Baltic Earth Gulf of Finland Workshop, Helsinki, 24-25 November 2014
Working Group Discussion Notes

Thematic group A

A. Cost-effective nutrient load reductions, main findings

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Questions to be answered:

1. What is our **knowledge of the environmental state of the Gulf** now? How **vulnerable** is the Gulf towards anthropogenic impacts?

    - GoF experiences strong benthic-pelagic coupling, vulnerable because of shallow water
    - Upwelling along the Finnish and Estonian coasts frequent
    - Short residence times
    - Intermediate status and vulnerability between the open Baltic Sea and coastal areas
    - P-Loads from Neva, St. Petersburg have decreased from 2.300t yr^{-1} (2004) to 500 t yr^{-1} (2013)
    - N, P retention by St. Petersburg dam
    - Still, approx. 5% of St. Petersburg and many small towns have inefficient waste water treatment
    - Chl.a reductions observed in Eastern part of the GoF, water clarity has improved
    - Improvements in Eastern part of GoF largest; Improvements after 2000 in oxygen and P loads and concentrations;
    - Main problem: Internal loads: P storage in sediments, slowly released to water body. Large P storage in Baltic proper area with potential to reach western GoF
    - Exchange between BP and GoF is constantly ongoing
    - Winter storms may bring deep water P to the surface layer, triggering phytoplankton blooms following summer
    - Even with largely reduced external loads, the internal loads will continue for many decades; very slow recovery due to long P residence times in the water-sediment system

2. Which fundamental **research gaps** are there and what kind of new scientific **innovations/modelling tools** do we need in Gulf of Finland studies in the future to learn more about the ecosystem functioning?

    - More accurate data from agricultural and point sources is needed (60% of P loads are from agricultural sources in the Finnish catchment)
    - P reductions observed still mostly due to wastewater treatments, slight reductions in agricultural P loads are becoming more visible (Finland)

- New methods considered ("nutrient tagging" to follow from source)
- Evaluate the role of the coasts in nutrient retention, more regionalized modelling efforts are needed, as there are large regional differences in nutrient loads, concentrations, oceanography, and topography
- More research needed on N and P storage and release (processes in sediments, transport, denitrification, etc.)
- More accurate data for field plots, farming actions, fertilization is needed to be able to estimate accurately present and future nutrient loading and find cost-effective actions for nutrient load reductions
- Geo-engineering solutions to be discussed and studies; take into account the ecological risks
- New modelling effort to model the eutrophication and nutrient status of the GoF in the past decades based on the new comprehensive dataset of the new GoF Year assessment; using ensembles whenever possible, taking into account changing internal and external loads over time
- High temporal resolution measurements in the near bottom layer (nutrient gradients in the sediment, flux measurements, microbial processes included, sedimentation rates)
- Integrated use of monitoring techniques (Remote sensing Chl. a, buoys, ships of opportunity, research cruises

3. What is our **message to decision makers**? What should our **common research and modelling efforts** be directed to in order to support environmental protection activities?

- Coordinated monitoring with harmonized methods is crucial (confidentiality in published data reports is low due to missing data from Russia (HELCOM 2007, 2011), inhomogeneous sample treatment (filtered/unfiltered prior to analysis))
- New GoF year assessment in preparation, now data available; Oxygen, Chl.a, Nutrient loads and conc.
- Time series of nutrient concentrations 1996-2014
- No data before 2009 on lowest part of Luga

Socio-economic perspective should be taken into account in addition to the scientific

- The present agricultural subsidy system is not effective for reducing nutrient leaching in present nor future climate. Financial support to farmers should depend more directly on the expected nutrient leaching reductions in a field plot.
- Investigate new increasing loads due to more excessive animal farming, fate of manure, changes in life style, reasons, mitigation
- Improving N reductions from municipal loading
- Agriculture (animal farming) in Russian part of the catchment?

Recommendations to the Declaration:
How can the state of the Gulf be **improved rapidly and cost-effectively**?
Which **concrete actions** do our modelling results indicate?

Thematic group B

B. Preventive methods and forecasting of oils spills and other marine accidents, new methods

Questions to be answered:

1. What is our knowledge of the environmental state of the Gulf now? How vulnerable is the Gulf towards anthropogenic impacts?
2. Which fundamental research gaps are there and what kind of new scientific innovations/modelling tools do we need in Gulf of Finland studies in the future to learn more about the ecosystem functioning?
3. What is our message to decision makers? What should our common research and modelling efforts be directed to in order to support environmental protection activities?

Recommendations to the Declaration: How can the state of the Gulf be improved rapidly and cost-effectively? Which concrete actions do our modelling results indicate?

Gulf of Finland Year
Modelling tool workshop - 24.11.2014 - SYKE
Group "oil spill - preventing/modelling"

Group:
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- Markus Meier
- Floris Goerlandt
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Kick-off: Formalism to prepare GoF-declaration
- Similar phrasing / structuring as in Rome Declaration (BSAP / BONUS / ...)
- Declaration: high-level aims ("what")
- Roadmap: practical implementation ("how")

-> Need to stress "observation, modelling and fundamental research"

Q1. Knowledge of environmental / vulnerability state of GoF
- Complexity of driving forces and system dynamics
- Level of vulnerability due to transport of contaminants is quite poorly known-
- Complexity due to the coast line layout - FIN/EST/RUS, geographical and topological

Holistic view on environmental pollution: oil spills, litter, other contaminants

Q2. Fundamental research gaps, scientific innovations, modelling tools

ABOUT ENVIRONMENTAL SCIENCES
- "How is pollution carried and how does it spread?", i.e. lacking knowledge on fundamental issues
- horizontal/vertical luxes, mixing parameters of sea dynamics models
- Pollution spreading dynamics in water, in ice, in suspension

- Especially in ice: entire world can learn from GoF -> Arctic environment
- Data-related uncertainties: forcing data, homogenous time series, reliability of forcing data
- Qualitative improvements needed in hydrological and atmospheric models for pollution dynamics, and of data, especially over the sea areas

ABOUT THE MARITIME TRANSPORTATION SYSTEM
- Fundamental questions related to the occurrence of accidents, what are the driving factors
- How to measure the system safety level from the system operation point of a view, in absence of accident data
- Several currently available methods and approaches are uncertain and of limited validity
- Existing methods have enabled a reduction of risk and accident occurrence to a low degree
- New methods and approaches are needed to evaluate safety level of shipping to further decrease
- Fundamental research needed on validation of risk and safety models
- Understanding of the dynamics of safety, how "safety is achieved"
- How to cover the gaps between responsibilities -> enhance system operation at borders of responsibility
- Harmonization of reporting needs -> 1 system that is used cross-border, preventing confusion (dependable programming)
- Intelligent systems for onboard and shoreline decision support [E-Navigation]

Q3. Recommendations to decision makers

- Despite progresses made in the sciences, there are oustanding uncertainties
- Stress commitment to open data, open models, open code
- GoF focusing on cutting-edge research, open laboratory which has benefits for other areas

**** Concrete actions -**
- Costs of accidents can be reduced by shifting fairways
- Carrying of pollution to marine protection areas can be reduced by shifting fairways
- Risk assessment models (MIMIC / WINOIL) indicate which measures to prioritize to reduce accidental risk in maritime system

Thematic group C

C. The impacts of climate change on physics and biogeochemistry, main effects

Questions to be answered:

1. What is our knowledge of the environmental state of the Gulf now? How vulnerable is the Gulf towards anthropogenic impacts?
2. Which fundamental research gaps are there and what kind of new scientific innovations/modelling tools do we need in Gulf of Finland studies in the future to learn more about the ecosystem functioning?
3. What is our message to decision makers? What should our common research and modelling efforts be directed to in order to support environmental protection activities?

Recommendations to the Declaration: How can the state of the Gulf be improved rapidly and cost-effectively? Which concrete actions do our modelling results indicate?

Impacts of climate change on physics and biogeochemistry

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Main Climate Change Issues

- Quantitative projections of potential effects of CC in the future is only possible with models
- The models need to desribe relevant processes in the GoF and be validated with available data and knowledge on past processes, including regime shifts
- Necessary to design more elaborate high resolution sub-models for the Gulf of Finland to describe the spatial, biogeochemical and food web processes correctly.

- Necessary to understand the potential regime shifts: thresholds, tipping points; what needs to be done to rebuild the resilience of the system?
- Alternative approach: using innovative approaches to determine the range of possible future CC effects (e.g. Bayesian modelling of processes; Ensemble modelling; Sensitivity analyses)

Major gaps in knowledge

Proper data for certain relevant parameters is missing, e.g. for

- Freshwater discharge and nutrient loading data for all rivers in all riparian countries of the Baltic Sea
- Atmospheric deposition of nutrients
- Farm level / regional development scenarios for agriculture
- High resolution bottom topography

Baltic Sea scale models have a too coarse resolution for estimating coastal and archipelago processes

- Fine scale processes not understood well enough to make long-term projections

Certain processes not known good enough, e.g.:

- Future changes in weather variability, and associated changes in water temperature and mixing, on benthic biogeochemical processes

Biogeochemical and food web models are not coupled, which makes it difficult to make projections on the effects of CC on food webs

- Interactions between high and low trophic levels not accounted for (from e.g. fish to phytoplankton and nutrients, and vice versa)
- ”Ecological surprises” (including regime shifts and non-indigenous species) may influence the dynamics in unpredictable ways

Aperiodic significant change within the climate system cannot be analysed by the current modelling methods

- Potential approach: time series techniques

Messages to Decision Makers

- CC makes it more probable that eutrophication gets worse. This needs to be taken into account when estimating minimum levels of nutrient reductions needed
- CC will also influence the biogeography of species, food web intercations, and biochemical functions in species
- Projections of the future are always uncertain; decisions need to be made despite uncertainties; precautionary principle is called upon

Practical measures

- To understand the responses of the GoF to CC, all available data needs to be collated and analysed jointly
- To be able to distinguish human impacts from natural variability, and to make projections of future changes in GoF environment, future monitoring needs to be planned and conducted in cooperation, tri-laterally

GoF Declaration – Suggestion for climate change text

Recent research has shown that climate change will impact the Baltic Sea environment in the coming decades. Water temperature will increase, salinity will probably decrease, and extreme weather events will become more frequent.

These changes will disfavour marine species, many of which are key components of the Gulf of Finland ecosystem, and favour certain freshwater species, that may expand their biogeographic distribution. Also new non-indigenous invasive species from other sea areas may be introduced into the Gulf of Finland. Unpredictability increases the probability of catastrophic events, such as alteration of biogeochemical processes and losses of habitat-forming species.

Climate studies indicate that there will be more rainfall and warmer temperatures during wintertime. According to most modelling efforts this will increase loading of nutrients from land into the already nutrient-laden Gulf of Finland. Eutrophication may be enhanced, and its symptoms, like anoxia, algal blooms, and shores covered by filamentous algae, may become even more common than today. Climate change may thus erode the resilience of the Gulf of Finland ecosystem and make it remain in a deteriorated state.

This calls for a proactive approach when designing mitigative and adaptive actions: effective reduction of nutrients from all sources, spatial protection of habitats and key species, as well as proper spatial planning of the marine and maritime activities are needed to achieve the good ecosystem state in the Gulf of Finland.