Impacts of societal and climatic changes on nutrient loading to the Baltic Sea

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Aims & Objectives

extends nutrient load projections for relevant combinations of regionally downscaled shared socioeconomic pathways (SSPs) and two RCPs (RCP4.5 and RCP8.5) over the period 2010-2100.

All major sources including agricultural nutrient loading, point source loading and the atmospheric deposition are accounted for.

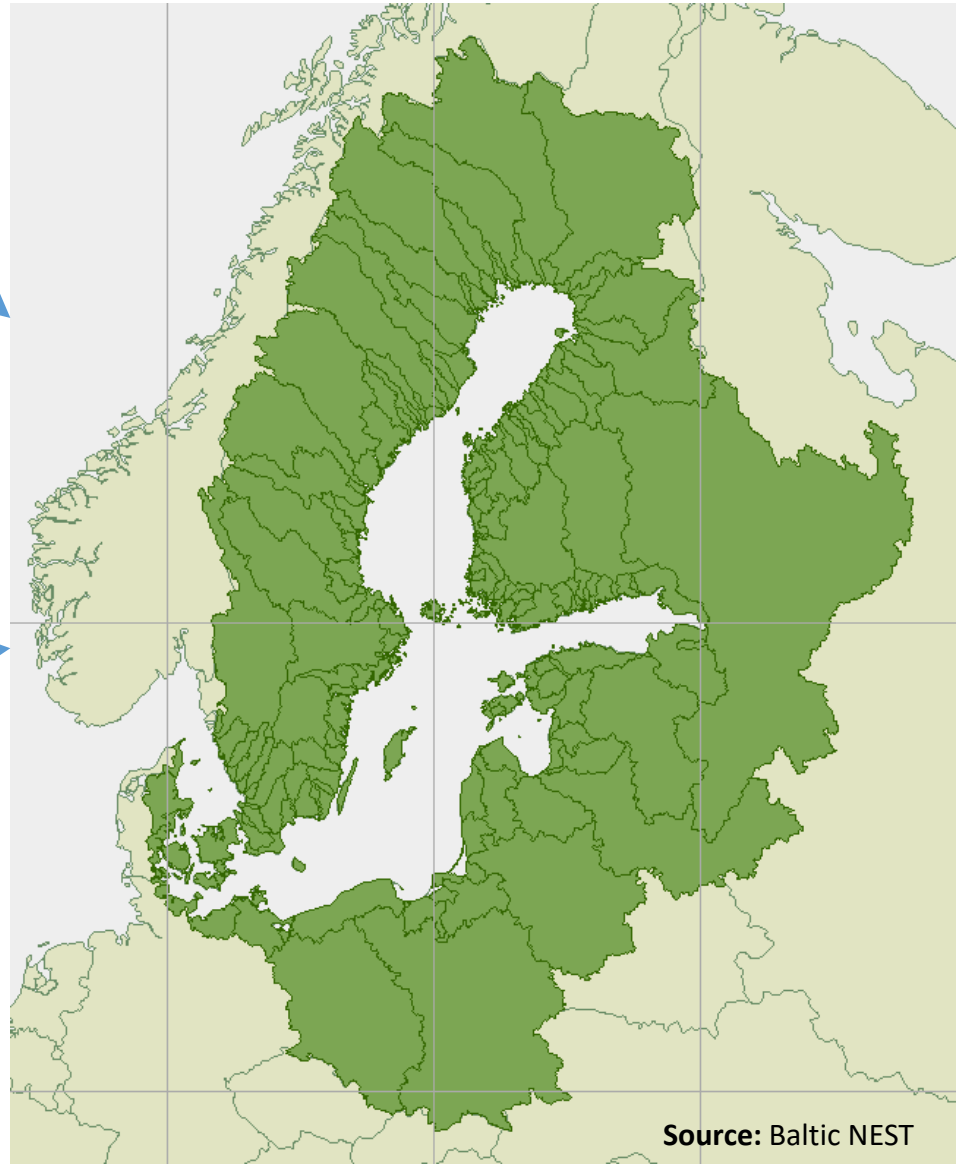
The scenarios can be used for estimating the additional nutrient abatement effort needed to reach the goals of marine protections, such as the HELCOM BSAP

Changing climate

RCP4.5 & RCP8.5

Changing society:

SSP1 – Sustainability
SSP2 – Middle of the road
SSP3 – Fragmentation
SSP4 – Inequality
SSP5 – Fossil-fuel dev.



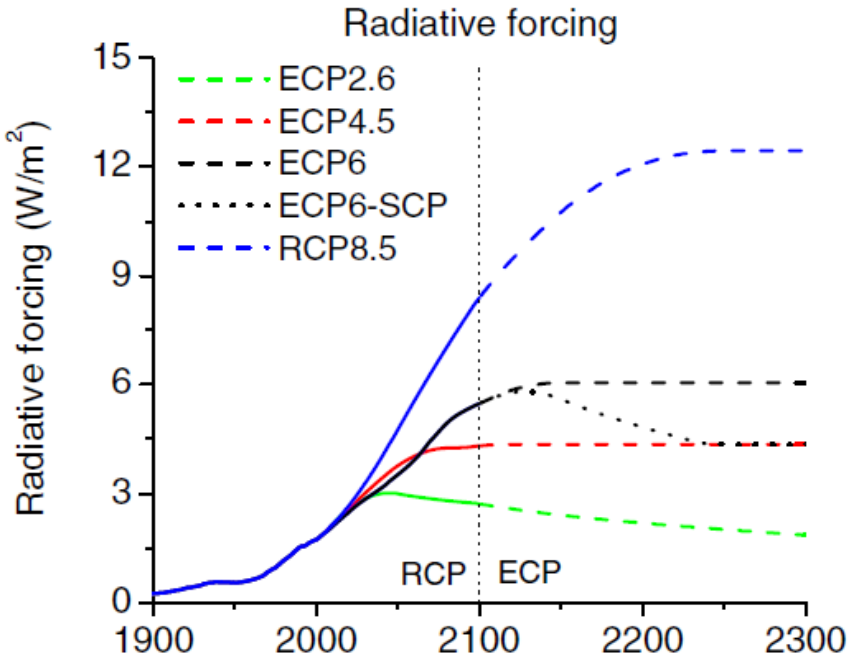
Source: Baltic NEST

Time frame:
2010 - 2100

Scenarios

Climate change

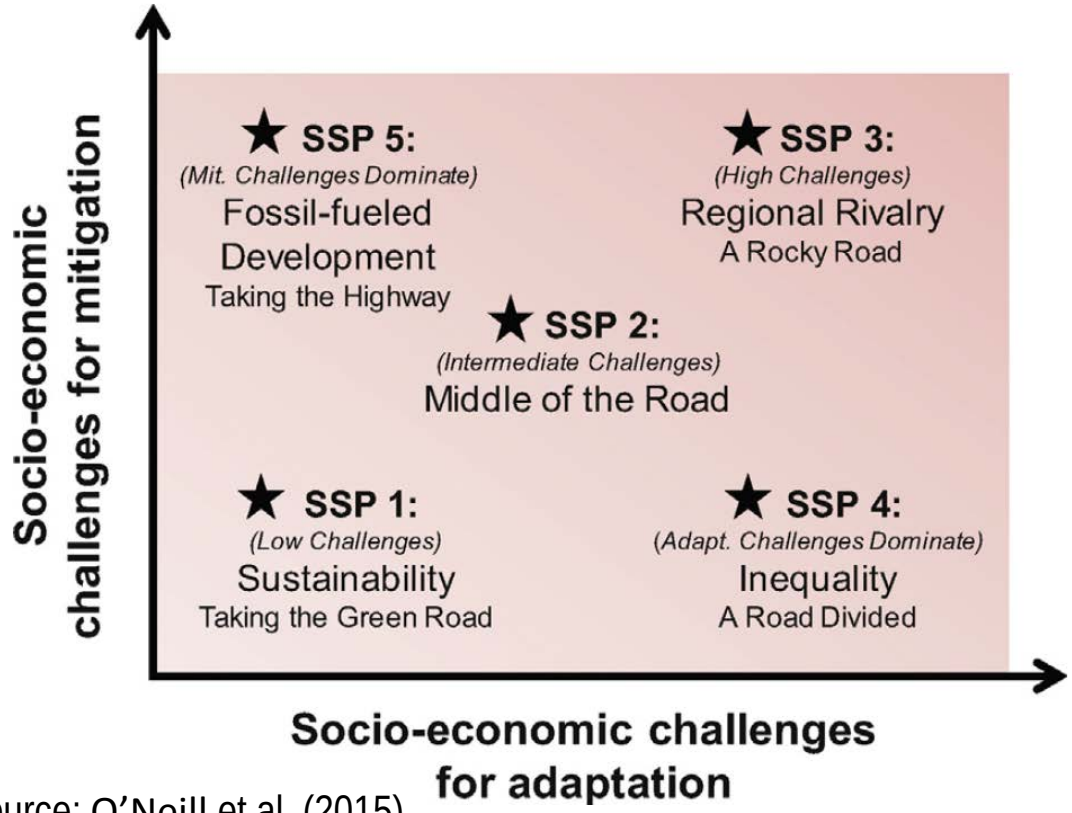
Representative Concentration Pathways (RCPs)



Source: van Vuuren et al. (2011)

Socio-economic development

Shared Socioeconomic Pathways (SSPs)



Source: O'Neill et al. (2015)

Management and policies

Shared Climate Policy Assumptions (SPAs)

Drivers

SSP1, Sustainability	SSP5, Fossil-fueled development
• Population in the region and globally peaks and starts to decline after 2050 • Rapid urbanization • Gradual move towards less resource intensive lifestyles	• Global population peaks in 2050, population in the Baltic Sea region increases steadily • Rapid urbanization • Resource and energy intensive lifestyles prevail
• Increased plant based diet • High N efficiency, high share of local & organic products • Reduced agricultural land cover & livestock	• Increased meat and dairy products in diet • Globalised, export oriented sector, intensification • Increased livestocks => expansion of agricultural land cover
• Tertiary treatment becomes the standard • Separation of rainwater and sanitation • Advanced on-the-site treatment common in rural areas	• New investments made to serve growing urban areas • focus on human health rather than environmental quality • Some upgrading due to technology spill-overs

Nutrient loadings

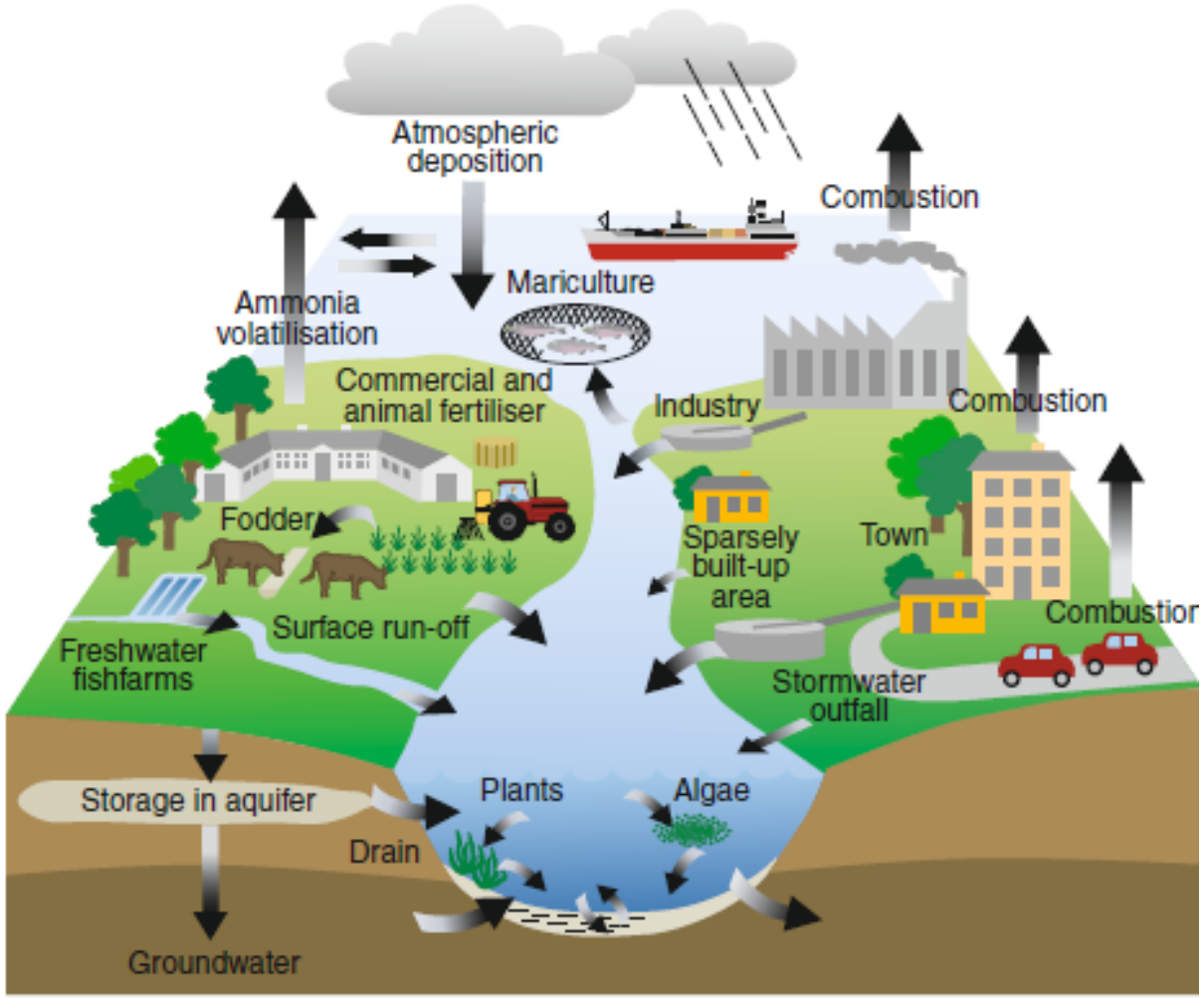


Figure 1-2 Different sources of nutrients to the sea and examples of nitrogen and phosphorus cycles (Source: Ærtebjerg et al. 2003).

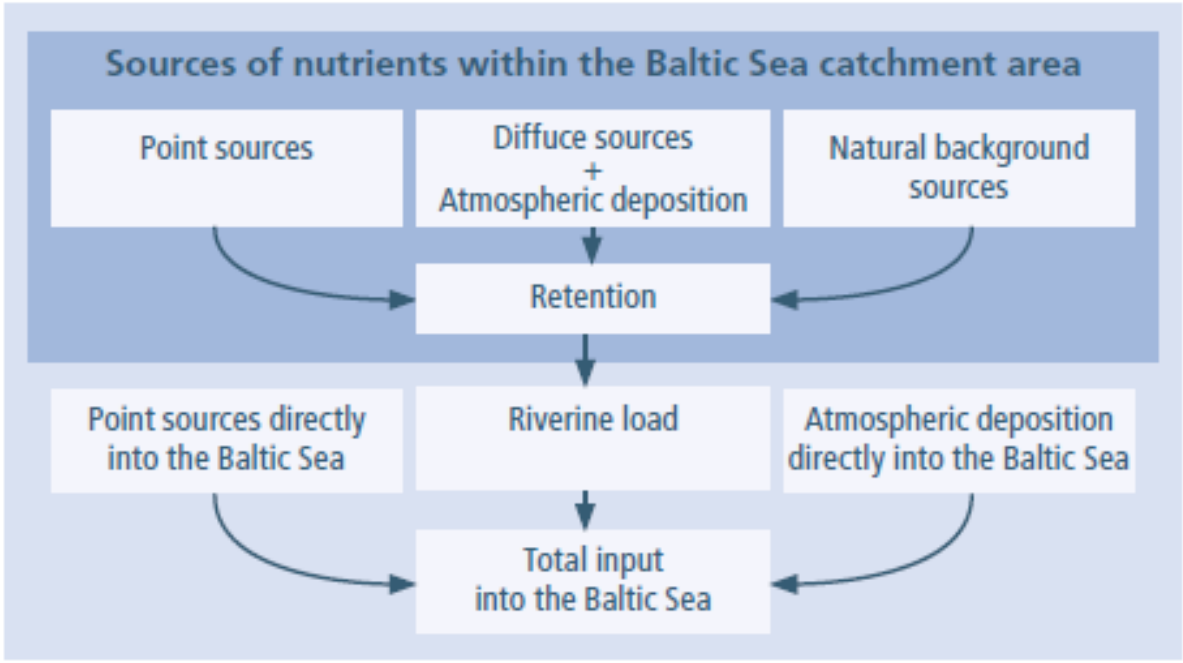
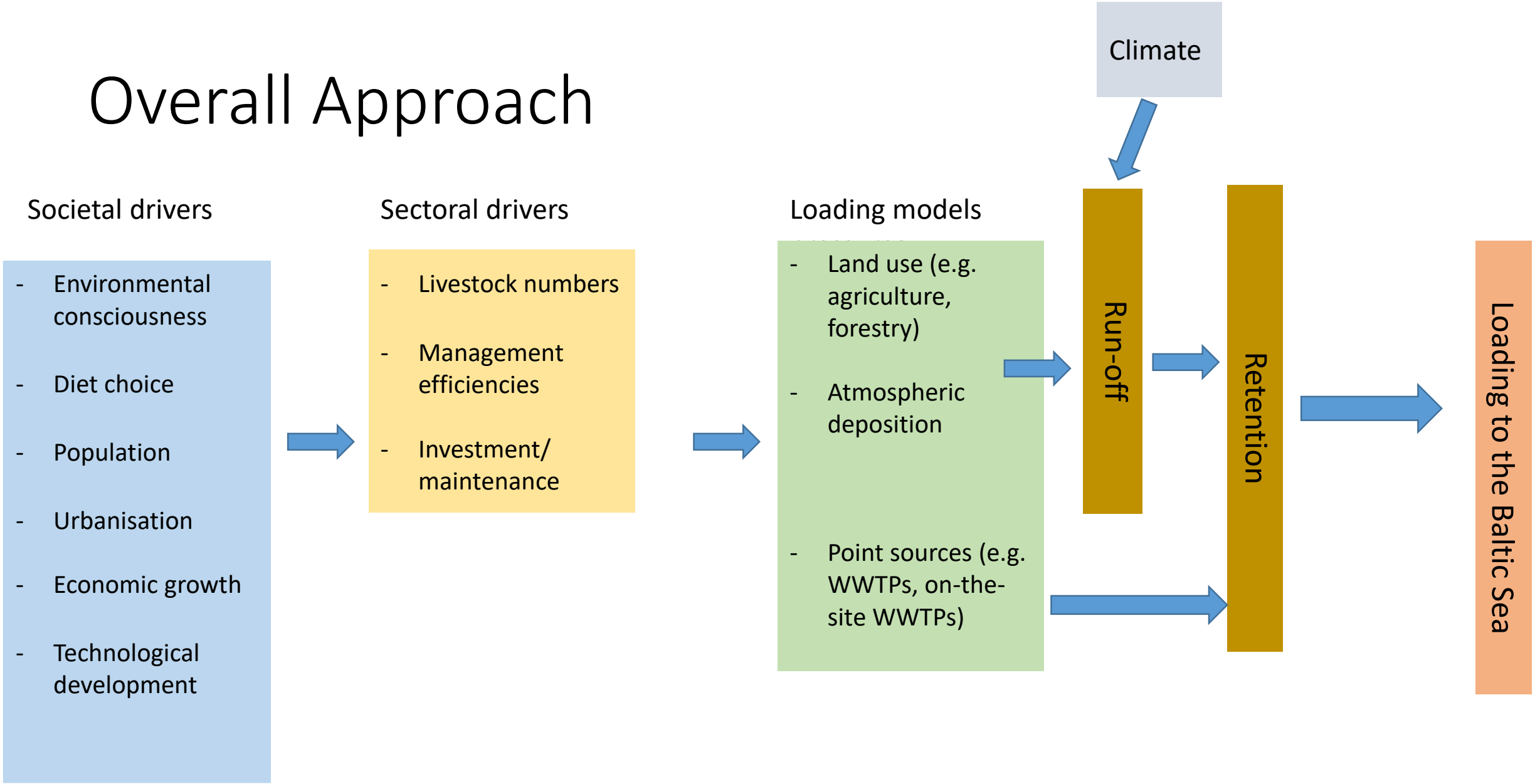


Figure 1-1 Conceptual model of sources of inputs to inland surface waters and to the Baltic Sea.

Source: Fifth Baltic Sea Pollution Load Compilation (PLC-5)

Overall Approach



Loading models

- Land use change
- Agriculture and other land use pressures
- Waste water treatment
- Atmospheric deposition

Nutrient loading to the Baltic Sea 2010

	Nitrogen	Phosphorus
Riverine loads		
Agricultural land, forests and managed lands	470	18.7
Scattered dwellings	33	2.4
Industrial load	14	0.8
Municipal load	85	5.9
Fish farms	2	0.2
Direct loads		
Atmospheric deposition	193	2.1
Direct point source loads	29	1.8
Total	825	31.9

Source: PLC5.5 (total loading in 2010-12) and PLC5 (source apportionment)

Agriculture and other land use

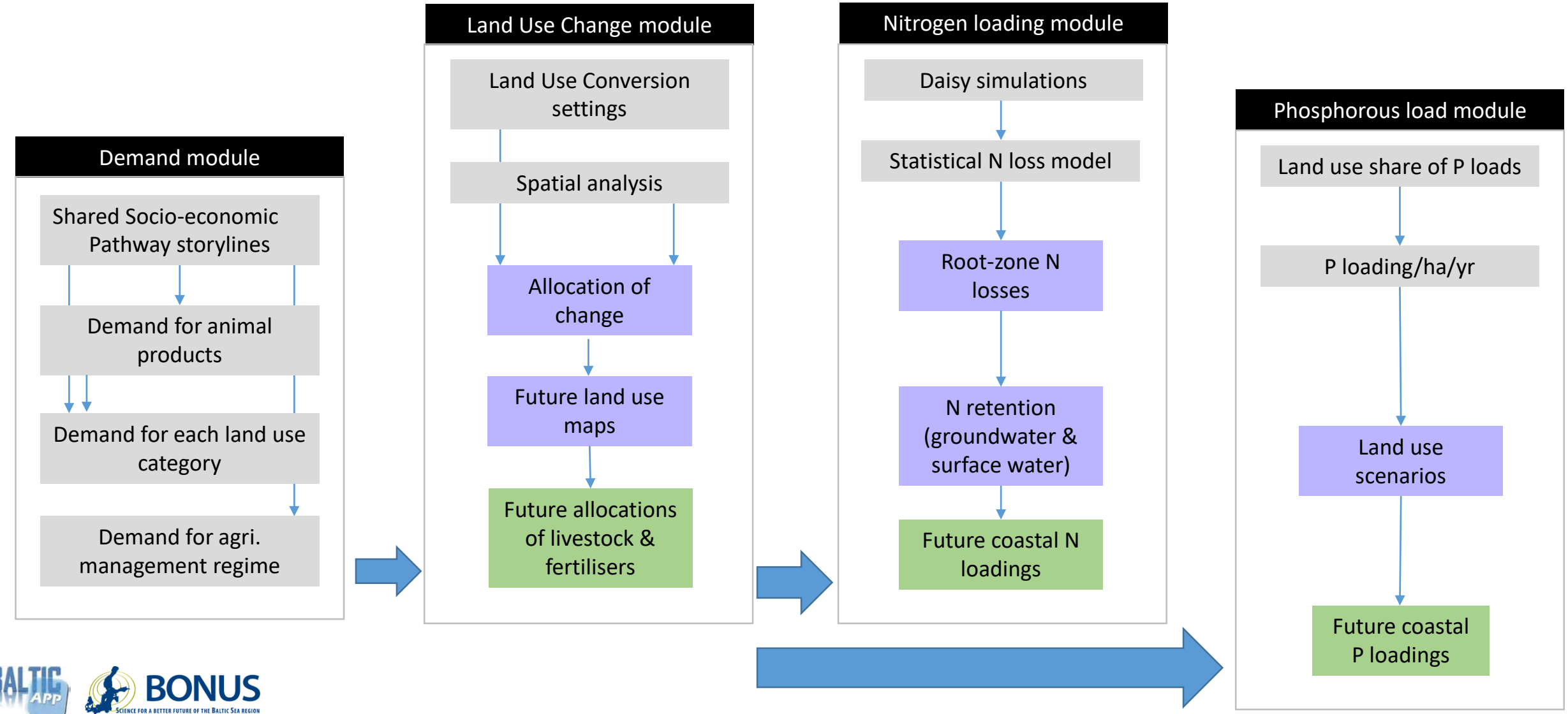
Diffuse loading from agriculture is based on scenarios that vary by

i) agricultural area;
ii) livestock intensity; and
iii) efficiency in use of manure

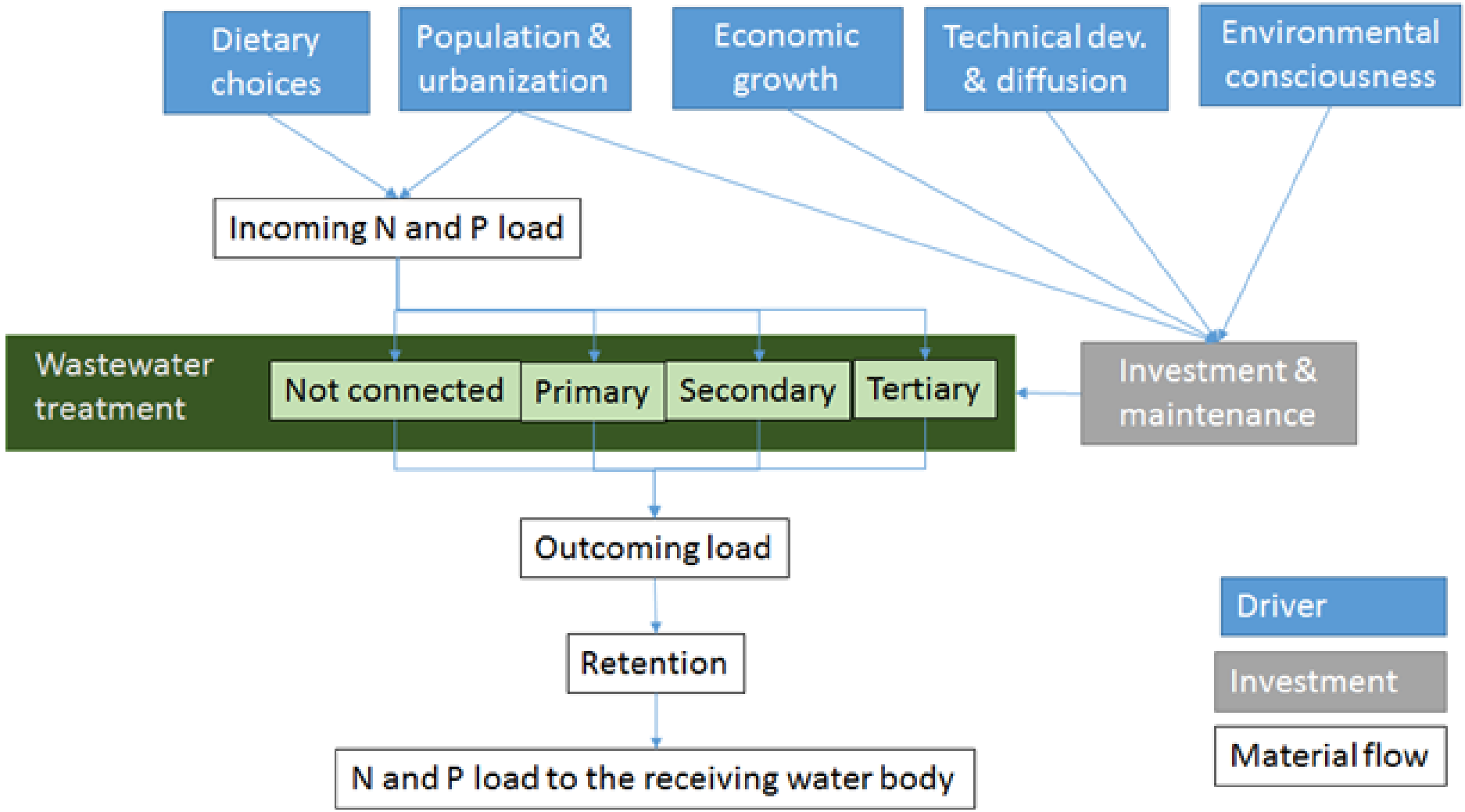
Two driver modules (demand module and land use change module)
Two pressure modules (N loading module and P loading module)

Loading from 117 catchments to 7 sub-basins by 5 SSPs up to end of the century

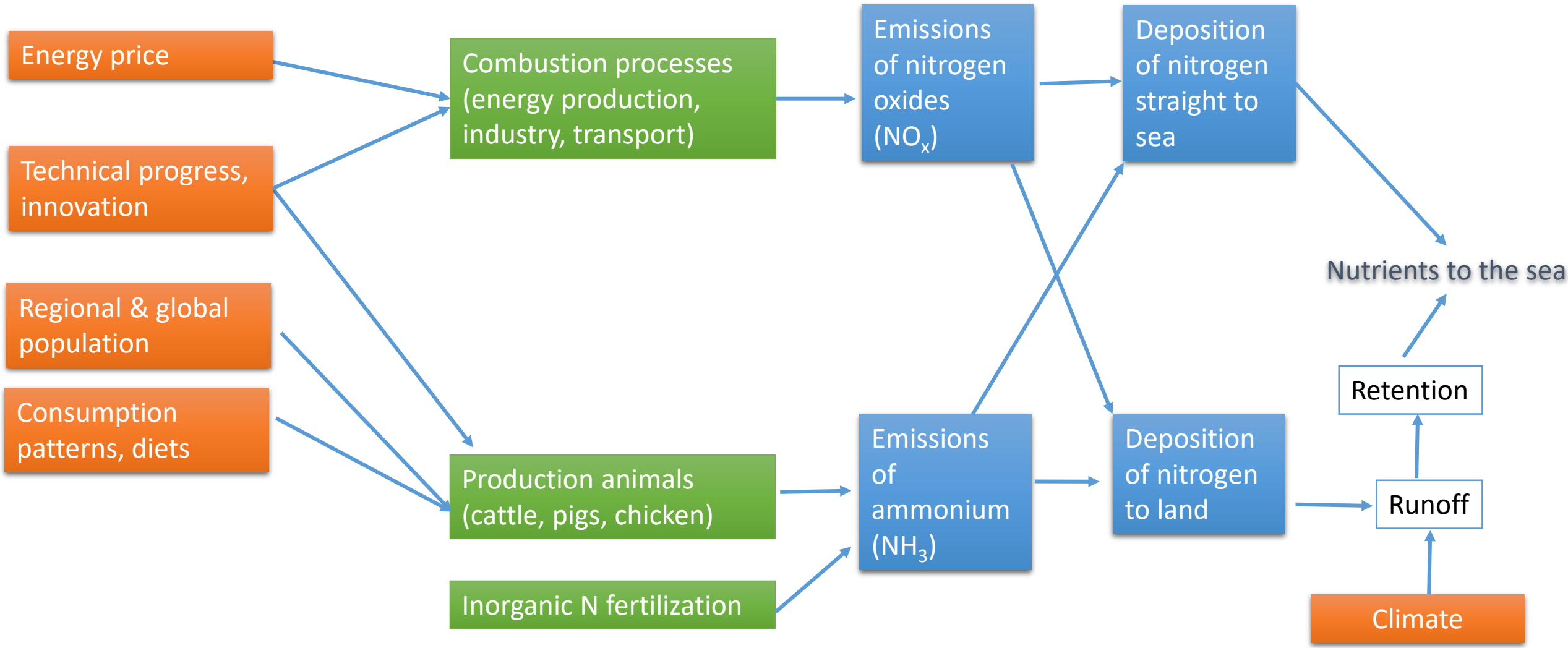
Agriculture and other land use loading



Waste water treatment



ATMOSPHERIC DEPOSITION OF NITROGEN

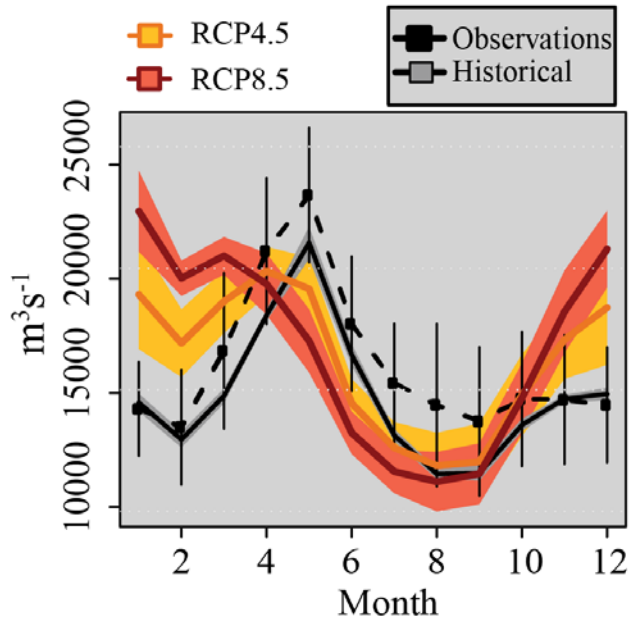


Source: BalticAPP Deliverable D1.1

Climate Impacts on Run-Off

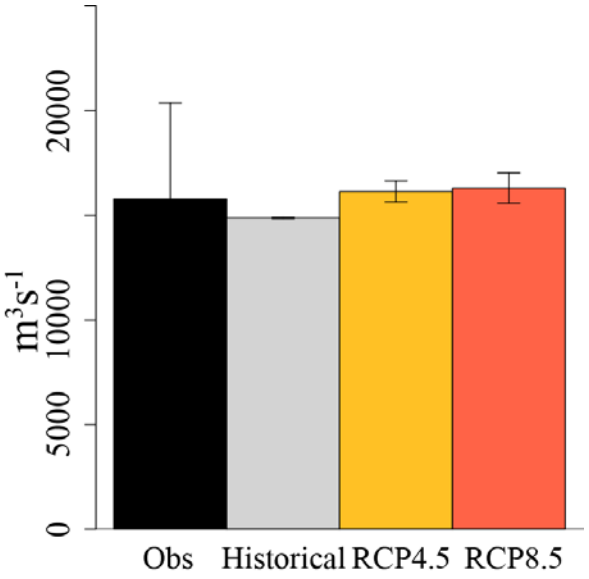
- Climate scenarios imply increasing precipitation, in particular in the northern catchments of the Baltic Sea
- => increase non-point pollution : 20-25% in RCP8.5; 10% in RCP4.5

Seasonal pattern of total runoff



Higher runoff during winter compared with present

Annual average runoff



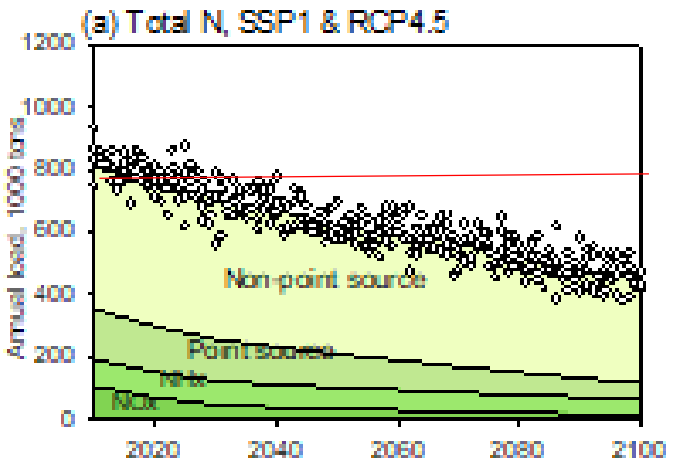
RCP 8.5 implies higher runoff than RCP 4.5, which is higher than present.

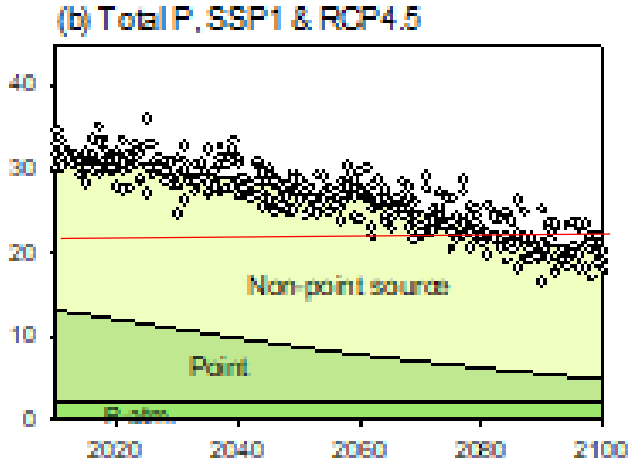
Results - nutrient projections

without any additional policies or measures

With sustained development (SSP1)
and moderate climate change (RCP4.5),

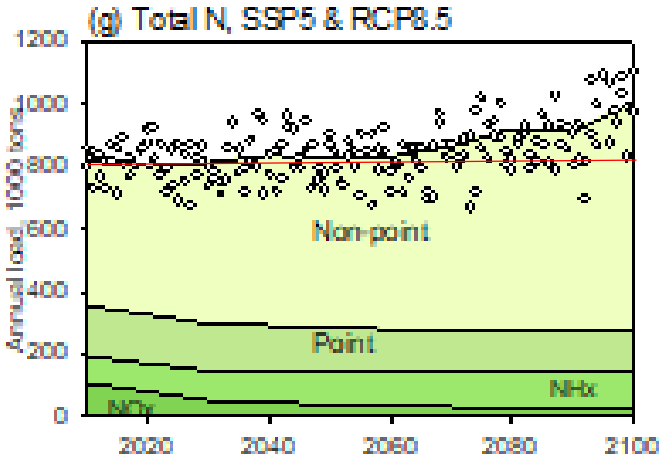
- N load targets will be met early on
- P load targets are met late in the century

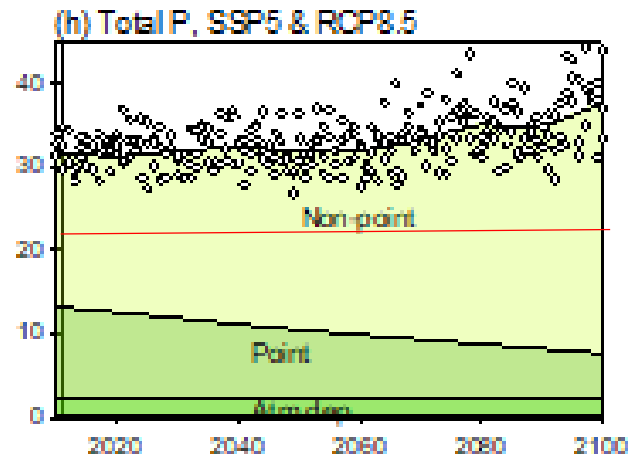




For fossil fueled world (SSP5)
and extreme climate change (RCP4.5),

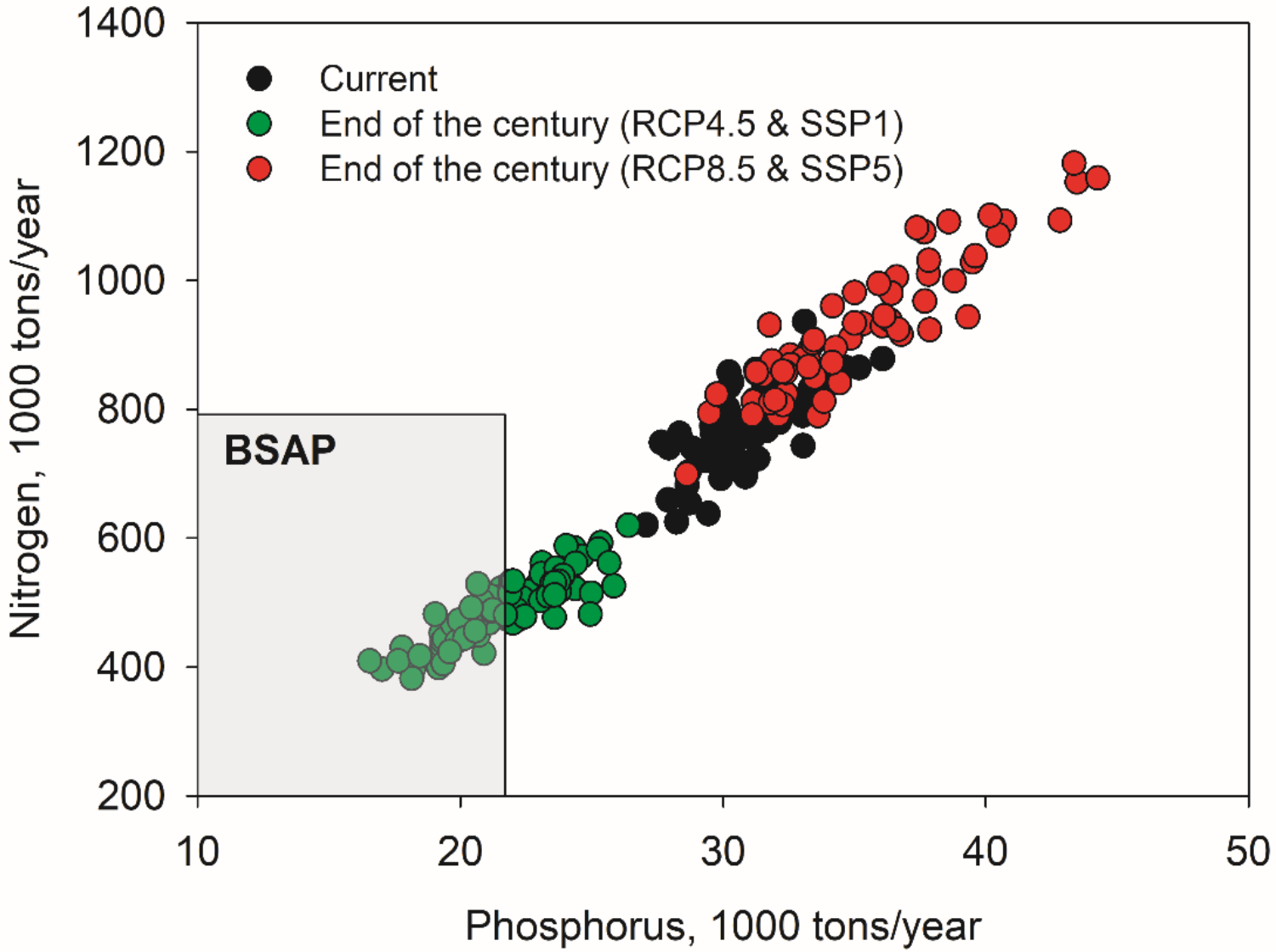
- the nutrient loads will increase
- the BSAP is far from reached



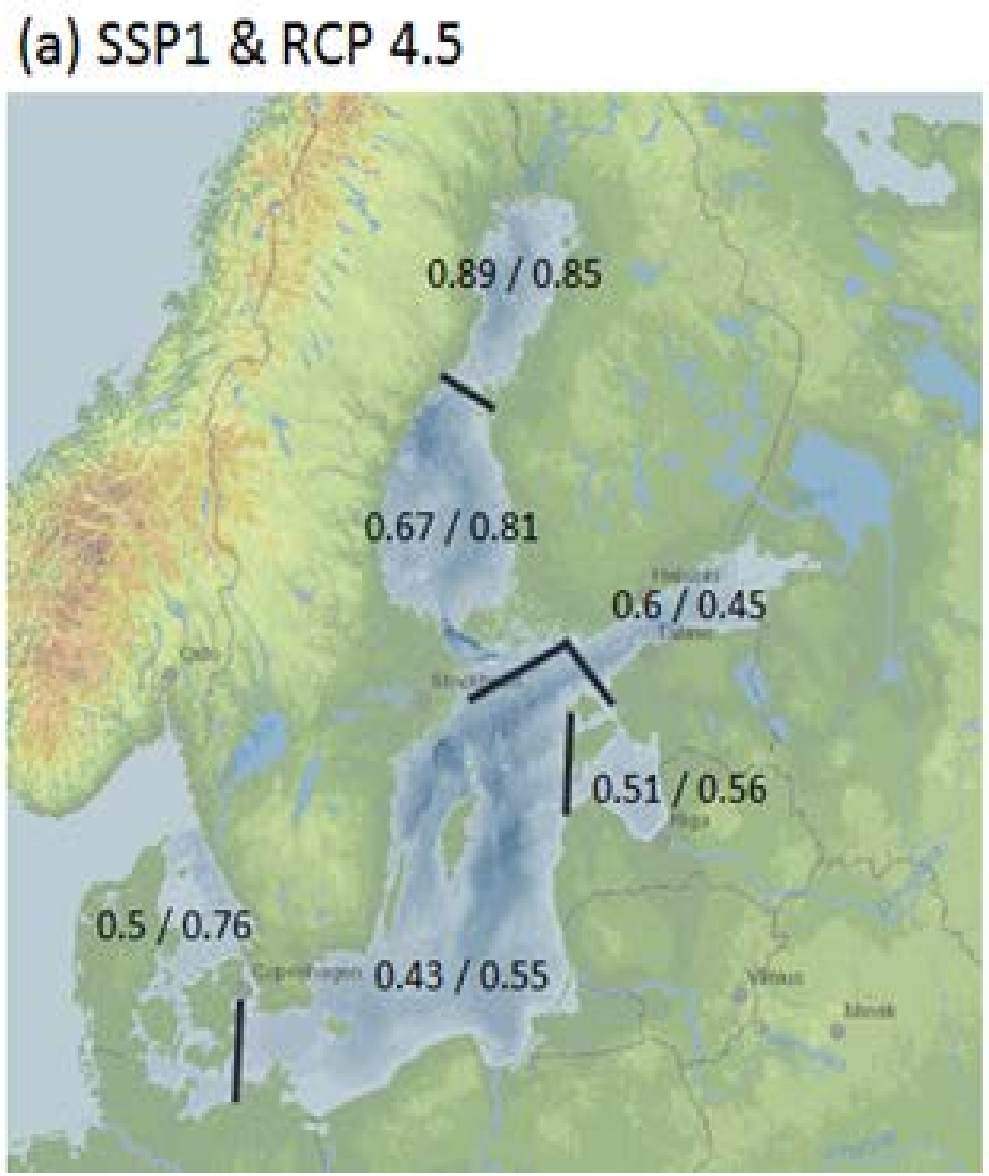


End-of-century results

Annual variability in nutrient loads to the Baltic Sea currently (2010-2030) and at the end of the century (2078-2098) for combinations of global sustainability & medium climate change (SSP1 & RCP4.5) and fossil-fueled development & high-end climate outcome (SSP5 & RCP8.5).



External nutrient loads (N / P) in year 2100 relative to loads in 2010



Conclusions

Sustainable society/medium climate:

- nutrient loading will continue to ***decrease*** despite climate change (15-25%).
- Climate alone may lead to nutrient load ***increases*** (15-18%)
- BSAP goals for nitrogen could be met early on
- Substantial additional mitigation efforts are needed compared to today in order to reach the BSAP goal for phosphorus over the next 20-30 years.

Fossil-fueled future/high-end climate:

- Nutrient loading will ***increase*** drastically (65-68%)
- Climate alone would be responsible for a 25-34% ***increase*** in loading.
- reaching BSAP goal is realistic only through dramatic structural changes in the agricultural sector, adoption of policy instruments directed to steer consumer decisions, or new technological leaps in manure handling

Acknowledgements

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http://https://blogs.helsinki.fi/balticapp/

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