Environment and Climate Regional Accession Network ECRAN

"Workshop on Eutrophication Reduction Measures under EU Directives in the Domain of Water "

16-18 May 2016

ECRAN 62260

Approaches and methods for eutrophication target setting in the Baltic Sea region

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Structure of the presentation

- Baltic Sea map
- Baltic Sea eutrophication
- Baltic Sea Action Plan
- Target setting concepts
- NEST model
- Danube Delta MONERIS

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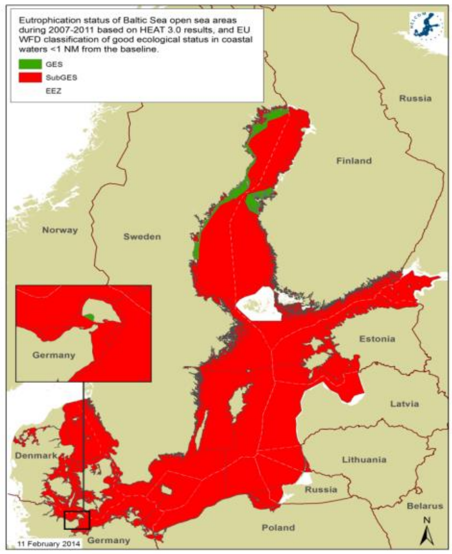
Baltic sea map



The entire open Baltic Sea was assessed as being eutrophied!

Red – less than GES

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Baltic Sea eutrophication

Eutrophication is driven by a surplus of the nutrients nitrogen and phosphorus in the sea.

Nutrient over-enrichment causes elevated levels of algal and plant growth, increased turbidity, oxygen depletion, changes in species composition and nuisance blooms of algae.

The main pathways of nutrients to the sea are:

- –riverine inputs
- –atmospheric deposition of nitrogen to the water surface and
- –direct waterborne discharges to the sea either from coastal point sources, run-off from diffuse sources in coastal areas and
- –discharges from ships.

In addition, excess nutrients stored in bottom sediments can enter the water column and enhance primary production of plants.

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The Baltic Sea Action Plan (BSAP)

Vision for the Baltic Sea

“A healthy Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable human economic and social activities”.

Four thematic issues (also referred to as segments):

- eutrophication
- hazardous substances
- maritime activities
- biodiversity.

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BSAP Activities

(1) Agreeing on principles for target setting in regard to nutrients, clear water, algae, submerged aquatic vegetation, benthic invertebrates and oxygen;

(2) Estimations of critical loads (threshold values) per basin and per objective; and

(3) Overlay of the critical loads per basins in order to estimate the load reductions needed to fulfill all ecological targets.

The HELCOM BSAP is based on just one of the five ecological objectives, “clear water“, which in practice is equivalent to “light penetration“, measured as **Secchi depth**. As this target has been considered **preliminary**, the subsequent estimation of critical loads (total allowable loads) as well as the country-wise allocation of the critical loads also has to be regarded as preliminary.

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Targeting setting protocol

It has three steps:

Step 1: Dividing the Baltic Sea into ecologically relevant basins and sub-basins with regard to eutrophication.

Step 2: Analyses of temporal trends per basin or sub-basins identified in Step 1 and the identification of any thresholds.

Step 3: From thresholds to targets – an evaluation of the ecological relevance of statistically identified thresholds.

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Target setting concepts (1)

(1) The **concept of 'reference conditions'** as derived from the WFD:

Reference condition - is a description of the biological quality elements that exist, or would exist, at high status, that is, with no, or very minor disturbance from human activities.

The objective of setting reference condition standards is to enable the assessment of ecological quality against these standards.

The concept of reference condition has a number of strengths:

• It is a well consolidated concept used in all EU coastal and transitional waters – mostly because it originates from the WFD.

• Reference conditions are generally determined by scientific methods, e.g. the analysis of historical data, modelling and reference sites – or by expert judgments.

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Weaknesses of the concept of using reference condition

- The current use of reference conditions within the Baltic Sea is not 100% harmonised
- There are no undisturbed reference sites in the Baltic Sea
- Setting inaccurate values of reference conditions will result in inaccurate target values.

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Target setting concepts (2)

2) The **concept of 'acceptable deviation'** from reference conditions also originates from the WFD, where the acceptable deviations are no deviation or a slight deviation from the reference conditions, whilst deviations being 'moderate' or 'high' are regarded 'unacceptable deviations' indicative of impaired ecological status

A combination of the above two terms would lead to the following interpretation of Acceptable Deviation:

A divergence worth accepting or
a divergence within a range considered normal.

The objective of setting an acceptable deviation from reference conditions is **to define the boundary between acceptable and unacceptable eutrophication status** and thus the **setting of operational targets for relevant eutrophication indicators**.

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Targets in the Baltic Sea

(1) **Group 1 targets**: Oxygen and Secchi depth, which are labelled directly and are observation-based targets;
(2) **Group 2 targets**: Chlorophyll a and nutrients, which are labelled indirectly and are preliminary established targets.

Recommendations: directly and observation based targets from Group 1 are used for calculating the maximum allowable inputs in the revision exceeding the proposed targets.

The nutrient and Chlorophyl a targets should also be seen as targets to be used in the assessment of the eutrophication status.

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NEST model – nutrient reduction schemes for Baltic Sea

- Basic principles
- How to estimate Maximum allowable inputs (sustainable loads to the Baltic Sea)
- How to share the reduction burden – Country Allocation

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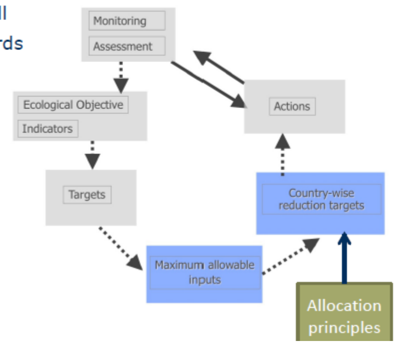
Country allocation and target

The BSAP Management cycle

Stockholm University

Maximum allowable inputs: the basin-wise maximal nitrogen and phosphorus loads that will result in a development towards reaching the targets

Country-wise reduction targets: the necessary load reduction distributed per Country according to agreed principles



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Basic principles

Stockholm University

1. At *some scale* there are relationships between anthropogenic pressure (i.e. nutrient loads) and eutrophication status
2. A model that quantifies these relationships
3. The concept of good environmental status has to be quantified with indicators that can be modeled accurately (targets), preferable independently from the model

Together this leads to an estimate of the nutrient loads that will (at some point in the future) result in good environmental status

In BSAP terminology we call this load Maximum allowable input (MAI)

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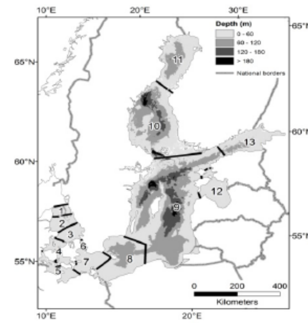
Baltic Sea eutrophication model

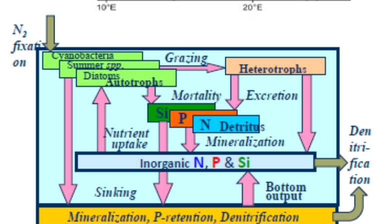
BAltic sea Long-Term large-Scale Eutrophication Model

Main characteristics:

- 13 sub-basins
- High vertical resolution
- Full air-sea exchange including sea ice
- Water exchange from well-founded steady state dynamics
- Wind and buoyancy forced mixed-layer dynamics and wind-forced deep-water mixing
- Dense gravity current mixing sub-models
- Typical simulation times on a high-end workstation 200 simulation years in 30 - 60 minutes

Available on-line in Nest: http://nest.su.se





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Recommendations

Stockholm University

Finding optimal solution:

1. Make systematic test of simultaneous load changes to Baltic proper (both N and P), and P to Gulf of Finland and Gulf of Riga
2. Considering the target variables
   1. Summer Secchi
   2. O2 debt
   3. Winter DIN (in BP) and DIP (in BP, GR and GF)
3. Check under what conditions targets are satisfied
4. Find the maximal sum of the phosphorus loads to the three basins that still satisfies targets
5. Investigate individually MAI for N in GR and GF; and for N and P in remaining basins

Baltic Nest Institute

DRAFT – not final figures

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- Reference to Danube delta – assessment of eutrophication with Moneris

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Thank you!

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