Developing cumulative anthropogenic impact models for sustainable sea use planning

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Implementation of ecosystem-based approach in Marine Spatial Planning

- Increasing human uses at sea → adverse effects on species
- Identification of **actual** and **potential** threats and impacts on the marine ecosystems
- **Cumulative effects**
- **Visualizing** cumulative pressures and impacts → georeferenced data in the core

- Transboundary data & harmonization
- Joint collaboration

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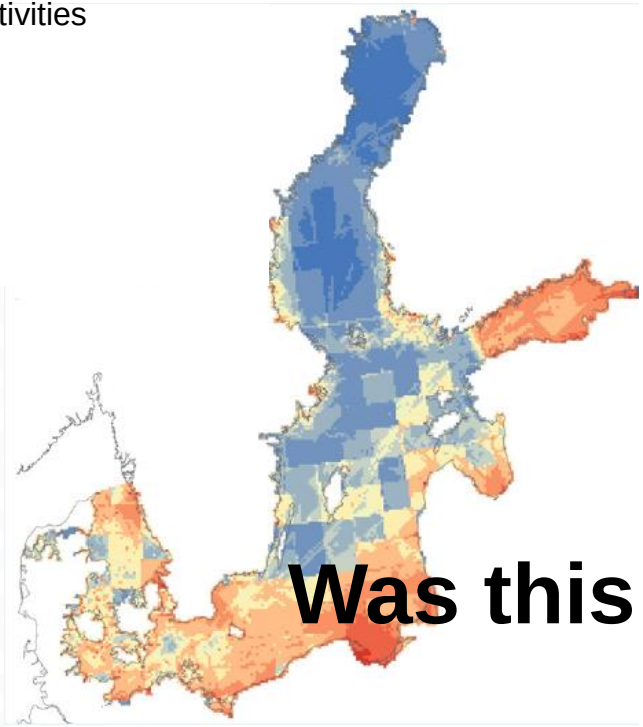
Background for the international work in the Baltic Sea

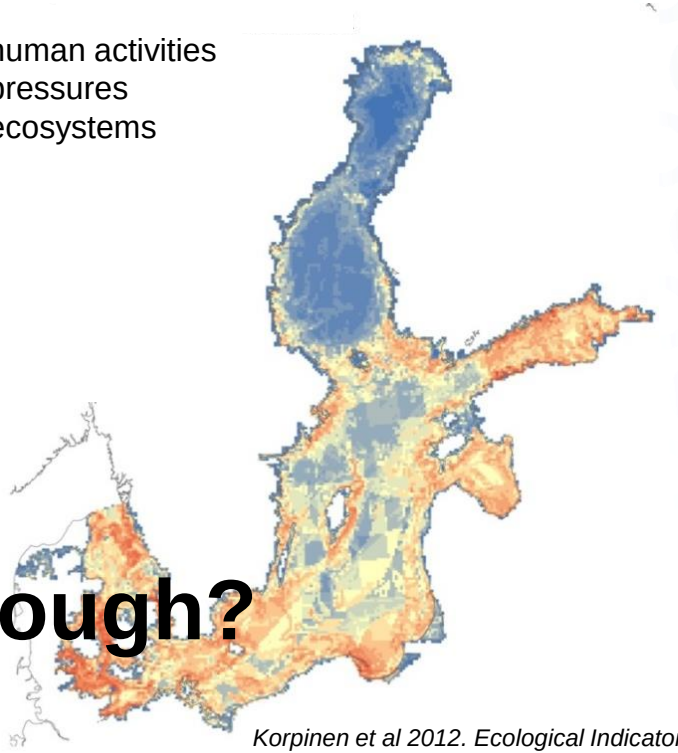
HELCOM Baltic Sea Pressure index
Focusing on cumulative pressures

- human activities
- pressures



HELCOM Baltic Sea Impact Index
Cumulative impacts on marine environment

- human activities
- pressures
- ecosystems



Was this enough?

Korpinen et al 2012. Ecological Indicators 15:105-114.

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Second cycle of the cumulative pressure assessments (published July/2018)

- Covering years between 2011-2016
- Spatial distribution of human activities and pressures
  - 39 human activities, 6 measured pressure datasets

  →18 aggregated pressures impacting cumulatively to the environment
  - 36 ecosystem components for benthic species, birds, broadscale habitats, fish, mammals, natura habitats, pelagic habitats




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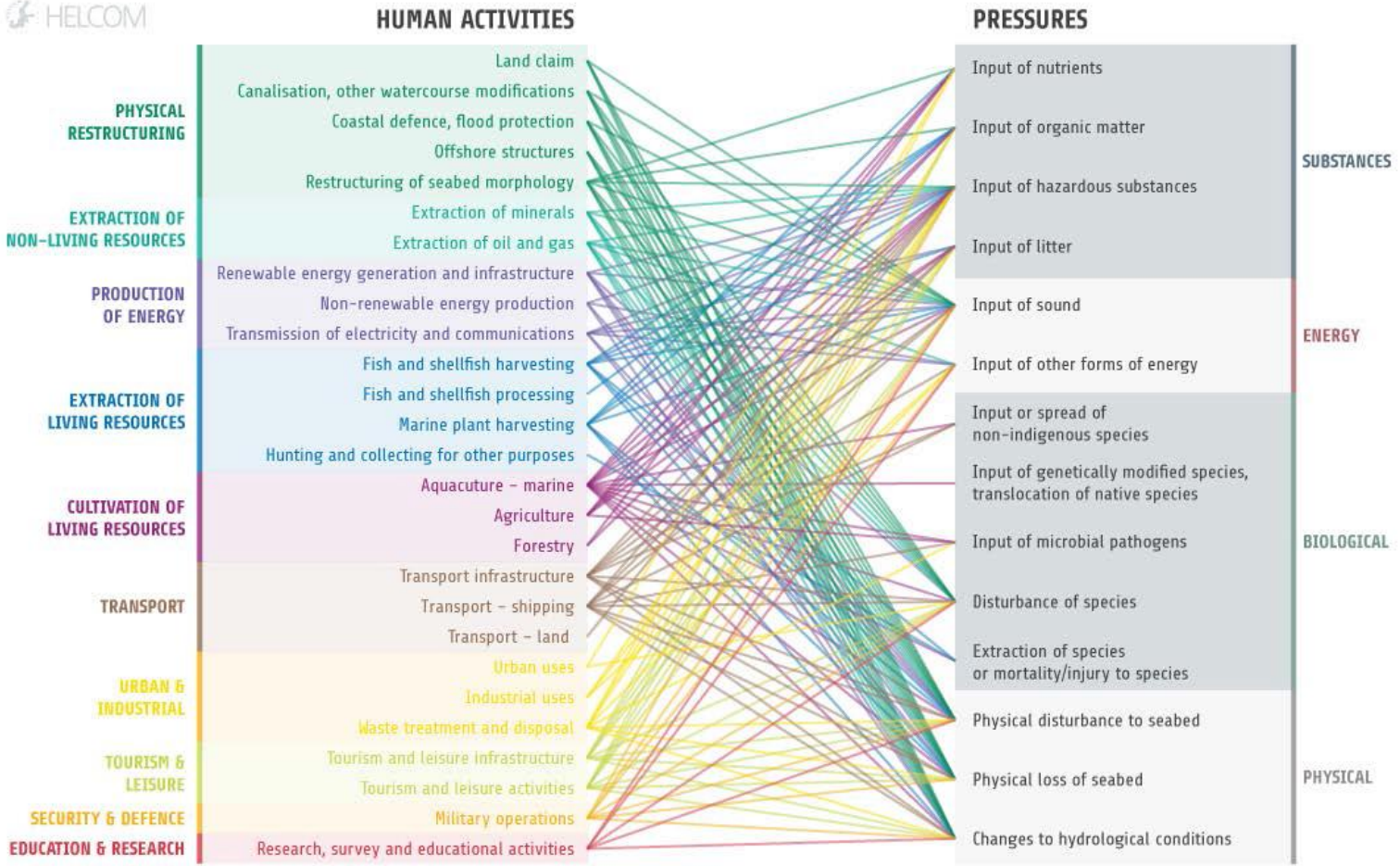
HELCOM
HUMAN ACTIVITIES
PRESSURES
PHYSICAL RESTRUCTURING
Land claim
Canalisation, other watercourse modifications
Coastal defence, flood protection
Offshore structures
Restructuring of seabed morphology
EXTRACTION OF NON-LIVING RESOURCES
Extraction of minerals
Extraction of oil and gas
PRODUCTION OF ENERGY
Renewable energy generation and infrastructure
Non-renewable energy production
Transmission of electricity and communications
EXTRACTION OF LIVING RESOURCES
Fish and shellfish harvesting
Fish and shellfish processing
Marine plant harvesting
Hunting and collecting for other purposes
CULTIVATION OF LIVING RESOURCES
Aquacuture - marine
Agriculture
Forestry
TRANSPORT
Transport infrastructure
Transport - shipping
Transport - land
URBAN & INDUSTRIAL
Urban uses
Industrial uses
Waste treatment and disposal
TOURISM & LEISURE
Tourism and leisure infrastructure
Tourism and leisure activities
SECURITY & DEFENCE
Military operations
EDUCATION & RESEARCH
Research, survey and educational activities
Input of nutrients
Input of organic matter
Input of hazardous substances
Input of litter
Input of sound
Input of other forms of energy
Input or spread of non-indigenous species
Input of genetically modified species, translocation of native species
Input of microbial pathogens
Disturbance of species
Extraction of species or mortality/injury to species
Physical disturbance to seabed
Physical loss of seabed
Changes to hydrological conditions
SUBSTANCES
ENERGY
BIOLOGICAL
PHYSICAL

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New developments – linkage between human activities and pressures

MATRIX BETWEEN HUMAN ACTIVITIES AND PRESSURES

This matrix visualizes linkages between human activities and pressures affecting the Baltic marine environment.

Human activities occurring in the Baltic Sea are shown on the left whereas the pressures are on the top bar.

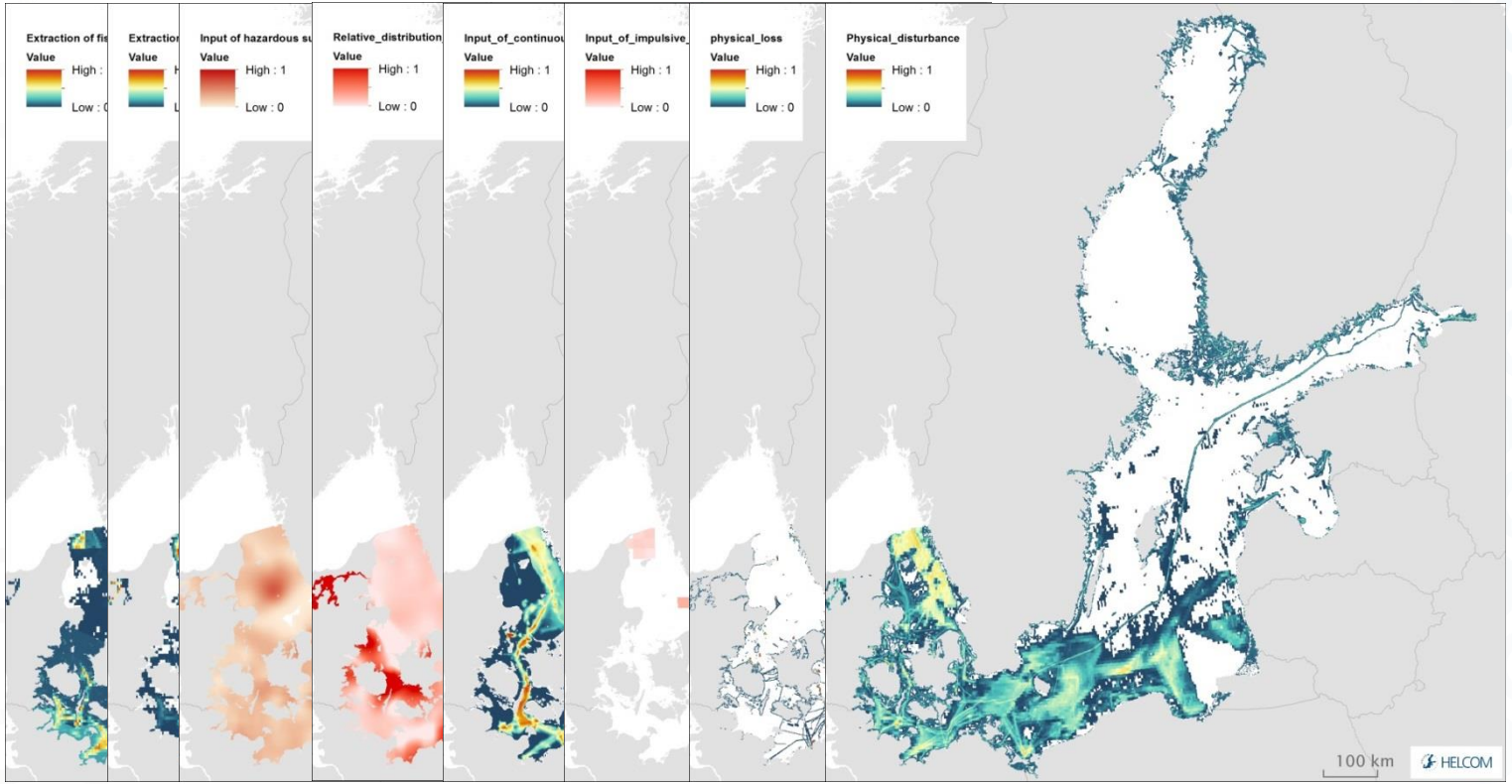
Both human activities and pressures are categorized under broader themes adopted from the proposed revision of MSFD Annex III.

Pressure themes	Physical			Energy		Substances				Biological					
Pressures	Change of seabed substrate or morphology	Disturbance or damage to seabed	Changes to hydrological conditions	Input of sound	Input of other forms of energy	Input of hazardous substances	Input of litter	Input of nutrients	Input of organic matter	Disturbance of species	Extraction of, or mortality/injury to, species, including target and non-targeted catches (by	Input of genetically modified species and translocation of	Input of microbial	Input or spread of non-	Non-indigenous species

Themes of activities	Activities
Cultivation of living resources	Aquaculture - marine
	Aquaculture - fresh water
	Agriculture
	Forestry
Production of energy	Renewable energy generation
	Non-renewable energy generation
Tourism and leisure	Tourism and leisure infrastructure
	Tourism and leisure activities
Transport	Transport infrastructure
	Transport - shipping
	Transport - air
	Transport - land
	Urban uses

Pressure themes	Physical			Energy			
Pressures	Change of seabed substrate or morphology (" physical loss)	Disturbance or damage to seabed	Changes to hydrological conditions	Input of sound		Input of other forms of energy	
Specification of pathways or sources				Ambient underwater noise	Impulsive noise	Input of electromagnetic	Input of seismic waves
Themes of activities / **Activities** / Specification of activities							
Cultivation of living resources	Aquaculture - marine	Finfish mariculture (Aquaculture)	■	■	■	■			
		Shellfish mariculture	■	■	■	■			
	Aquaculture - fresh water								
	Agriculture	animal pastures, crop farming			■				
	Forestry								
Production of energy	Renewable energy generation	Wind energy production: operational wind farms	■	■	■	■			
		Wind energy production: wind farms under	■	■	■		■		
		Tidal barrages	■	■	■	■			
		Wave energy production	■	■	■	■			

Developments: massive amount of new data for pressure layers



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Developments: habitat and species sensitivity estimates

- **The “relation” between pressures and marine environment**
- Sensitivity estimates developed further via expert questionnaire:
  - Tolerance/resistance
  - Recoverability
  - Sensitivity
  - Impact distance
- 18 pressures and 36 ecosystem components → over **640** potential pressure-ecosystem-specific combinations

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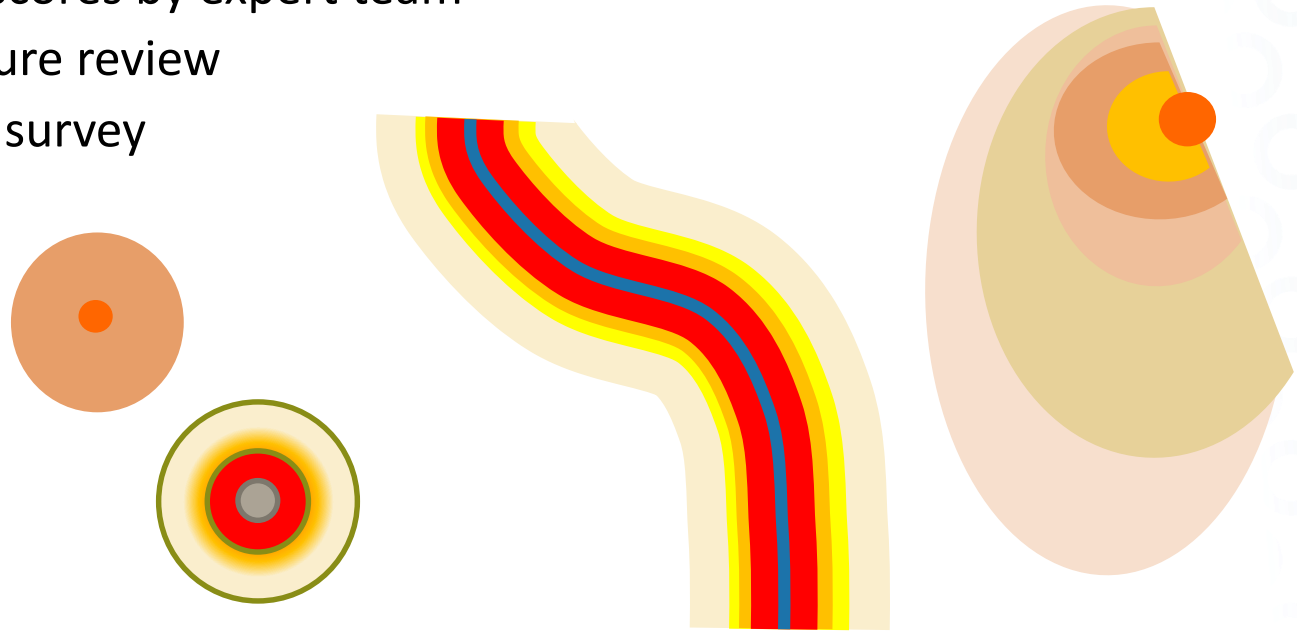
Developments: Spatial extent of the pressure from human activities?

Spatial 'buffer' around the points/lines/polygons:

- Initial scores by expert team
- Literature review
- Expert survey



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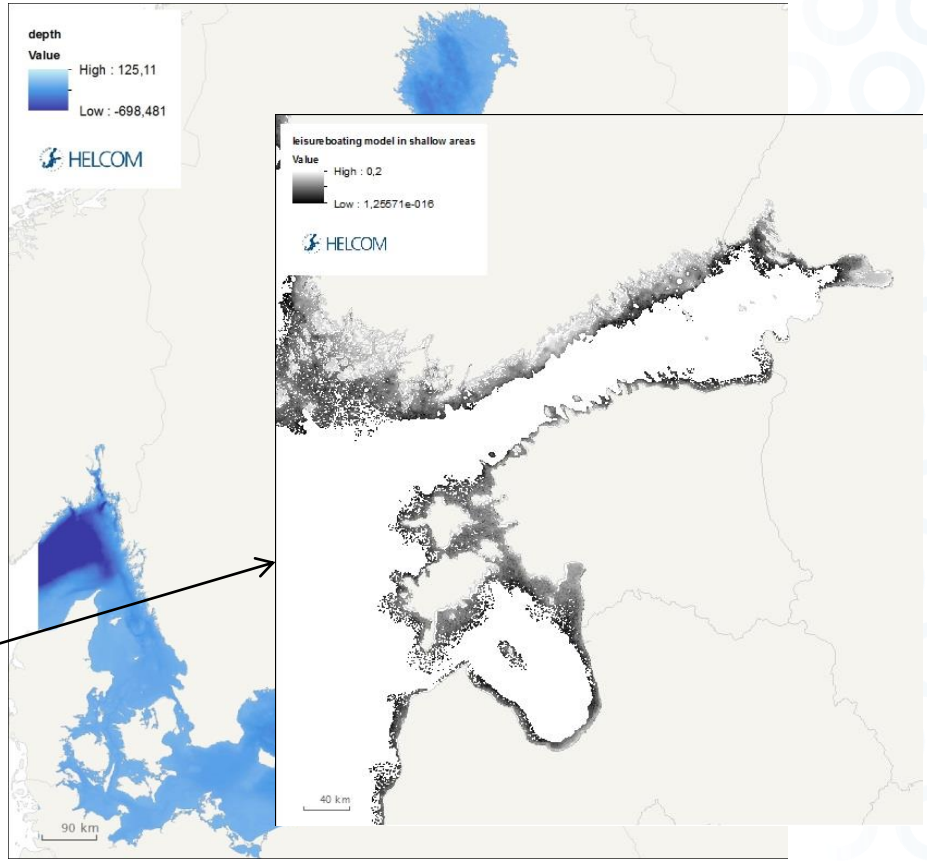
Developments: Water depth suppresses some pressures

Disturbance of species due to human presence

Changes to hydrological conditions

Physical disturbance or damage to sea bed

- Shipping
- Recreational boating



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Developments: Energy affects the pressure intensity

Physical disturbance	Input of nutrients*	Input of contaminants*
Input of beach litter*	Input of org. Matter*	

Marine Geodesy, 31: 1–11, 2008

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DOI: 10.1080/01490410802053674

Taylor & Francis
Taylor & Francis Group

GIS Modeling of Wave Exposure at the Seabed: A Depth-attenuated Wave Exposure Model

TRINE BEKKBY,[1] PAL ERIK ISACHSEN,[2] MARTIN ISÆUS,[3] AND VEGAR BAKKESTUEN[4,5]

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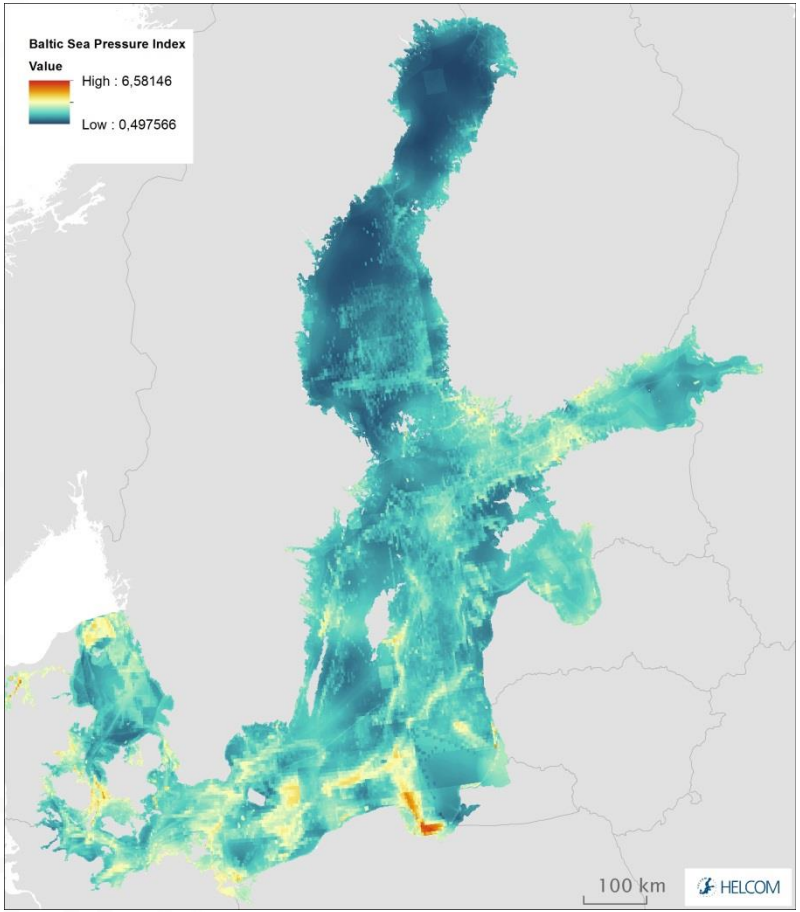
Thematic assessment of cumulative impacts on the Baltic Sea 2011–2016

Baltic Marine Environment Protection Commission

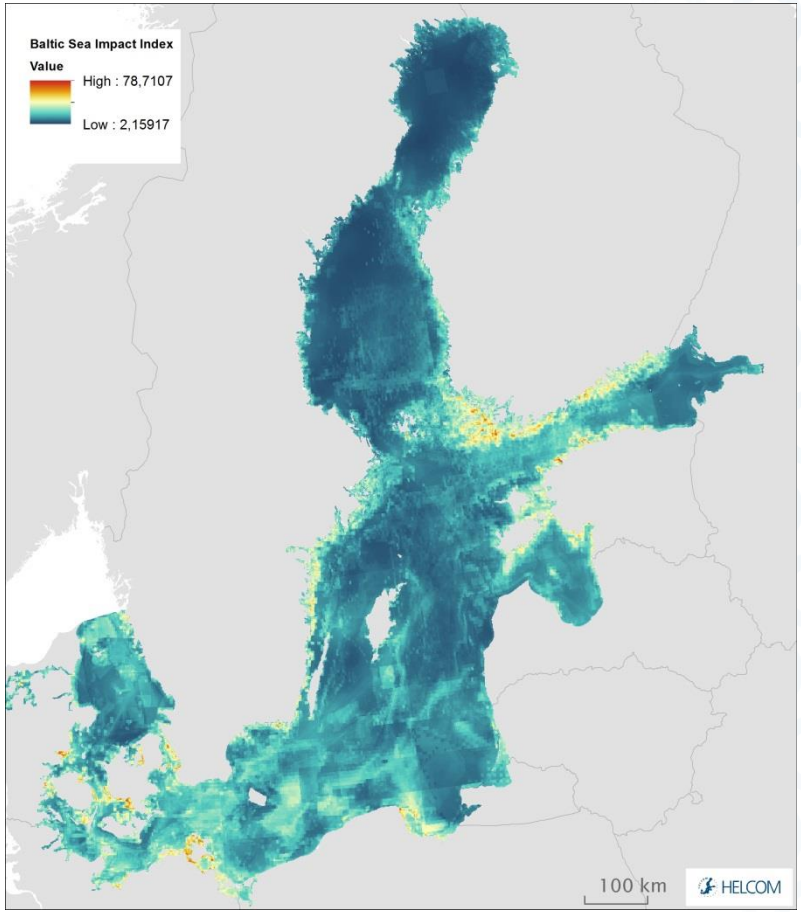
Supplementary report to the HELCOM 'State of the Baltic Sea' report (PRE-PUBLICATION)

STATE OF THE BALTIC SEA - HOLISTIC ASSESSMENT -

Baltic Sea Pressure index



Baltic Sea Impact index



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To be further developed

- Temporal aspects in aggregation (seasonality, frequency)
- Synergistic and antagonistic effects
- Differences between acute and chronic effects

- Ecosystem services
- Risk scenarios
- Maximum levels of accepted cumulative pressures?

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Enormous potential for sustainable use of the seas

- Working with planners early in an MSP process can help ensure that ecosystem effects are considered throughout
- Build planners' understanding and capacity on cumulative impact assessment results
- Communication and awareness raising
- Increasing science-policy dialoque

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Thank you!

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