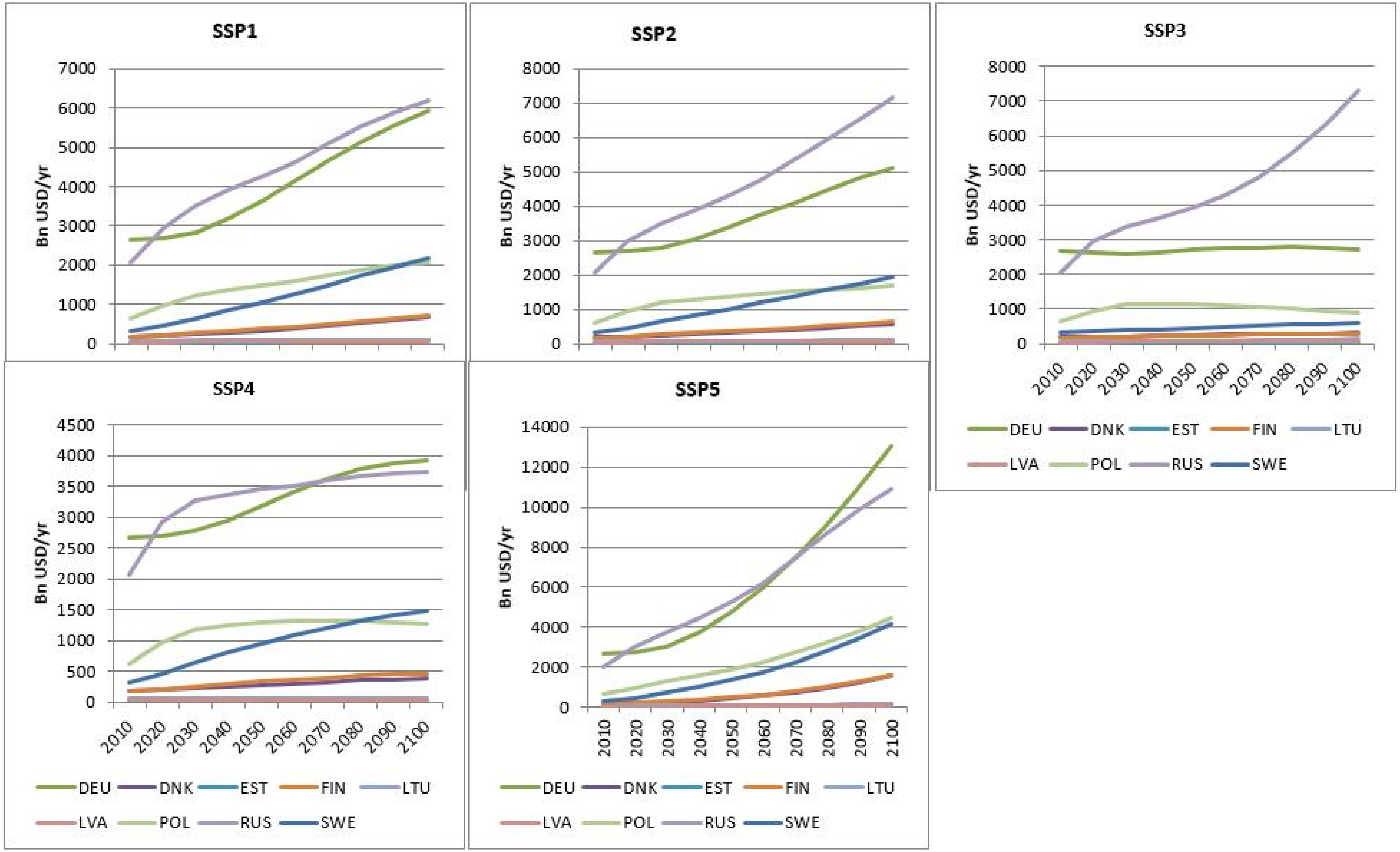
10.1. Population projections by country and SSP



10.2 Urbanisation rate by country and SSP



10.3 GDP development by country and SSP



PART 2: AGENDA FOR WORKSHOP

The workshop was organized 6-7 April, 2016 at Helsinki. The venue was Minerva-tori at the University of Helsinki city campus (Siltavuorenpenger 5a), room K226.

Below is the detailed agenda for the workshop. The presentations are available at the project website http://blogs.helsinki.fi/balticapp/events/.

Wednesday 6.4.2016 Scenario workshop, Day 1

Moderator: Bo Gustafsson

11:00 – 12:00 Lunch (salad lunch served in K1 aula)

12:00 – 12:20 Welcoming words, Kaisa Kononen

12:20 – 13:30 Keynote presentation, Detlef van Vuuren

13:30 – 14:00 Coffee

14:00 – 15:40 Plenary session: from global to regional scenarios

Background material: Overview, framework and a first step towards Baltic Sea storylines, Marianne Zandersen

Future climate projections for the Baltic Sea region, water quality and lower trophic levels perspective, Sofia Saraiva

Reflections on global outlooks, Jan Bakkes

Introduction to the group work, Kari Hyytiäinen

15:40 – 17:00 Group work I (rooms: K226 and K227)

Thursday 7.4.2016 Scenario workshop, Day 2

9:00 – 9:20 Plenary session – feedback from the first day's discussions

9:20 – 10:20 Panel discussion: uses of scenarios in research and policy support
Moderator: Henrik Hamrén, Panelists: Günter Hörmandinger, Martin LeTissier, Jan Bakkes, Jens Christian Refsgaard

10:20 – 10:40 Coffee

10:40 – 12:00 Group work II (rooms: K226, K222.1, K222.2)

12:00 – 13:00 Lunch

13:00 – 14:10 Group work III (rooms: K226, K222.1, K222.2)

14:10 – 14:30 Coffee

14:30 – 16:00 Plenary session, moderator: Kari Hyytiäinen

Chairs of the group work report the outcomes of group work

Discussion about the next steps

Summing up the event, Andris Andrusaitis

PART 3: GROUP WORK DISCUSSIONS

3.1 Procedure

The aim of the group discussion was to debate over the conceptual framework of regional storylines for the Baltic Sea up to 2010 and to exchange ideas on plausible future sectoral developments. In order to facilitate large group discussions and to link ideas within a larger group to access collective intelligence, the "world café" technique was applied (see details in http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/).

The participants (detailed participant list with affiliations in Appendix 1) were divided in three interdisciplinary groups (fig 3.1). Each group started discussion on one of three predetermined themes, facilitated by two persons (figure 3.2). After the discussion session, the group moved to another theme and continued from the state reached by the previous group. After yet one (the third) discussion round, all groups had discussed three predetermined topics, and the facilitators put the discussion together and presented the ideas to the whole group for information and further discussion.

GROUP 1	GROUP 2	GROUP 3
Alena Bartosova	Chantal Donnelly	Fatemeh Hashemi
Mohamed Jabloun	Jørgen E. Olesen	Magdalena Kwiecien
Olli Niskanen	Ben Boteler	Päivi Haapasaari
Heidi Pihlak	Eija Pouta	Jan Bakkes
Lassi Ahlvik	Henrik Hamrén	Kari Hyytiäinen
Johanna Andreasson	Andris Andrusaitis	Sofia Saraiva
Martin Le Tissier	Talis Linkaits	Barbara Bauer
Anna-Kaisa Kosenius	Wolfram Schrimpf	
	Laura Eskelinen	

Figure 3.1 Groups (preliminary).

PRESSURE/STATE CHANGE:	GROUP CHAIR:	NOTES:
(1) Eutrophication	Jens Christian Refsgaard (SOILS2SEAS)	Matti Sihvonen
(2) Risks of marine traffic (oil, invasive species, hazardous substances)	Erik Fridell (SHEBA)	Uzma Aslam
(3) Biodiversity (with emphasis on fish & fisheries)	Bo Gustafsson	Eva Ehrnsten

Figure 3.2 Themes (=pressures or state changes) focused on the workshop and two facilitators by theme.

Three pressures or state changes focused on were eutrophication, risks of marine traffic, and biodiversity. Each were discussed in accordance with at least three shared socio-economic pathways (SSPs), that is, narratives of possible socio-economic futures without climate change and climate change impacts, out of five demonstrated in background material (see pages 20-23 in this document): Sustainability (SSP1), Middle of the road (SSP2), and Fragmentation (SSP3).

In addition to background material and plenary and panel sessions during the workshop, participants were introduced to group work by the following questions:

1. What are the main regional drivers (economic sectors) causing the change in state of the sea (with respect to the pressure / descriptor of state)?
2. Develop narratives about how global socio-economic developments (population, urbanization, GDP) are likely to affect those sectors?
    a. General (qualitative/quantitave) trends for the Baltic sea region
    b. Consider developments in the country level
    c. If adequate tools /knowledge is missing: consider the data needs, expertise, modelling tools, etc. needed for conducting such analysis
3. Can we associate alternative trends (or family or narratives) for each global socioeconomic future (e.g. increased /decreased agricultural land for SSP1?)
4. How are the EU policies that make part of the SSP (e.g. fisheries and agricultural policies) likely to develop and affect the challenge to mitigate the environmental problems of the Baltic Sea

Regarding main regional drivers affecting the state of the sea that apply to all three themes focused on, the pressures related to maritime traffic (theme 2) are presented in table 3.1.

Drivers	**Pressures**
Tourism	Marine noise
Infrastructure development (harbours etc)	spills (oil)
Trade	Atmo pollution
transportation	NOx
Consumption patterns	Waste
Production patterns	Invasive species
Globalization	Physical Impacts in shallow water (Both above and below water level)
Fishing	Substances from anti-fouling paints
Military activities	Emissions of grey & Black water
Recreational activities	
Population	
Fossil fuel consumption	
Regulation & policies	

Table 3.1 Main regional drivers in the Baltic Sea and, as an example, the pressures related to maritime traffic.

The groups discussed and specified general trends in riparian Baltic Sea countries up to the year 2100 as well as deviations from these trends. The following sub-chapters sum up the main points of discussions by theme, demonstrating the differences between the SSPs. Full notes on group discussions are in Appendix 2.

3.2 Theme 1: Eutrophication

Three main sources (or sectors of interest of workshop participants) related to eutrophication were specified as agriculture, sewage sector, and air pollution. The aspects discussed included the implementation of management plans (e.g. WFD) and other regulation as well as the drivers behind the pressure, such as technological development, intensity of farming, consumption patterns, and energy production.

Regarding pathway SSP1 (Sustainability), the full implementation management plans required by the Water Framework Directive (WFD) and all other plans as well as the change in consumption trends (less demand for meat and more demand for local and organic food) will lead to decrease in nutrient loads. Technological development related to *agricultural* practices involves risks and the experiments (needed at development stage) need to be regulated. The *sewage* sector applies more sophisticated and comprehensive treatment. *Air pollution* reduces along with cleaner energy production and the growing number of electric vehicles.

Regarding pathway SSP2 (Middle of the road), the management plans (e.g. WFD) are partly implemented. *Agricultural* sector involves larger farms and more intensive and industrialized farming while agricultural land area remains unchanged or decreasing but concentrated to certain areas; leading to unchanged or slightly increased loads. Loads from the *sewage* sector decreased due to technological development although increased urbanization induces more pressure and more plants to be built. *Air pollution* (NOX, urban emissions) will decrease along with the increase in the amount of hybrid and electric cars.

Pathway SSP3 (Fragmentation) brings the split of the European Union into regional blocks, the end of the HELCOM, reduced environmental regulations, and, due to less trade and food security, national (or even regional) agricultural regulations. *Agricultural* loads will increase. For the *sewage* sector, there might be economic incentive to develop recycling technology for phosphorous, thus, the development of the load from this sector was left unspecified. *Air emissions*, however, will be stable or increasing due to potential increase in the use of coal, break down of Sulphur regulations, and the lack of incentives for emission control.

Pathway SSP4 (Inequality) involves the domination of the private sector over the public sector, the weakening of environmental regulation framework, increased demand (from the wealthy part of the population) for clean production and high quality food, and high and unregulated trade driven by market economics. *Agricultural* loads might increase and vary regionally due to differences in the demand for clean areas with stronger regulation. The private companies will take over the *sewage* sector and the demand of the cleaner environment (by the wealthy part of population) will lead even more efficient sewage treatment. The same reason will drive the technological development related to *air pollution*, however, ammonia emissions will increase due to weak institutions and regulations.

Pathway SSP5 (Conventional development) leads to an increase in *agricultural* loads due to less regulations, better conditions for agriculture, and potentially higher demand for meat. However, the presence of compensating policies and cleaning technologies may reduce the increase in loads. Regarding the *sewage* sector, higher levels of waste water resulting from increased urbanization and seasonal tourism in conjunction with less incentives to treat waste water will increase the loads. *Air* emissions will slightly increase due to weaker regulations and increased (trade and related) transportation.

3.3 Theme 2: Risks of marine traffic

The theme risks of marine traffic involved various drivers and resulting pressures listed in table 3.1.

In pathway SSP1 (Sustainability), the decrease in fossil fuel consumption will lead to decrease in shipping and make it environmentally safer. Increase in tourism increases risks of accidents, however, technological development will reduce risks.

In pathway SSP2 (Middle of the road), shipping and recreational activities will increase as well as pressures. Weaker regulations than in SSP1 will be implemented.

Pathway SSP3 (Fragmentation) will lead to the decrease in touristic transportation, safety, ship quality, external trade, to difficulties of environmental regulation, and to the increase in fossil fuel trade and in pressures to the Baltic Sea. However, some countries may have increased ship quality, and instead of common regulations and collaboration, local regulations will increase.

The futures SSP4 and SSP5 were not discussed.

3.4 Theme 3: Biodiversity (with emphasis on fish & fisheries)

Pathway SSP1 (Sustainability) will induce less coastal construction and a more coherent and well-managed network of marine protected areas. Strong regulations (e.g. fishing bans) will be possible. Industrial fisheries will decrease, which, however, might be compensated by sustainable fish farming, and recreational fisheries will be prioritized for, e.g. salmon and trout. Educated consumers will demand less animal-protein for consumption and fish for humans instead of animal feed. The total population in the BS area decreases (but increases in Finland, Sweden, and Denmark) and urbanization distributes population along the coast, leading to higher tourism pressure and less rural run-off.

In pathway SSP2 (Middle of the road), the declining trend of number of fishermen will continue, and fisheries will be managed suboptimally with MSY-based quotas (however, probably exceeding ICES advices).

SSP3 (Fragmentation) will lead to the diminishing strength of the European Union, the division into poor and rich countries around the Baltic Sea, and the lack of normative agreement on the aimable state of the Baltic Sea. Policies will be defined by national interests and aquaculture and local food production will increase. Fisheries will be open-access based and role of the ICES will be weak. There will be no or few marine protected areas, and biodiversity levels will vary across the Baltic Sea. Less regulated building and less population and urbanization will potentially lead to less pressure on fish nursery grounds.

SSP4 was not discussed.

In SSP5 (Conventional development), increased agricultural land will increase eutrophication and increased marine traffic will increase pressure for biodiversity in terms of oil spill risks and invasive species. While the Baltic Sea region will import food from other areas, aquaculture might increase as well as imported food for aquaculture, causing increased eutrophication in case of high technological development might not decrease environmental effects. Fossil-fuel driven development will accelerate climate change, causing high pressure for biodiversity in terms of, e.g. sea level rise, and high adaption costs for coastal protection with sand walls, affecting potentially, e.g. flatfish populations and seal breeding areas. Climate warming has an uncertain effect on salinity and species distributions in the Baltic Sea.

APPENDIX 1. PARTICIPANTS

	First name	Last name	Affiliation	Project (if applicable)
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11	Laura	Eskelinen	BONUS Secretariat	
12	Erik	Fridell	IVL Swedish Environmental Research Institute	SHEBA
13	Bo	Gustafsson	Stockholm University	BALTICAPP
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28	Sofia	Saraiva	SMHI	Baltic App
29	Wolfram	Schrimpf	Climate change and marine Adviser	
30	Matti	Sihvonen	University of Helsinki	BALTICAPP

SKYPE CONNECTION

31	Markus	Meier	SMHI	BALTICAPP
32	Detlef	van Vuuren	PBL	keynote presentation
33	Marianne	Zandersen	Aarhus University	BONUS BalticAPP

APPENDIX 2. NOTES FROM GROUP WORK

BONUS PILOT WORKSHOP ON SCENARIOS, HELSINKI, APRIL 6-7, 2016

This document summarizes the outcomes of group work in the BONUS pilot workshop on scenarios in Helsinki, April 6-7, 2016. The aim of the group work was to exchange ideas about the plausible future sectoral developments in the Baltic Sea region under different global socioeconomic futures (SSPs).

THEMES

PRESSURE/STATE CHANGE:	GROUP CHAIR:	NOTES:
(1) Eutrophication	Jens Christian Refsgaard (SOILS2SEAS)	Matti Sihvonen
(2) Risks of marine traffic (oil, invasive species, hazardous substances)	Erik Fridell (SHEBA)	Uzma Aslam
(3) Biodiversity (with emphasis on fish & fisheries)	Bo Gustafsson	Eva Ehrnsten

THEME 1 Eutrophication, Group chair: Jens Christian Refsgaard, notes: Matti Sihvonen

Pathway	General Trends - Riparian BS countries	Deviations from general trends
SSP1 – Sustainability	**Agriculture**: Management plans (WFD) and all the other plans are fully implemented. Consumption trends change: less demand for meat. Loads will decrease. More local and organic food. Technological development: experiment space is needed. There will be risks. Regulation is needed around experiments. **Sewage:** More sophisticated and comprehensive treatment. **Air pollution**: Cleaner energy production. Electric vehicles.	There might be some demand for local plants, which are not good for the environment?
SSP2 - Middle of the road	**Agriculture:** Larger farms, intense farming, industrialized more effective agriculture. Agriculture land area remains the same or decreasing and focusing on certain areas. More regulations. Management plans (WFD), but not fully implemented, only partly implemented.. Loads might remain the same, or slight increase. **Sewage**: technological development, urbanization increases, more plants will be built. Loads will be decreased.	Agriculture Organic farming (policy driven and consumption trends). Local farming. Russian? Sewage economic crisis might have a negative effect on plant investment. Air pollution Ammonia from agriculture? Technological development will probably take care of this..

	Air pollution: NOX-emissions decrease. Hybrid and electric cars will be more common. Urban emissions will decrease.	
SSP3 - Fragmentation	**Agriculture**: Nationally (regionally) based agriculture regulations because there's less trade and because of the food security. Even there would be customs and taxes on trade, there would be some trade. It might also be that the reduced environmental regulations increase trade. EU splits to regional blocks. HELCOM will end. High costs. Regional limits will drive the consumption trends. Lower GDPs. "WFD" and other EU-regulations will be abandoned. Loads will increase. Energy? Reduced import of energy supplies might increase the technological development. **Sewage:** Status quo? There might be economic incentive to develop technology to recycle phosphorus from the waste? **Air pollution**: No incentive to control emissions. Thus the emissions would increase or be stable in this sector. Sulphur regulation breaks down. Coal use might increase which would also increase emissions.	There might be deviations in some countries because countries develop differently. There might be trade-offs in trade development paths. There might be exchange between some countries resulting from the common interests. Trade patterns are hard to predict.

SSP4 - Inequality	**Agriculture**: Regulatory framework will be weakened. Private sector dominates public sector (it's already happening). Less environmental regulations because the aim to decrease production costs. Industrialized agriculture. Consumption trends (of the rich people) drive the clean production trends. There will not be so many subsidies on agriculture. High trade driven by market economics. Trade is not very regulated. Demand for high quality food (food safety, organic food..) increases. Loads? There might be regional variety within the loads. Clean areas for rich people. Within these areas there might be strong regulations. There might be firms that don't care about the weakened regulations. Hard to predict what will happen. There might be lots of different kind of crisis across and within the countries which will put environmental regulations on hold. Loads might increase. **Sewage**: even more efficient? Private companies takes over the sewage systems: Phenomena is driven by long term interests. Elite wants to protect the environment. Costs are put on the poor. **Air pollution**: Elite wants to enjoy clear air. That will drive technological development in this sector. Loads? There might be increased ammonia emissions because of the weak institutions and regulations.	Elite might want stronger regulations on short term effects. Which would lead a better state of environment. In the other hand, elite might not care about the environment. Lots of uncertainty.

SSP5 – Conventional development	**Agriculture:** Increasing agriculture. There might be shift to more demand for meat. Lot of trade. It will relatively better conditions for agriculture around the Baltic area. People will want to come to Baltic sea area. Need for regulations on trade and tourism? But if free markets dominate there might not be so much regulations. Less regulations. Better conditions for agriculture. Loads will increase. But there might be cleaning technology or compensating policies. US style of doing things. **Sewage:** Higher level of waste water because of the increased urbanization and seasonal tourism. Infrastructure will be built to optimize production (maximize economic profits) not to control overflow. There will only be treatment if there's a visible problem. **Air pollution:** Slight increase of air pollution resulting from decreased regulations and increased transport (increased trade). Ammonia from agriculture will increase.	Production might move away from Europe, which might decrease emissions? There might be a shift away from fossil fuels in transport.

THEME 2 Risks of marine traffic (oil, invasive species, hazardous substances), Group chair: Erik Fridell, notes: Uzma Aslam

Pathway	General Trends - Riparian BS countries	Deviations from general trends
SSP1 – Sustainability	- shipping will generally decrease (due to lower fossil fuel consumption) - becomes more environmentally safer - Decoupling of GDP & transport sector - risk of accidents increases in the Baltic sea due to increase in tourism - With technical developments reduce risks	- Increase in local tourism in the Baltic sea region - better (more stringent) regulations in the Baltic sea region
SSP2 - Middle of the road	- increase in shipping leading to an increase in the pressures - regulations will be imposed but not as strict as SSP1 - Increase in recreational activities -	
SSP3 – Fragmentation	- Decrease in touristic transportation (ferries & cruises) - Low safety, quality of ships will degrade & livelihood issues (low paid staff etc) - external trade will decrease - difficult to develop environmental regulations - technological advancement (such as military) - an increased trend will be seen in the pressures on the marine environment - Increase in fossil fuel trade (especially coal from Poland)	- some countries will have increased ship quality - more local regulations & lesser collaboration/coalition - trade with Russia – might decrease

Drivers	Pressures
Tourism	Marine noise
Infrastructure development (harbours etc)	spills (oil)
Trade	Atmo pollution
transportation	NOx
Consumption patterns	Waste
Production patterns	Invasive species
Globalization	Physical Impacts in shallow water (Both above and below water level)
Fishing	Substances from anti-fouling paints
Military activities	Emissions of grey & Black water
Recreational activities	
Population	
Fossil fuel consumption	
Regulation & policies	

Fishing

THEME 3 Biodiversity (with emphasis on fish & fisheries), Group chair: Bo Gustafsson, notes: Eva Ehrnsten

General: SSP 1: Global sustainability – problems cannot be exported, SSP 2 - 5: Local

Fishery

SSP1:

Sustainable fishery – Opimized effort, selection and spatial arrangement!

Economy maximized? Could lead to

- Maximum economic yeald

- Priority to recreational fishery over commercial fishery

SSP2:

A) Like today: quotas partly higher than MSY -> to unstable population and fishery
B) Continued decrease in fishermen

SSP3:

No normative agreement. Policies based on national interests. Like SSP2 but worse

Biodiversity in general

SSP1:

High level of nature conservation ->

- Marine protected areas
- Less coastal constructions
- Sustainable fishfarming

SSP3: No or few protected areas

Pathway	General Trends - Riparian BS countries	Deviations from general trends
SSP1 - Sustainability	FISHERIES is a driver **Optimising effort & selection & spatial arrangement to sustain viable fish populations** - Modelled in BalticApp: goal of sustaining food-web structure under different climate projections (SMHIs models -> EwE) **How to define sustainability?** -Low-input & high-tech -GMO – make better food for fish or a high risk? -Experimenting atmosphere -Less resource intensive -High-tech? coupled with bio-based economy, growing food where it is most favourable -Sustainability implies that we can have a fishery High level of nature conservation -less coastal construction - Marine protected areas – coherent and well managed network Regulations for sustainable fisheries probable -Policy change allowing e.g. fishing bans possible Recreational fisheries for e.g. salmon and trout prioritised -industrial fisheries decrease -fish farming: depends on sustainability of the system. Fishing for aquaculture probably not sustainable, but aquaculture where fish eat vegetables might increase to compensate for less industrial fishing Maximum economic yield instead of MSY? Maximising well-being from ecosystem services by ecosystem-based management Trade-offs Global sustainability -> problems cannot be ‘exported’ **Consumption patterns** -Educated consumers, changed attitudes	A sector that can change fast – allows deviations for different countries Will fisheries be regulated in the same way? -Who can fish where -Fish farming - We may get entrepreneurs from other areas if it is permitted

	-Using fish for humans, not for animal feed -Low consumption of animal protein -> fish consumption according to what is considered sustainable EUTROPHICATION is a driver WATER QUALITY is a driver -Urbanisation, distribution of population along coast Biodiversity is needed for viable fisheries INVASIVE SPECIES affect biodiversity -Marine traffic is a vector -Climate warming facilitates establishment of new species **Urbanisation and population increase** in Fin, Swe, Den, but decrease in total More tourism pressure Less rural nutrient runoff	
SSP2 - Middle of the road	More **tourism** in the Baltic because of warmer summers but less because of more nutrient loading which leads to low water quality -> no change? **Fisheries management** MSY-based quotas, but might exceed ICES advices (as today)? Declining trend of fishermen will continue -Will fish populations stay low or recover? Suboptimal management of fisheries -> unstable system, unpredictable behaviour -reactive rather than proactive management Less focus on global sustainability -> problems can be exported to some extent	Population increase in Sweden and Finland and Denmark will increase building along the coast - Pressure on fish nursery grounds

SSP3 - Fragmentation	Fragmentation into poor and rich countries around the Baltic? -Compare to historical division into east and west Nordic countries more unified “against” the rest of Europe? The strength of the EU will diminish **Urbanisation** is slow Less regulated building, less population, less urbanisation - Less pressure on fish nursery grounds? **Management/regulations** No normative agreement on what state of the Baltic we aim for (all ‘bad’ SSPs) Policies defined by national interests, no joint solutions? -Least common denominator - Different levels of biodiversity in different parts of the Baltic Suboptimal or no management of fisheries -> unstable system, unpredictable behaviour - The role of ICES and regulations/implementations of the regulations will be less - Lack of control - More country wise regulations - > Some countries with no or very low ambition/resources for regulations Less focus on global sustainability -> problems can be exported to some extent Increased aquaculture – local food production No or few marine protected areas	

	Open-access fishery Seal hunting In the extreme case of open conflict, fish populations may benefit	
SSP4 - Inequality		
SSP5 – Conventional development	Eutrophication increase because of increased agricultural land Marine protected areas and their regulation - set off because we can afford it, but not managed well Increased marine traffic - oil spills - invasive species - -etc **High urbanisation** **Fisheries & aquaculture** The developed Baltic Sea region might import lots of food from other areas -> export environmental problems Aquaculture might increase Imported food for aquaculture -> more eutrophication High technological development might also decrease the environmental effects	Will countries like Sweden and Denmark care less about the environment in this scenario, or will the environmental awareness increase as is the trend today?

Market-driven, liberal -> Reactive society – short-term solutions to environmental problems

- health care costs will go up because the focus is on curing instead of proactive solutions

Fossil-fuel driven development -> **climate change**

High adaptation:
Coastal protection (S, SE Baltic): walls will prevent sand from buiding up on beaches, but get back into the sea
-impacts on flatfish?
-loss of seal breeding areas?

Stress on biodiversity because of:
Sea level rise
-some low island might disappear

Higher or lower salinity? depends on runoff, evaporation, precipitation, wind speed
-the effects of climate change are very uncertain
- lower salinity is bad for cod and other marine fish
-salinity is the main driver of species distribution

Climate warming can also change species distributions

Acidity – maybe not a big issue?

Wind also affect stratification, oxygen…

SITUATION TODAY - FISHERIES

Fisheries is a small sector in the Baltic, but politically important

-fishing is considered culturally valuable

-mostly within Baltic, Estonia exports some

-dioxins in herring is a problem

A sector that can change fast

Fish farming in the sea a local issue in. e.g. SW Finland, but on a Baltic scale the nutrient output is quite small

IMPACTS OF CLIMATE CHANGE need to be considered in the regionally downscaled SSPs

-changed environmental conditions will change the food-web, which affect the fisheries

-Fishing technology: climate warming may mean that modern technology is needed, e.g. freezers on board -> leads to bigger units that fish over larger areas

Global changes in production and demand will impact Baltic fisheries

CLIMATE CHANGE and EUTROPHICATION interact as the main drivers

TOOLS NEEDED FOR PROJECTIONS

- Good models and sources of information for regional trade
- Models/information on climate change effects on fish and species distribution in general