Die Leistung der Sedimente in deutschen Küstenmeeren – Bewertung der Funktion mariner benthischer Systeme im Kontext menschlicher Nutzung – Leistungen der Ostsee (SECOS)

SECOS- Synthese Team

Gefördert durch Bundesministerium für Bildung und Forschung

FONA Forschung für Nachhaltige Entwicklung BMBF

Projektträger Jülich Forschungszentrum Jülich

SECOS Synthese Team:

IOW

Helge Arz
Ulrich Bathmann
Michael E. Böttcher
Dennis Bunke
Bronwyn Cahill
Mayya Gogina
Anne Hiller
Miguel Inacio
Thomas Leipe
Marko Lipka
Bo Liu
Daniel Neumann
Thomas Neumann
Philipp Paysen
Gregor Rehder
Gerald Schernewski
Johanna Schumacher
Franz Tauber
Jana Wölfel
Michael L. Zettler

CAU

Marion Kruse
Felix Müller

BSH

Stefan Schmolke
Manfred Zeiler

Uni-HRO

Stefan Forster
Friederike Kunz
Judith Renz

Kontakt:
ulrich.bathmann@io-warnemuende.de
friederike.kunz@uni-rostock.de

Projektinformation:
https://secos.deutsche-kuestenforschung.de/

Gefördert durch

Bundesministerium für Bildung und Forschung

FONA Forschung für Nachhaltige Entwicklung BMBF

Affiliierungen:

KÜNO Küstenforschung Nordsee-Ostsee (https://deutsche-kuestenforschung.de/)

WISSENSCHAFTSCAMPUS PHOSPHORFORSCHUNG ROSTOCK (https://wissenschaftscampus-rostock.de/)

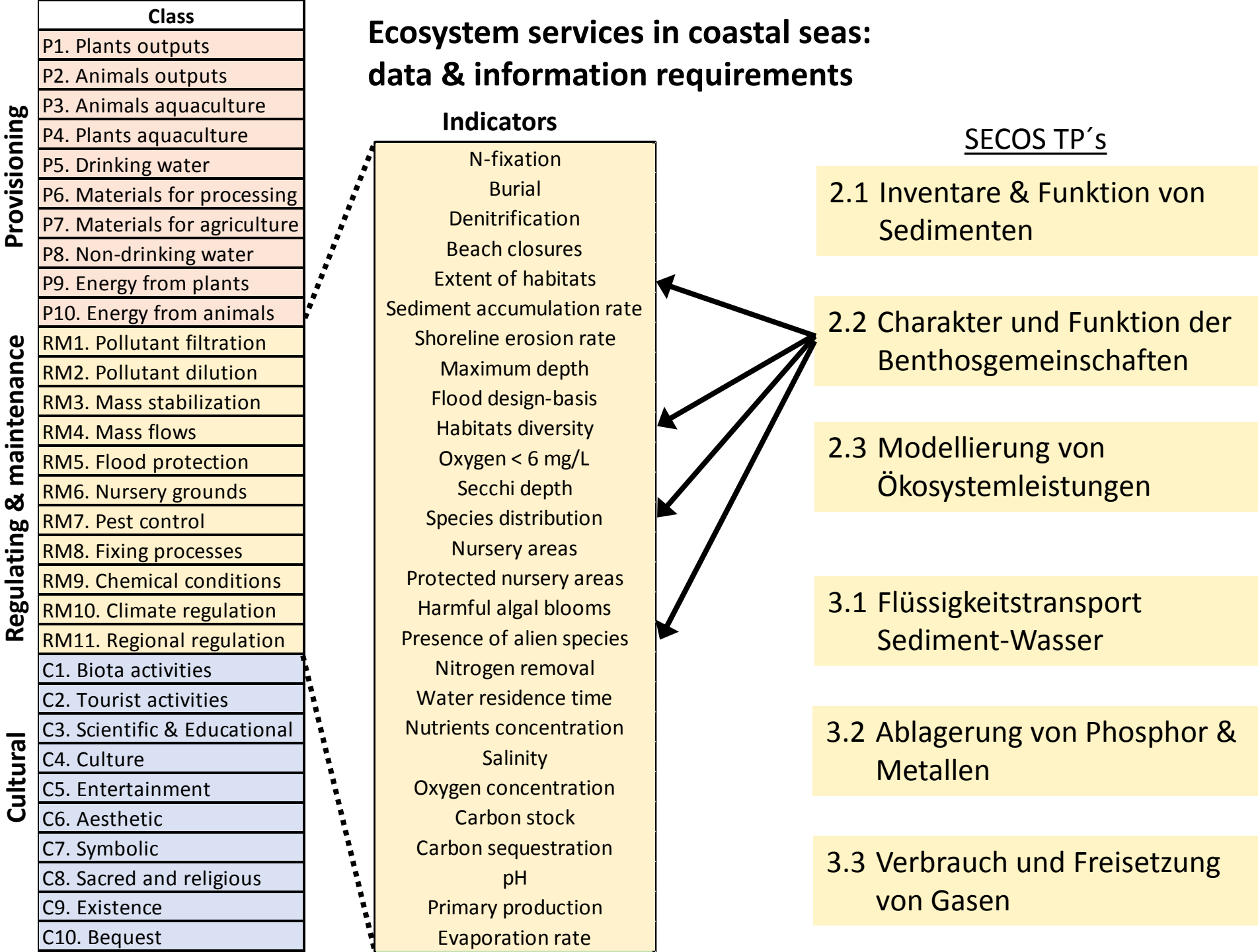
futureearth coasts land-ocean interactions in the coastal zone (https://www.futureearthcoasts.org/)

Ecosystem services in coastal seas as a framework for marine research

An ecosystem service assessment:

- Supports a **comprehensive understanding** of structures, processes and dependencies in coastal seas
- Allows the **reflection and visualization** of changes in ecosystems, resulting from anthropogenic impacts, measures or global changes
- Supports the **transfer** of complex messages to a broader public
- Supports the **implementation** of environmental policy, spatial planning and an ecosystem based management
- Provides a **justification** for protection or remediation measures
- Serves as **framework** and container for integrated and aggregated basic research results

Ecosystem services in coastal seas: data & information requirements

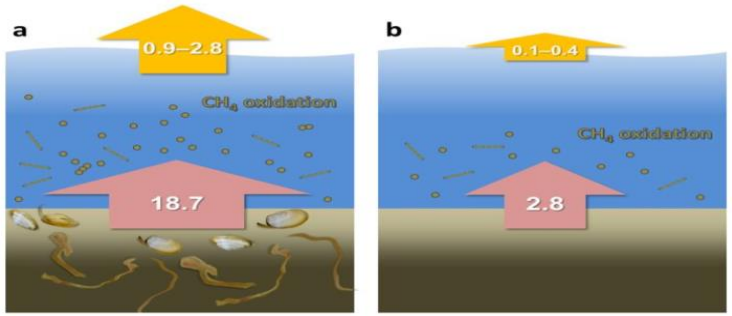


How can society benefit from research on benthic organisms?

2.2 Charakter und Funktion der Benthosgemeinschaften

Seabed habitat

Function: *e.g. nutrients and exchange of greenhouse gases, burial of harmful substances*



Bongalia et al. 2017 Sci. Rep.

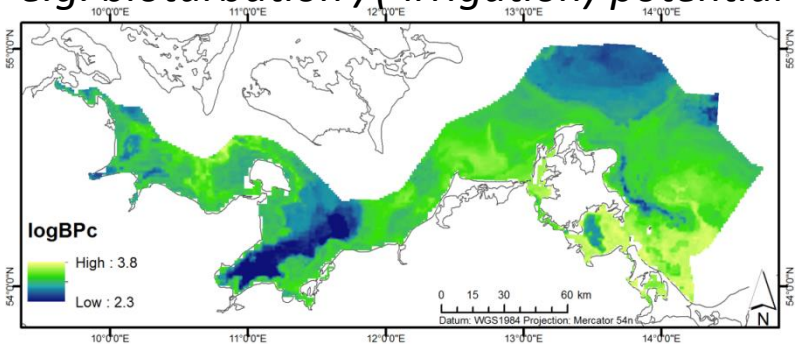
Ecosystem services: *e.g. food, climate regulation*

Balanced use with conservation of natural resources *(trade-offs, cost-effect)*

Values & advantages: *economic value, intangible human well-being*

On a wide range of spatial scales – for management & spatial planning

e.g. bioturbation /(-irrigation) potential



Gogina et al. 2017; Renz et al. subm.

e.g. Lohrer et al. 2015; Villnas et al. 2018

Bioirrigation potential of benthic communities (BIPc)

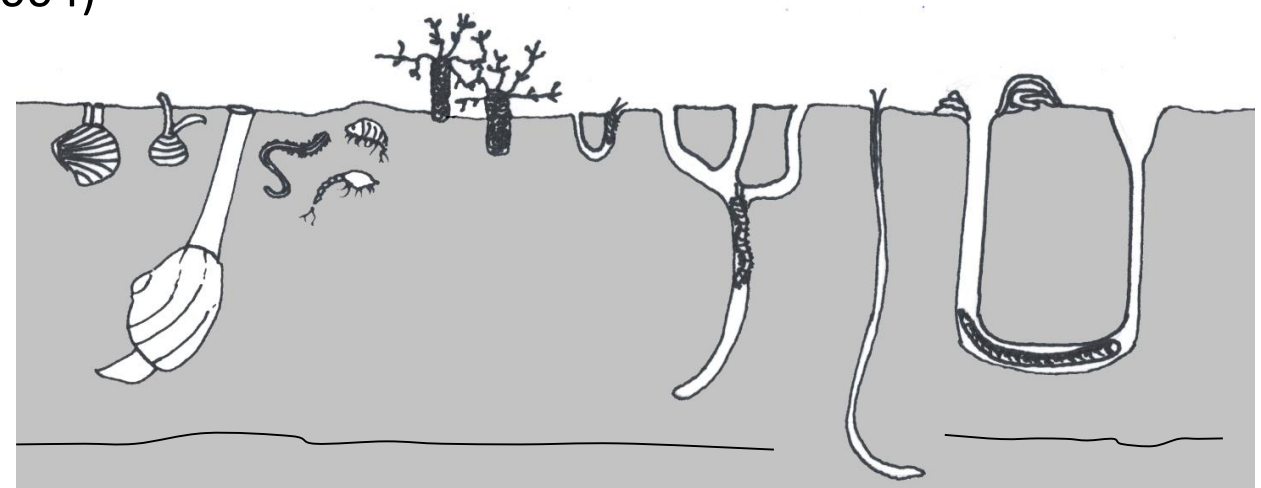
Marine Strategy Framework Directive: descriptor 6 (biodiversity & sea floor integrity)

- aiming to assess condition and function of benthic communities
- easily applicable descriptors are requested

Development of an index to predict relative intensities of bioirrigation

- biomass and abundance weighted scoring system
- fundamental functional traits analogy to the particle related bioturbation potential (Solan et al. 2004)
- wide applicability: largely available macrofaunal data

→ **spatial full coverage**
→ **estimates of the function of benthic communities**



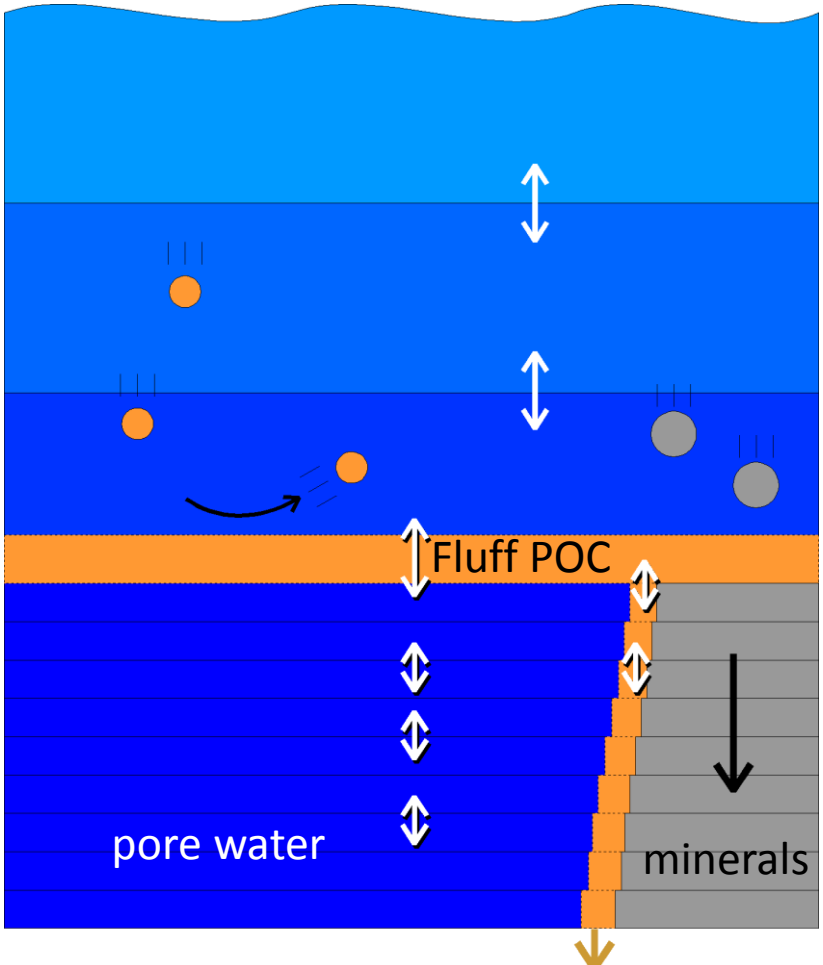
$$BIP_c = \sum_{i=1}^{n} \sqrt{\frac{B_i}{A_i}} \times A_i \times FT_i \times BT_i \times L_i$$

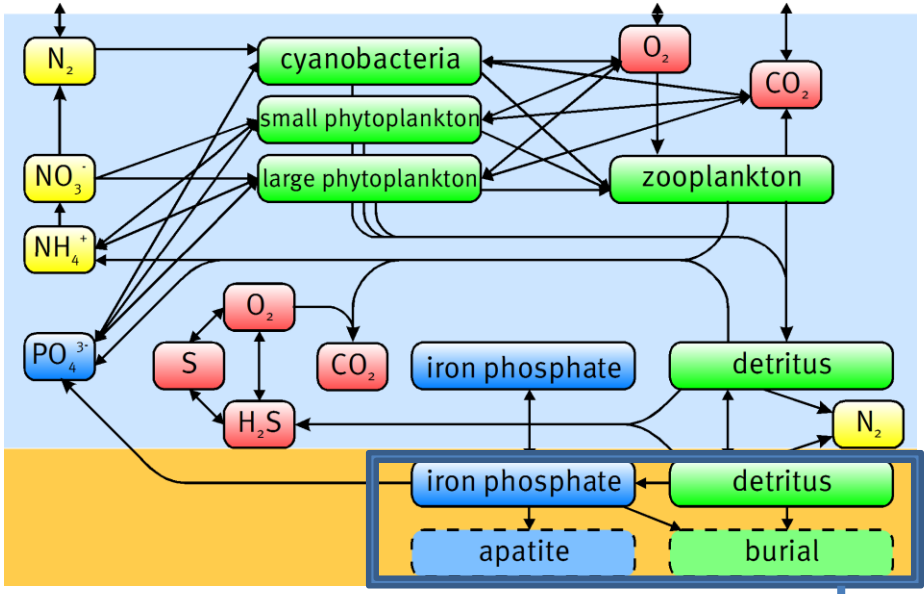
B_i – biomass (of species i)
A_i – abundance
Ft_i – feeding type
BT_i – burrowing type
L_i – depth

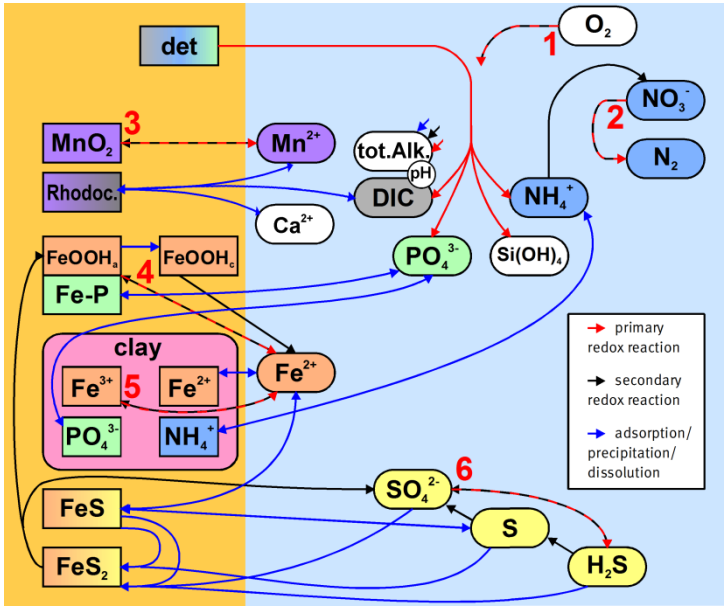
Ecological ReGional Ocean Model with vertically resolved sediments (ERGOM SED 1.0): Coupling benthic and pelagic biogeochemistry of the south-western Baltic Sea.

2.3 Modellierung von Ökosystemleistungen

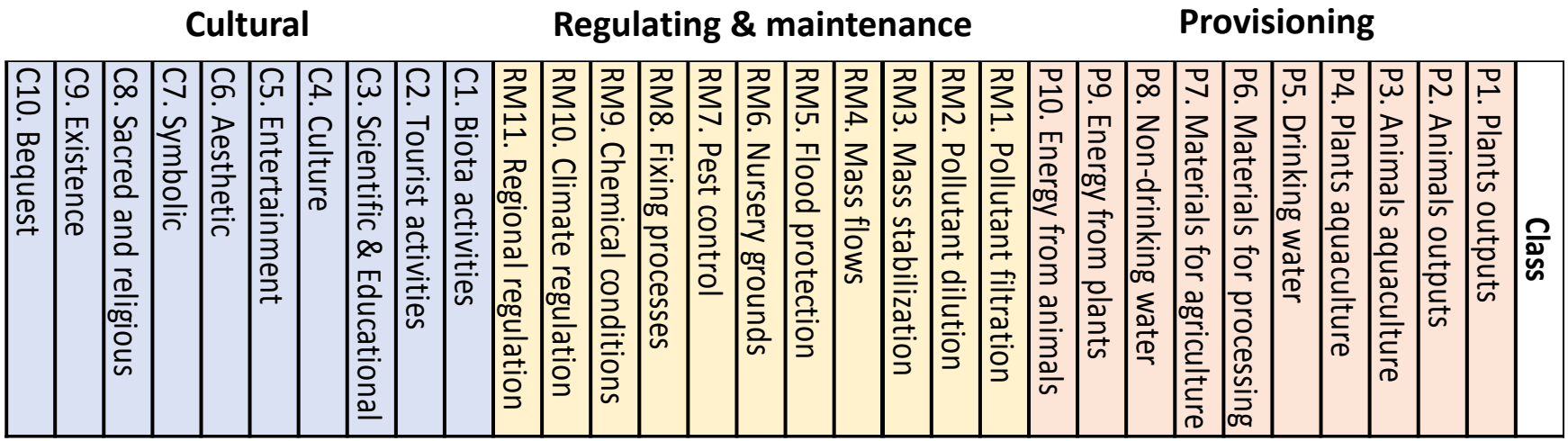
Radtke, H, Lipka, M, Bunke, D, Morys, C, Cahill, B, Böttcher, ME, Forster, S, Leipe, T, Neumann, T, *Geosci. Model Dev. Discuss.*, 2018, 1–42







Ecosystem services in coastal seas: transfer into spatial pattern



Data and spatial information

3D Ecosystem model data

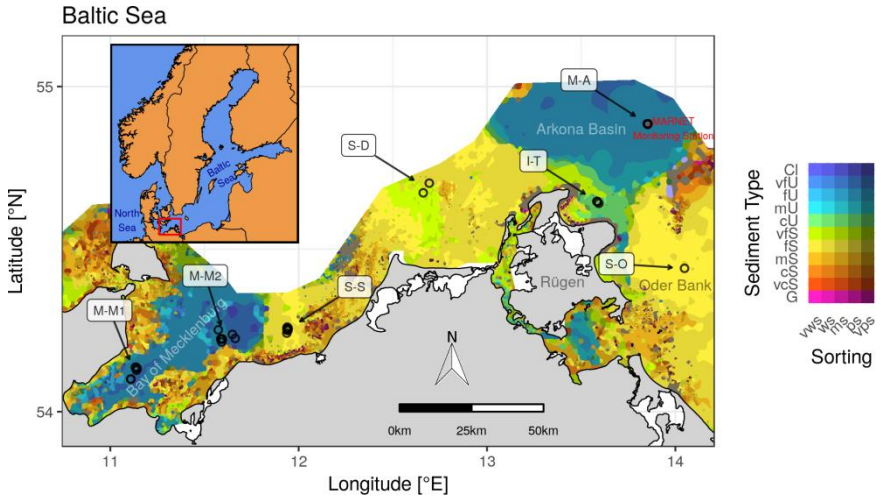
4.2 Spatial typology, integration & usability

4.1 Integrated ES assessment approach

1.2 Baltic Sea Atlas (Geo-Information System)

Ecosystem service map for the German Baltic coastal sea

WP 3: Basic research: mineralisation/accumulation processes- release and consumption



- **Lipka, 2018; PhD-thesis**
- **Lipka M, Woelfel J, Gogina M, Kallmeyer J, Liu B, Morys C, Forster S, Böttcher ME;** *Spatiotemporal dynamics in solute reservoirs of temperate brackish surface sediments*
- **Gogina M, Lipka M, Woelfel J, Liu B, Böttcher ME, Zettler ML;** *On the hunt for a field-based relationship between benthic macrofauna and biogeochemistry in a modern brackish coastal sea*

-> submitted to Marine Frontiers (special issue BSSC)

ORGANIC MATTER MINERALIZATION RATES...

- ... are **similar** in sandy and muddy sediments.
- ... are **higher** in the mud of the Mecklenburg Bight than in the deeper Arkona Basin.

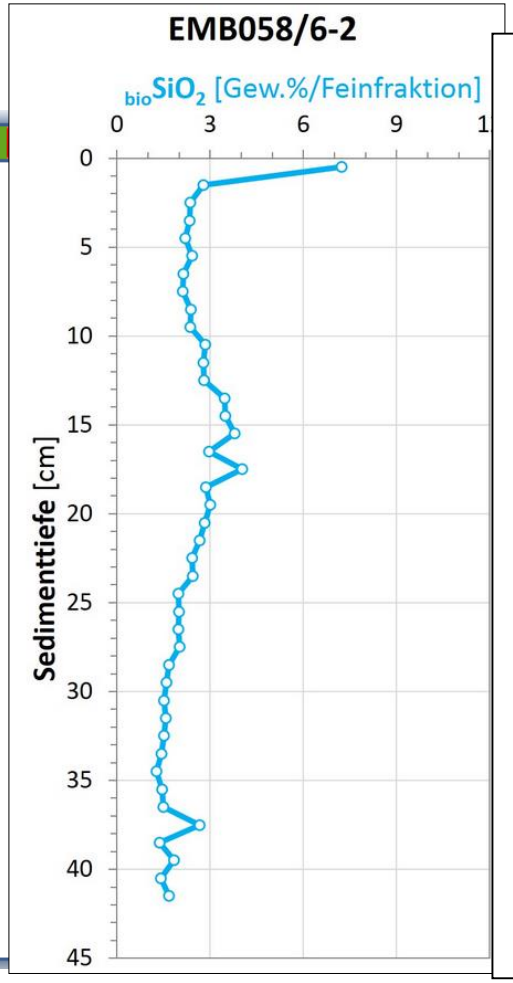
- Differences between muds can be attributed to **varying organic matter supply**.
- **Seasonal variability** and **salinity dynamics** in the bottom waters show minor or no effects.

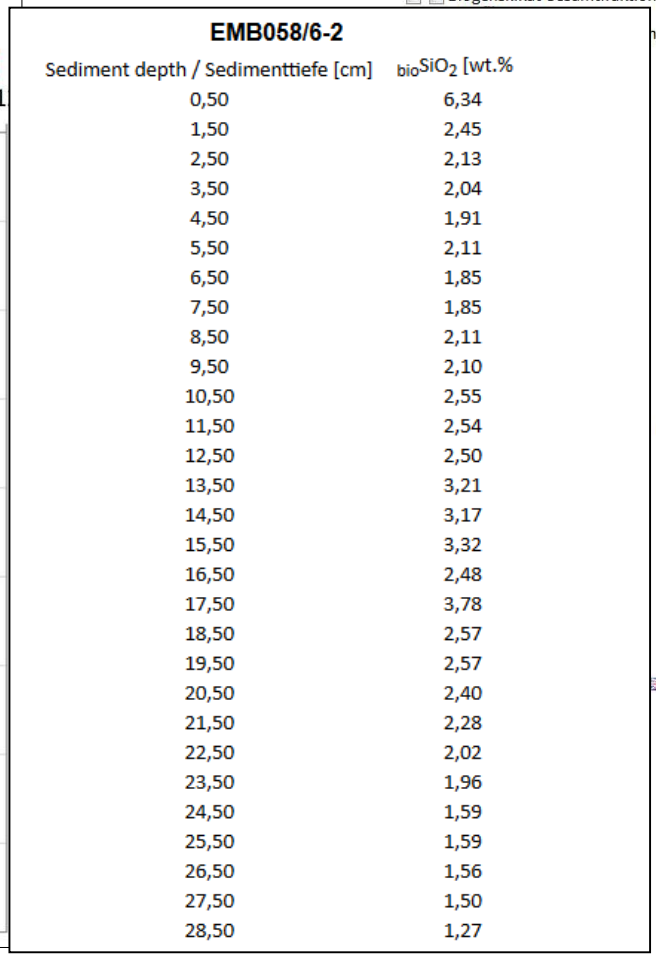
ADVECTIVE TRANSPORT due to currents, bioturbation/-irrigation, human impact…

- ... **are the main force for solute fluxes** across the sediment-water interface in sands and muds.
- ... affect **metal oxide contents** near the sediment surface, which can delay benthic nutrient fluxes after a shift to hypoxic bottom water conditions.

Baltic Sea Atlas – structure & function

Geochemical profiles

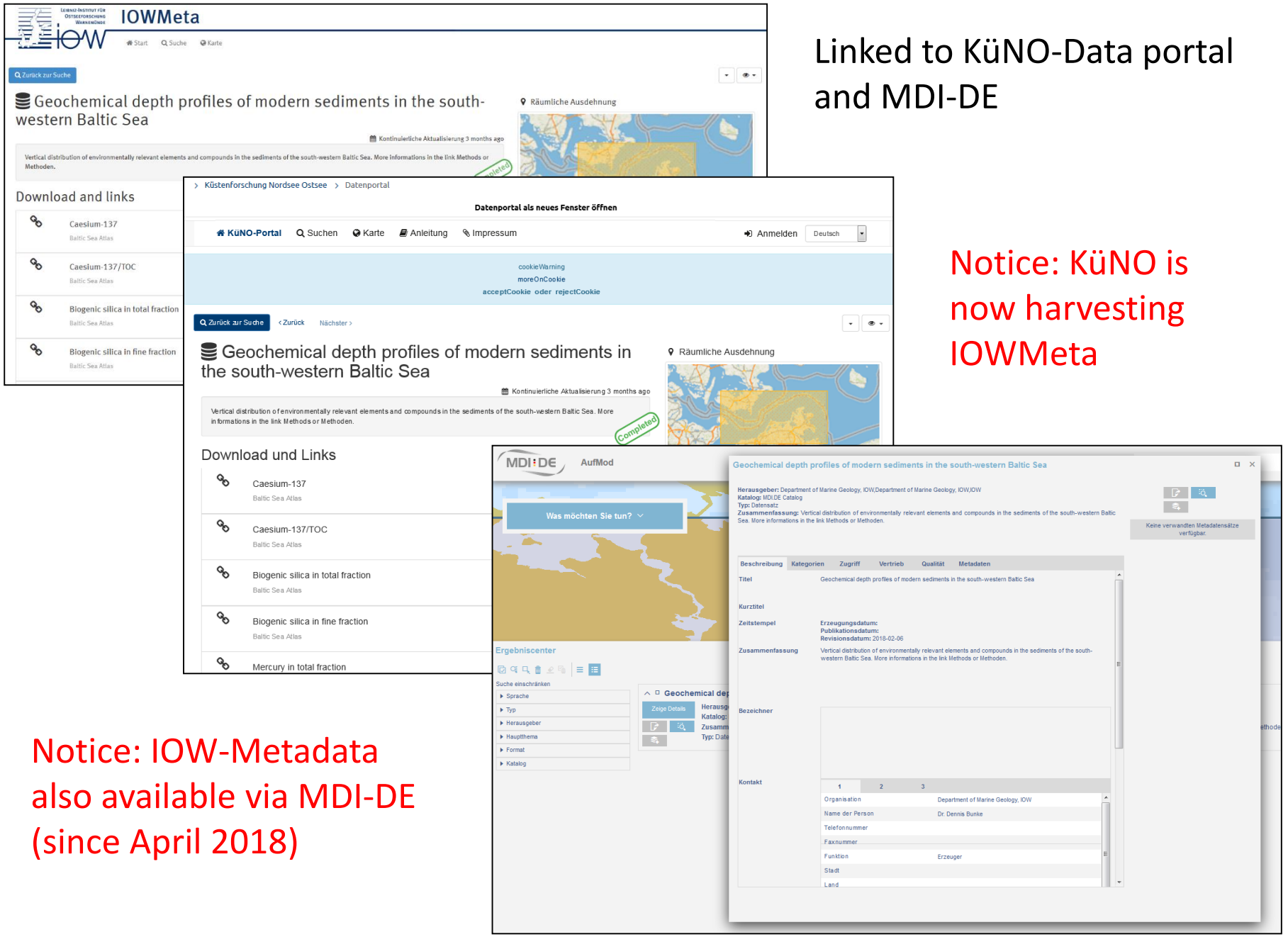




EMB058/6-2

Sediment depth / Sedimenttiefe [cm]	bioSiO2 [wt.%
0,50	6,34
1,50	2,45
2,50	2,13
3,50	2,04
4,50	1,91
5,50	2,11
6,50	1,85
7,50	1,85
8,50	2,11
9,50	2,10
10,50	2,55
11,50	2,54
12,50	2,50
13,50	3,21
14,50	3,17
15,50	3,32
16,50	2,48
17,50	3,78
18,50	2,57
19,50	2,57
20,50	2,40
21,50	2,28
22,50	2,02
23,50	1,96
24,50	1,59
25,50	1,59
26,50	1,56
27,50	1,50
28,50	1,27

Baltic Sea Atlas – access to metadata & data



Linked to KüNO-Data portal and MDI-DE

Notice: KüNO is now harvesting IOWMeta

Notice: IOW-Metadata also available via MDI-DE (since April 2018)

IOW MESAT:
Marine Ecosystem Service Assessment Tool

Objective:
Support of environmental policy implementation

Method/Approach:

- Adaptation of the Common International Classification on Ecosystem Services (CICES, version 5.1) (Haines-Young and Potschin 2018)
- Comparative, non-monetary assessments (time, space, state)
- Definition of spatial units according to the Water Framework Directive: characterization of types by major physico-chemical parameters, like depth, tidal range, salinity, temperature, turbidity, residence time, wave exposure and current velocities (Coast 2003)

Background

- For several EU-Directives
  (Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), Maritime Spatial Planning (MSP) Directive, Habitat-Directive) and strategies (Integrated Coastal Zone Management (ICZM), Biodiversity)
  an Ecosystem Service Assessment is recommended.

- Usually it is expected that Ecosystem Service assessments provide a comprehensive understanding of structures and dependencies and support the required „Ecosystem Approach to Management“.

- However, ideas and recommendations about concrete aims, where and when in the policy implementation process and how to use the results are either lacking or remain vague.

Methodology for comparative ecosystem service assessments

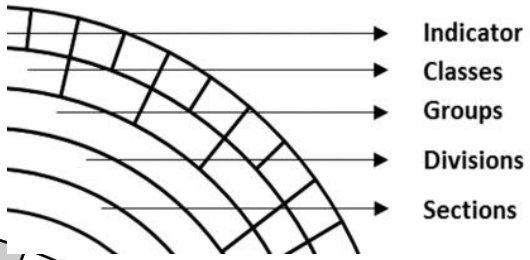
Division	Group	Class	S1. Mussel farm	Class	Group	Division	Section
Nutrition	Biomass	P1. Wild plants, algae and their outputs			2	2	2
		P2.Wild animals and their outputs	1 -3	-1			
		P3. Animals from in situ aquaculture	5 5	5			
		P4. Plants and algae from in situ aquaculture					
	Water	P5. Surface water for drinking purposes					
Materials	Biomass	P6. Fibres and other materials from plants, algae and animals for direct use or processing	3	3	3	2	
		P7. Materials from plants, algae and animals for agriculture	3	3			
	Water	P8. Surface water for non-drinking purposes	1	1	1		
Energy	Biomass-based energy resources	P9. Plant based resources		1	1	1	
		P10. Animal based resources	1	1			

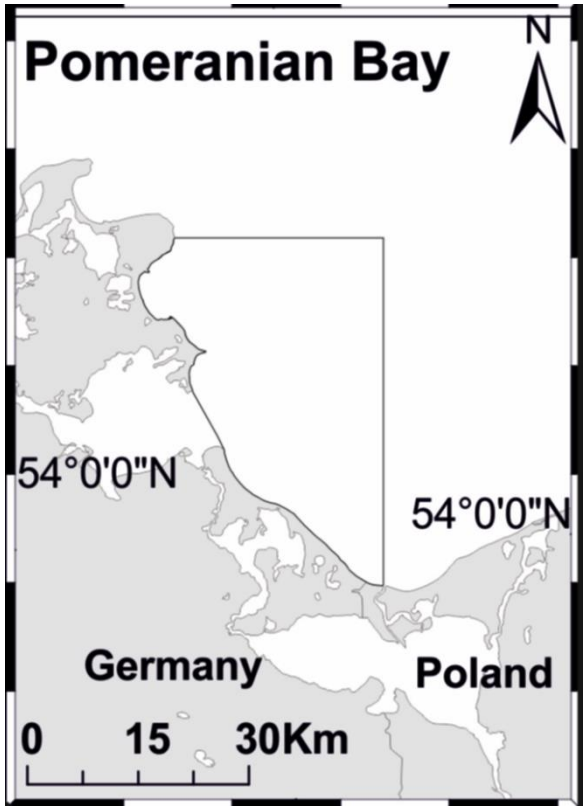
< 1/4.1	1/2.5 - 1/4.1	1/1.7 - 1/2.5	1/1.3 - 1/1.7	1/1.1 - 1/1.3	Initial Status	1.1 - 1.3	1.3 - 1.7	1.7 - 2.5	2.5 - 4.1	> 4.1
-5	-4	-3	-2	-1	0	1	2	3	4	5

Lower provision ← → No change → Higher provision

Inácio, Schernewski, Nazemtseva, Baltranaite, Friedland, Benz (subm.): Ecosystem services provision today and in the past: A comparative study in two Baltic lagoons. Ecological Research

Ecosystem services of coastal seas:
Pomeranian Bay
A comparative assessment between 1960 and today





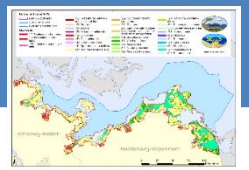
Inácio, Schernewski et al (in prep.)

Alternative assessment and mapping approach

Definition of spatial setting

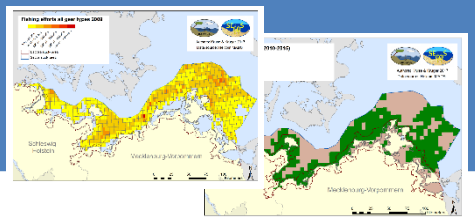
German Baltic Coast & Sea

and focus areas for detailed analysis



Data examples

e.g. sediment and key species distribution; literature; model results



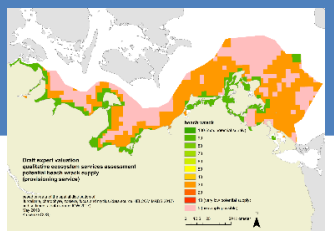
Results

Maps for

-Regulating

-Provisioning

-Cultural ecosystem services



→ Aims are to test the applicability of an integrative terrestrial-coastal-marine approach (Kiel Matrix approach) and

→ To visualize past, current and possible future states of ecosystem service supply (and demand) with spatially explicit maps for the case study area (cooperation with BACOSA II)