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Baltic Sea Maritime Spatial Planning for Sustainable Ecosystem Services

Spatial analysis of co-location in MSP

Part of PhD study 2017-2020

Part of the BONUS BASMATI project

Ida Maria Bonnevie, Aalborg University Copenhagen

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SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

Why do we need co-location in MSP?

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The image of the crowded Sea (here: crowded Baltic Sea)

due to new and existing expanding marine uses

→

Competition for marine space.

Potentially more conflicts.

Also synergies? Multi-use?

The spatial-temporal dimension and cross-sectoral planning is important!

I will answer three questions:

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1) How to understand and define co-location (theoretical framework)?

2) How do existing spatial decision support tools consider co-location?

3) How to develop a tool supporting co-location?

Co-location: Towards a definition

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- In existing literature: **diffuse separation** between concepts e.g. co-location, coexistence, multi-use, spatial compatibility, use-use interactions, use-environment interactions…

- What is a use?
  - *"a distinct and **intentional activity** through which a direct (e.g. profit) or indirect (e.g. nature conservation) **benefit** is drawn by one or more users"* [the EU MUSES project, 2019[b]]

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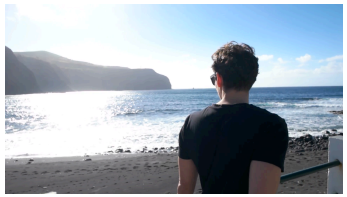

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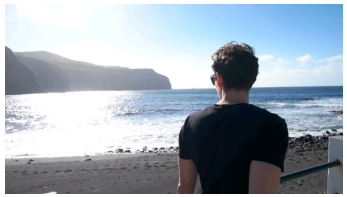

Is environment/ nature conservation a human use?

NATURA 2000

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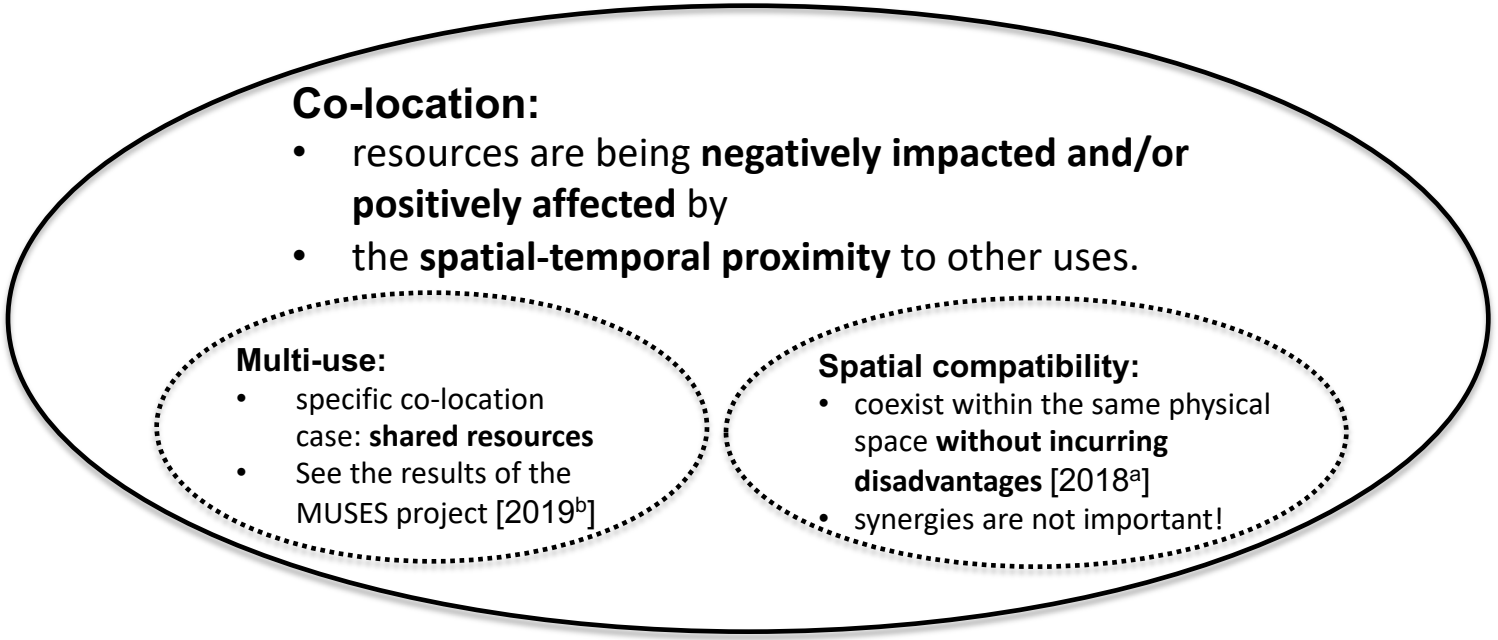
- Co-location definitions in my article [2019[a]] in press:



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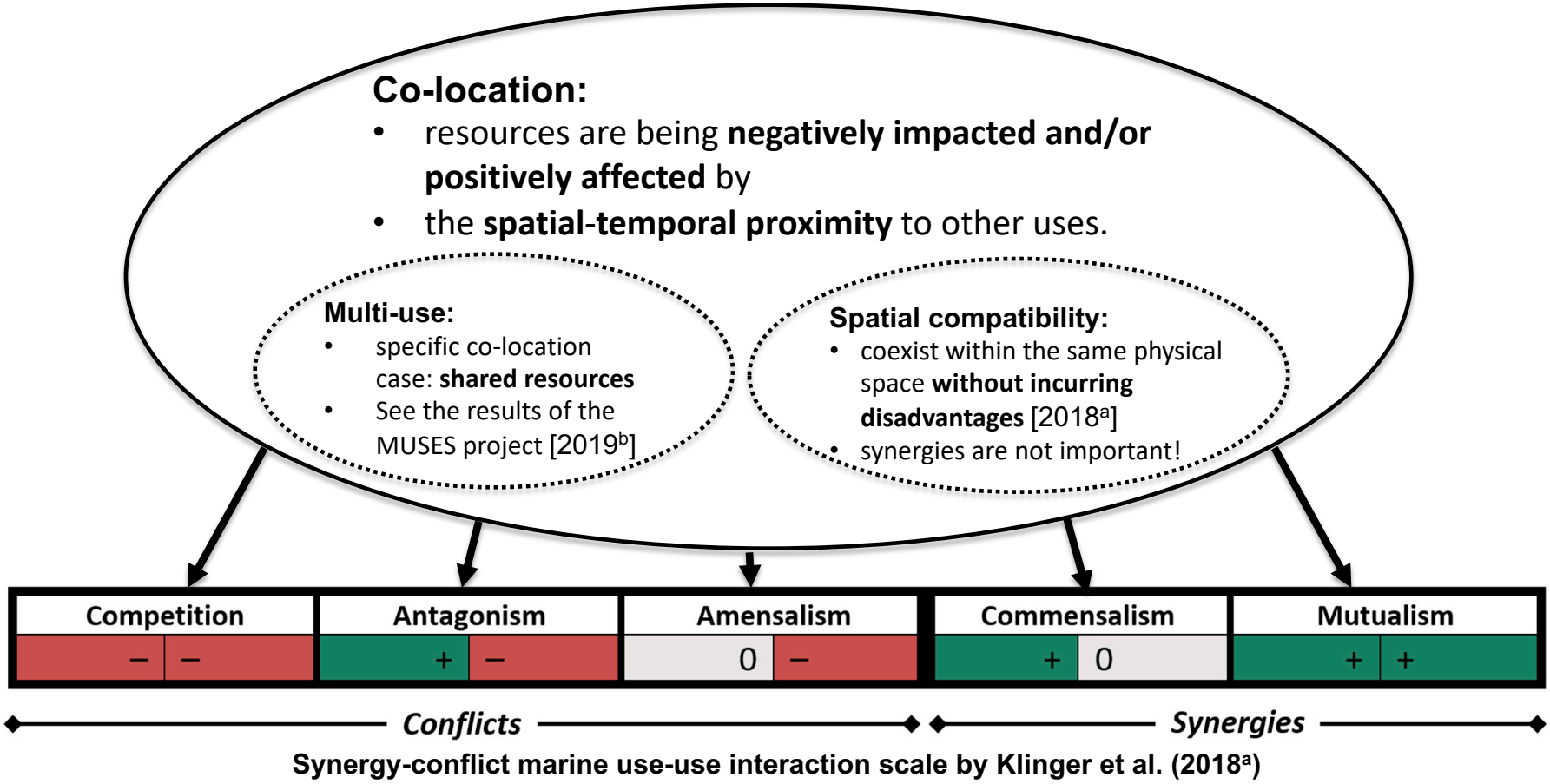

Synergy-conflict marine use-use interaction scale by Klinger et al. (2018[a])

No simple synergy-conflict relationships!

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THE TIMES

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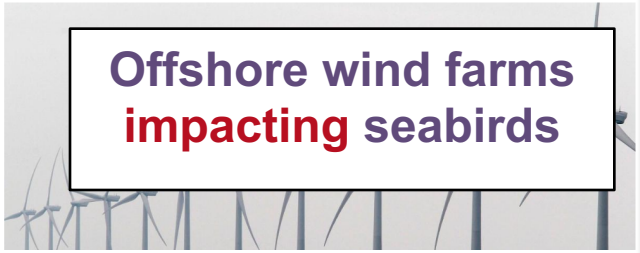
RSPB disputes research on turbine threat to seabirds

Jerome Starkey,
Countryside Correspondent

April 20 2018, 12:01am,
The Times

Animals



Offshore wind farms impacting seabirds

INDEPENDENT

Offshore wind farms create 'reef effect' perfect for marine wildlife - especially seals

Fish and crustaceans tend to cluster on the structures

Jonathan Owen | Monday 21 July 2014 17:11 | 17 comments

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Offshore wind farms constituting artificial reefs

Aquaculture North America

NEWS | RESEARCH | FISH | SHELLFISH | NUTRITION | SHOWC

Tourism and aquaculture join forces in Maine

February 27, 2014
By Muriel Hendrix

Tourism + aquaculture: multi-use

December MAA helped sponsor workshops on Fisheries, Aquaculture and Tourism that were held at three separate venues across the state.

The workshops attracted over 125 participants, including aquaculturists and fishermen, people from the tourism industry, support agencies and organizations. Topics included creating partnerships,

The Telegraph

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News

Salmon farming has done 'enormous harm' to fish and environment, warns Jeremy Paxman

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Save

Tourism + aquaculture: too high environmental impacts?

Co-location: Towards a definition

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- Co-location definitions in my article [2019[a]] in press:

Co-location:

Locating some uses in close proximity/ combining them.

Separating some uses.

Co-location management stages in MSP

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Conflict management stages [2018[b]]	**Co-location management stages [2019[a]]**
Detect conflicts	Detect conflicts, compatibilities and/or synergies
Conflict avoidance: Prevent conflicts	Conflict avoidance: Prevent conflicts and increase synergies
Conflict resolution: Minimise conflicts when they cannot be avoided	Conflict resolution: Minimise conflicts when they cannot be avoided and increase synergies

Which co-location factors in and outside MSP to be aware of?

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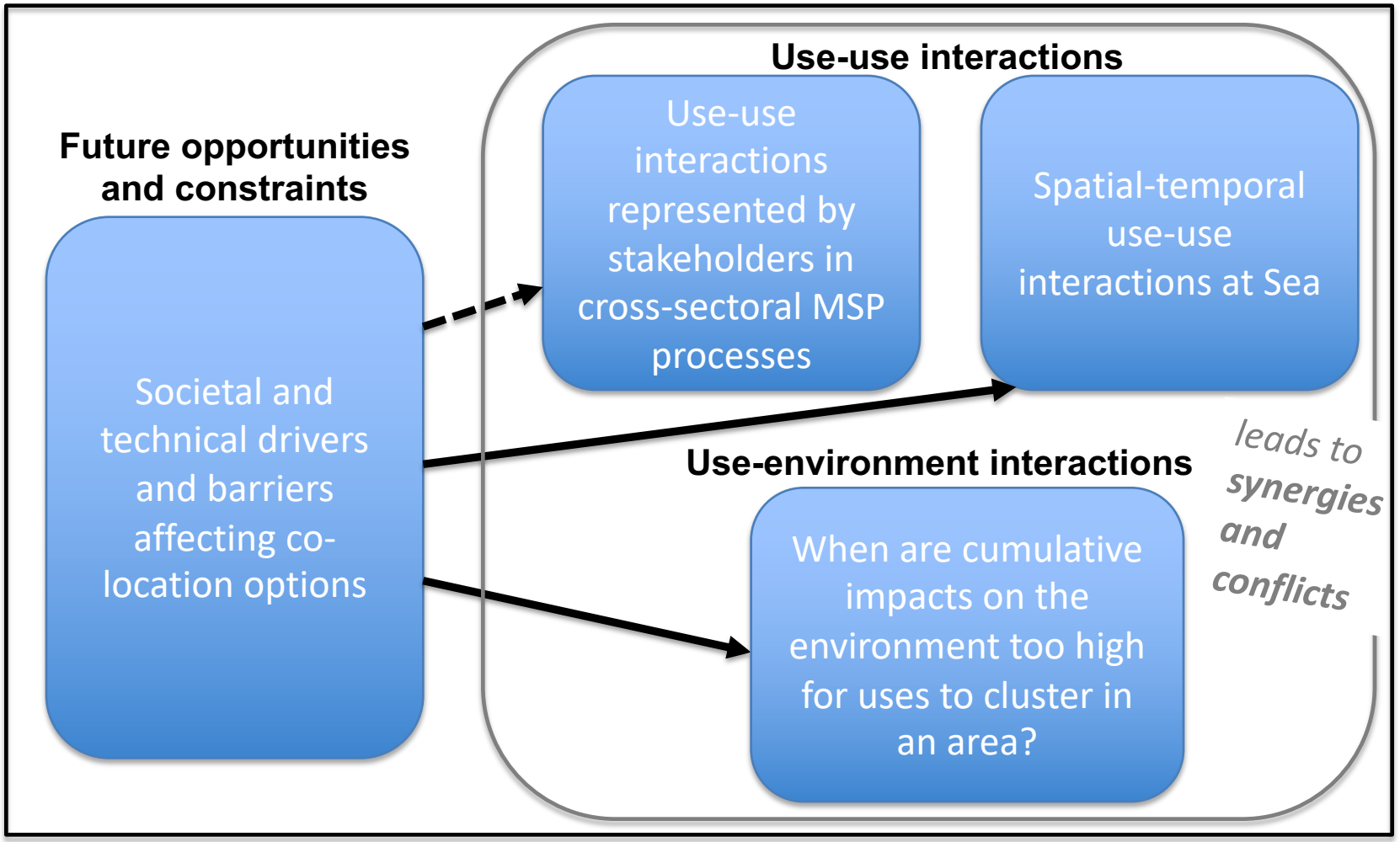

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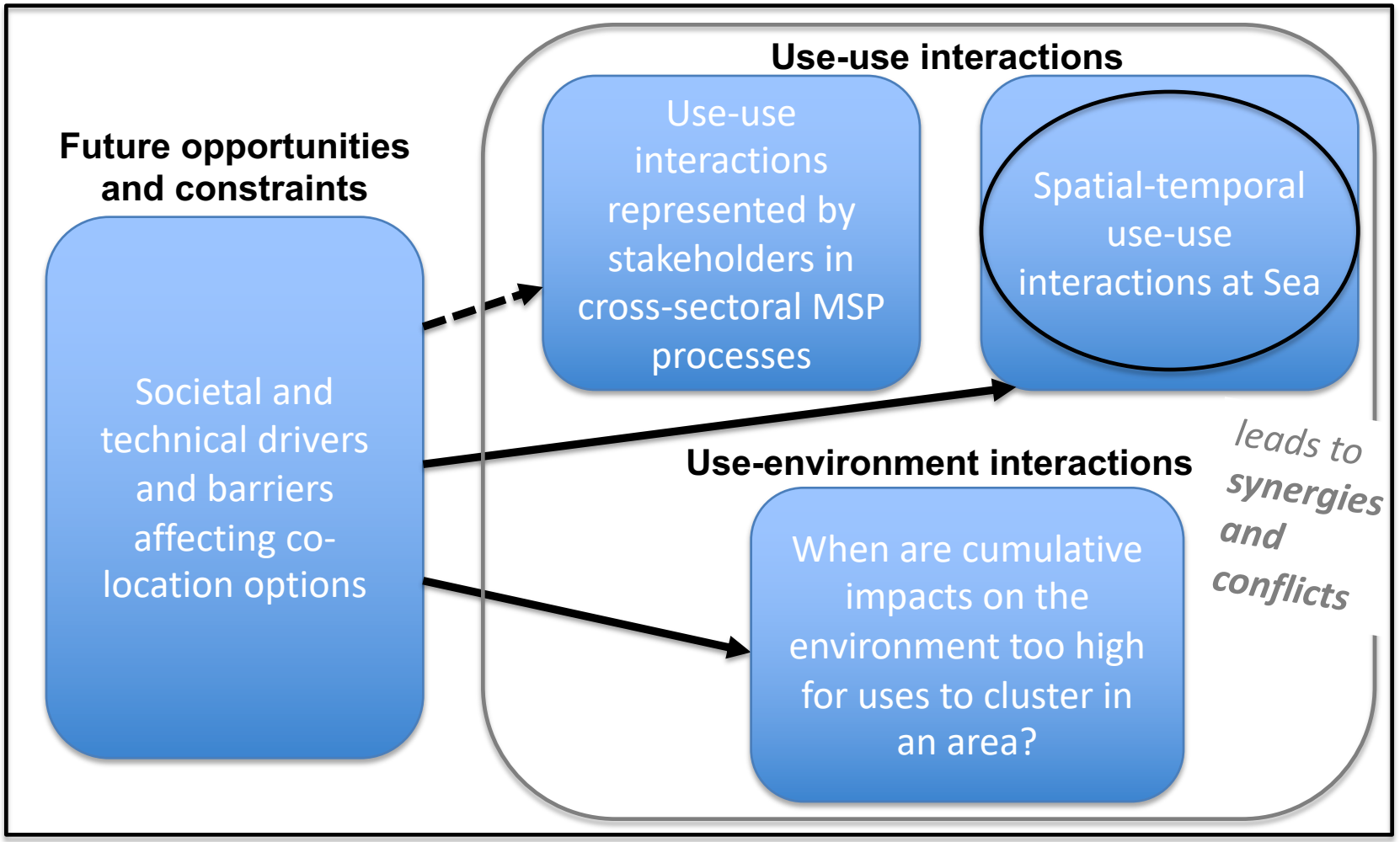

Use-use interaction characteristics

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Potential spatial-temporal links between uses in close spatial-temporal proximity
(the links can exist at the same time)

Location links: Connections between the extents-and-durations of uses.	**Environmental links:** Environmental processes from/ environmental aspects of uses affecting other uses.
Technical links: Links between uses concerning infrastructure, safety and/or tools.	**User attraction links:** Spatial-temporal proximity affecting the number of users. (Of high socio-economic importance).

Use-use interaction characteristics: Location links

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No shipping zone

Ice fishing during winter

Use-use interaction characteristics: Environmental links

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Mussels cleaning water and thus e.g. benefitting nearby seabass farms

Too much pollution?

Use-use interaction characteristics: Technical links

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Use-use interaction characteristics: User attraction links

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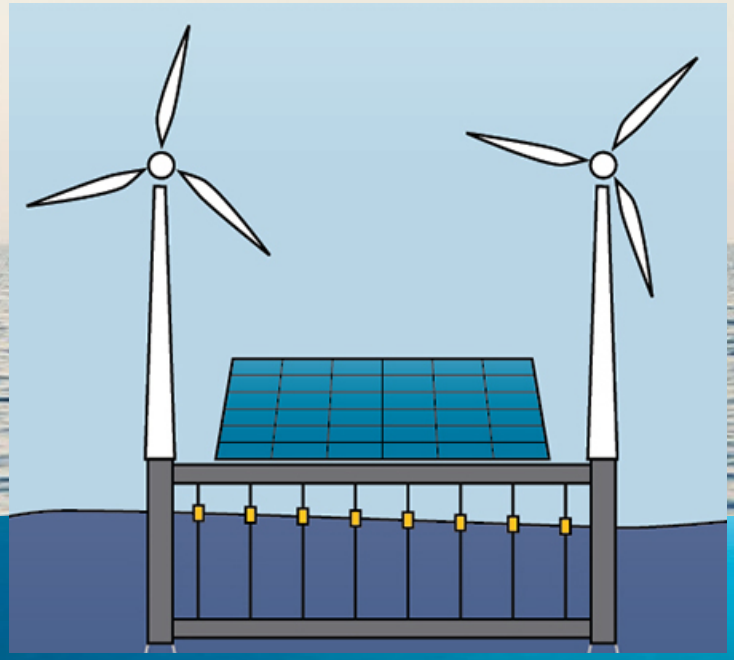

Renewable energy cluster: Wind energy, solar panel, and wave energy: Strong green image?

Too many divers for fishing to take place too?

Use-use interaction characteristics: Keywords

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Potential spatial-temporal links between uses in close spatial-temporal proximity
(the links can exist at the same time)

Location links:
Connections between the extents-and-durations of uses.
- Horizontal and vertical dimensions.
- Temporal dimensions.
- Multi-use vs. excluding other uses from specific marine space.

Environmental links:
Environmental processes from/ environmental aspects of uses affecting other uses.
- Artificial reef effects.
- Visibility of installations.
- Water clearing processes vs. pollution.

Technical links:
Links between uses concerning infrastructure, safety and/or tools.
- Shared infrastructure and/or gear.
- Safety zones.

User attraction links:
Spatial-temporal proximity affecting the number of users. (Of high socio-economic importance).
- Clustering effects.
- Too many users/ too many uses?

Iterative use-use interaction steps in MSP

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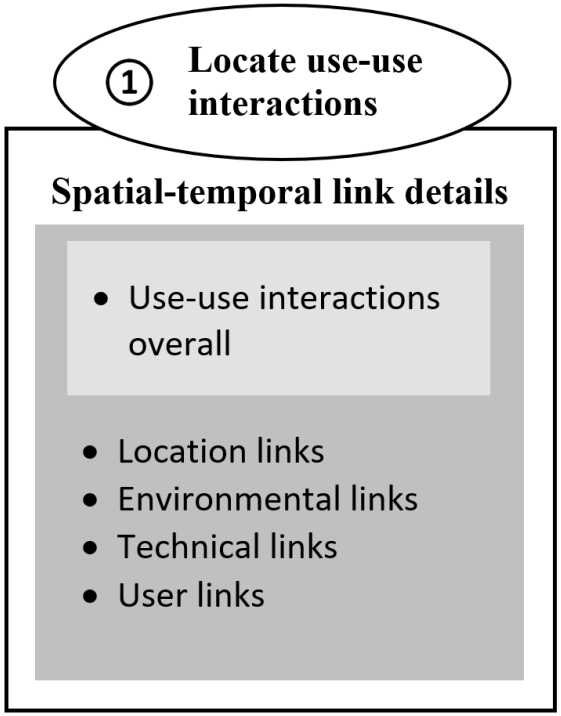

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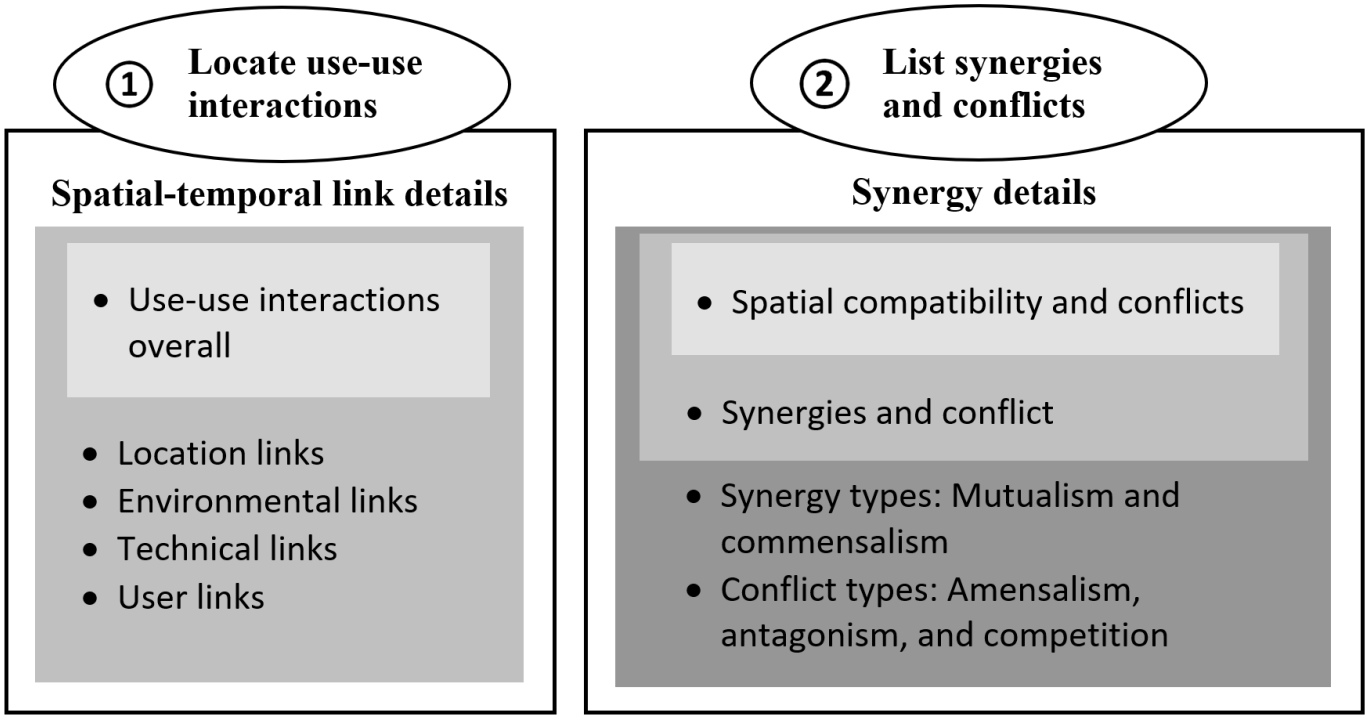

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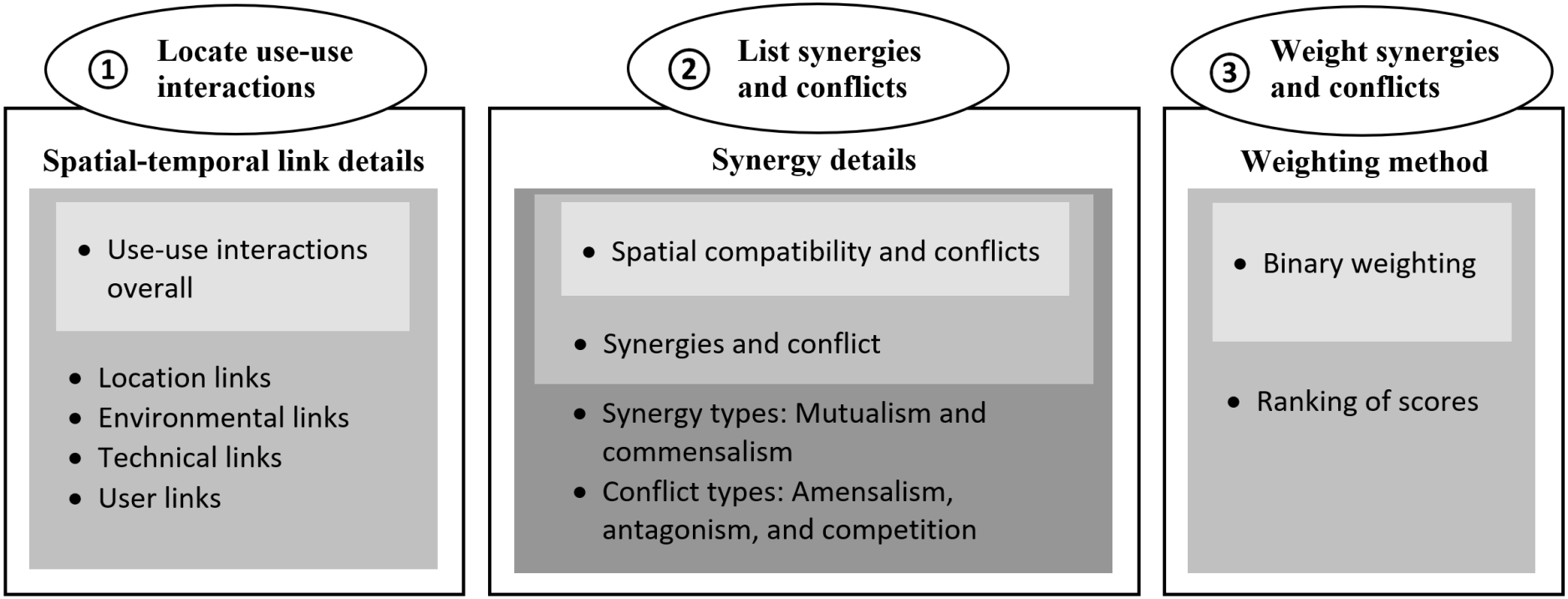

Two categories of existing tools analysed - reflecting co-location management stages in MSP

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1) ranking- and pairwise matrix-based use-use interaction tools
   - **Tools to detect conflicts and/or synergies**

2) Tools to distribute space to uses
   - **Tools to avoid/ minimise conflicts and optimise synergies**

Ranking- and matrix-based tools

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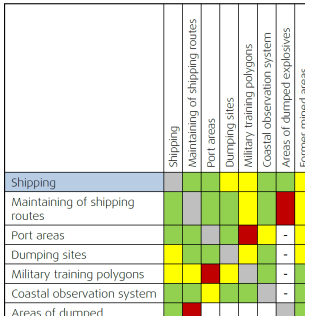
- **pairwise, matrix-based with binary scoring**
- **non-spatially**
- **spatial compatibility** instead of synergies
- **use-use interactions** are often considered overall.



[2009]
[2014]
[2018[b]]

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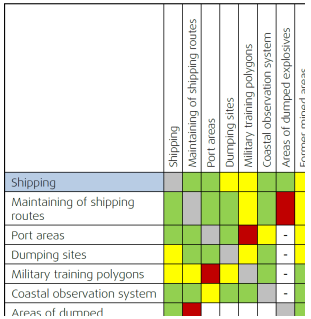

[2009]
[2014]
[2018[b]]

- **specific scenarios with ranking/ scoring**

· Technological challenges:	1	1	1
· Performance:	3	3	3
Score:	3.70	3.93	2.93
· Use of marine space:	4.33	4.33	3.67
· Wind piles/devices dimension	4	4	3
· Size of energy farm:	4	4	3

[2015]
[2016]
[2018[c]]

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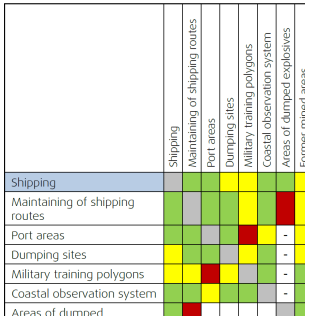

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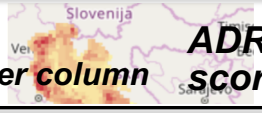
- **Overlaps: location links?** ***Mobile vs. fixed***
  Surface vs. benthic vs. whole water column



ADRIPLAN conflict score tool **[2017[b]]**

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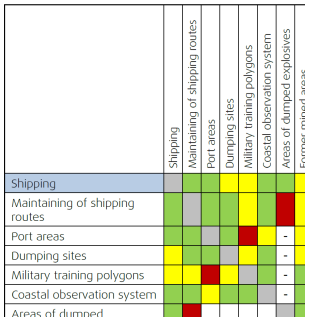

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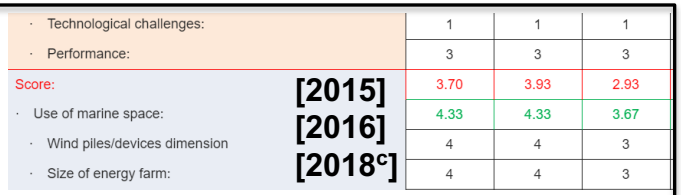

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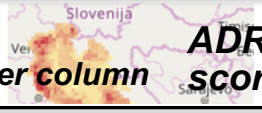
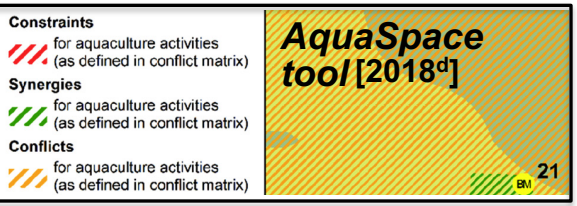


ADRIPLAN conflict score tool **[2017[b]]**

- **synergies** are included in some tools



Space allocation tools

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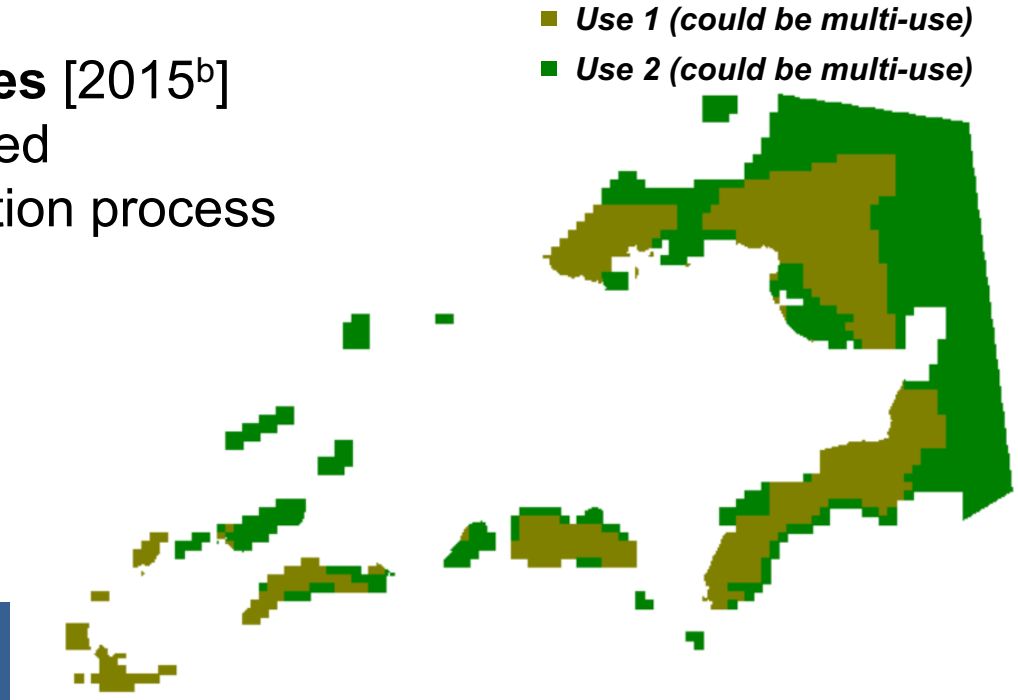
Can utilize synergy-conflict information to:

- → locate pre-defined multi-use constellations.
- → locate conflicting uses far from each other.

- A specific synergy type of mutualism: the extra total gain from being able to use more space through multi-use.

- E.g. **MARXAN With Zones** [2015[b]] and a game theory-inspired cooperative space allocation process by Kyriazi [2017[a]]



Challenges for future synergy-conflict tools

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- Consider location links, environmental links, technical links, and user attraction links
- Include synergies (not only spatial compatibility).
- Weight synergies and conflicts

What is cumulative environmental impact tools?

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- It calculates cumulative impacts by using **scores** specified by **experts** that determine each **pressure**'s effect on each **ecosystem component**
- Using raster maps.
- To illustrate: An example from the tool **MYTILUS** by professor Henning Sten Hansen [2019c] from AAU:

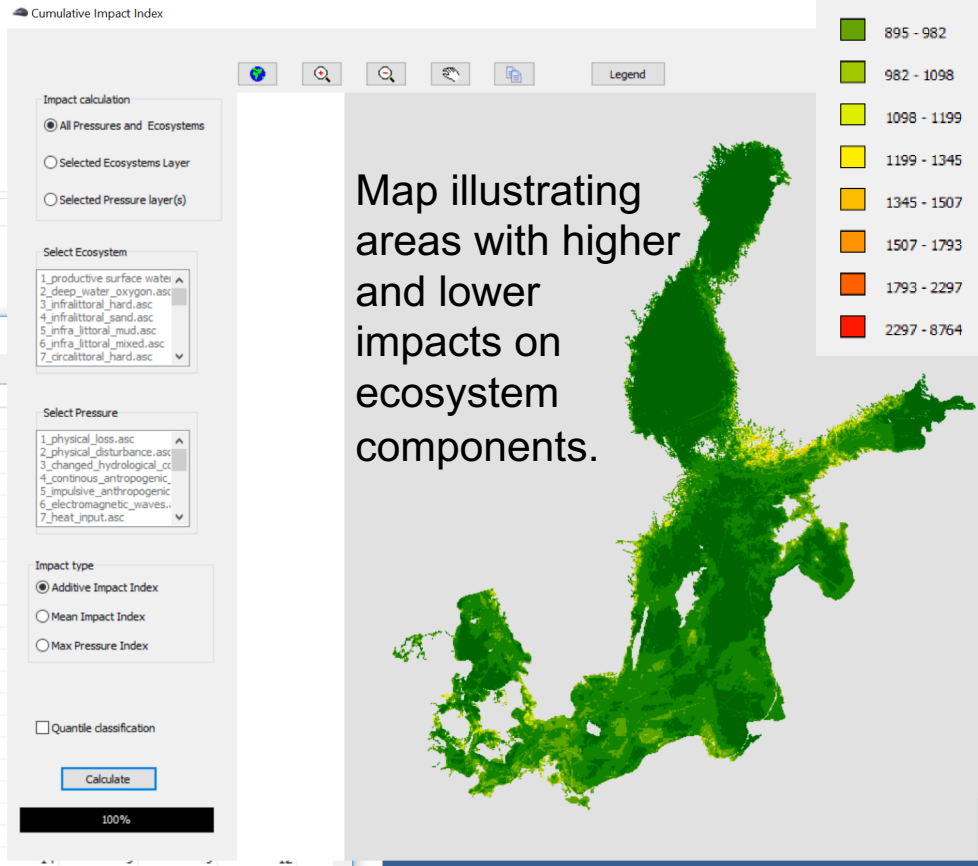
Scenarios:
Scenario_001 (test)
Scenario_002 (Scenarie 2)

Expert-based sensitivity matrix

Sensitivity Matrix

Save

ID	ECOSYSTEM	P1	P2	P3	P4	P5	P6
1	Productive_surface_waters	14	4	10	15	15	
2	Oxygenated_deep_waters	10	9	7	18	18	
3	Infralittoral_Hard_Bottom	17	18	13	13	13	
4	Infralittoral_sand	14	18	12	13	13	
5	Infralittoral_mud	14	17	11	13	13	
6	Infralittoral_mixed	15	18	12	13	13	
7	Circalittoral_hard	13	19	13	13	13	
8	Circalittoral_sand	9	18	11	12	12	
9	Circalittoral_mud	11	16	10	12	12	
10	Circalittoral_mixed	11	18	11	12	12	
11	Furcellaria_lumbricalis	15	19	17	15	15	
12	Zostera_marina	16	19	19	19	19	
13	Charophytes	15	19	19	17	17	
14	Mytilus_edulis	16	18	16	9	9	
15	Fucus_sp	14	18	17	13	13	
16	Sandbanks_slight_submerg	15	19	16	15	15	
17	Estuaries	16	18	16	14	14	
18	Mudflats_and_sandflats_nc	18	19	17	15	15	
19	Coastal_lagoons	17	19	17	15	15	
20	Large_shallow_inlets_bays	16	18	16	13	13	
21	Reefs	19	20	16	13	13	
22	Baltic_esker_island	16	18	15	13	13	
23	Submarine_struct_leaking_gas	18	17	12	16	16	
24	Boreal_Baltic_islands	16	18	15	12	12	



Map illustrating areas with higher and lower impacts on ecosystem components.

Creating a synergy-conflict matrix

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What about **continuing using expert-based knowledge**, but - instead of scoring the impacts from pressures on the environment - scoring conflicts and synergies between marine interactions?

→ Use-use synergy-conflict inputs from **tables from completed MSP projects**:

[2014] Kannen, A.

[2018d] Gimpel et al.

[2009] Ehler & Douvere (UNESCO)

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Baltic SCOPE
Towards coherence and cross-border solutions in Baltic Maritime Spatial Plans

MULTI-LEVEL GOVERNANCE IN MARITIME SPATIAL PLANNING THROUGHOUT THE BALTIC SEA REGION
PartiSEApate

MUSES Multi-Use in European Seas

Creating a synergy-conflict matrix

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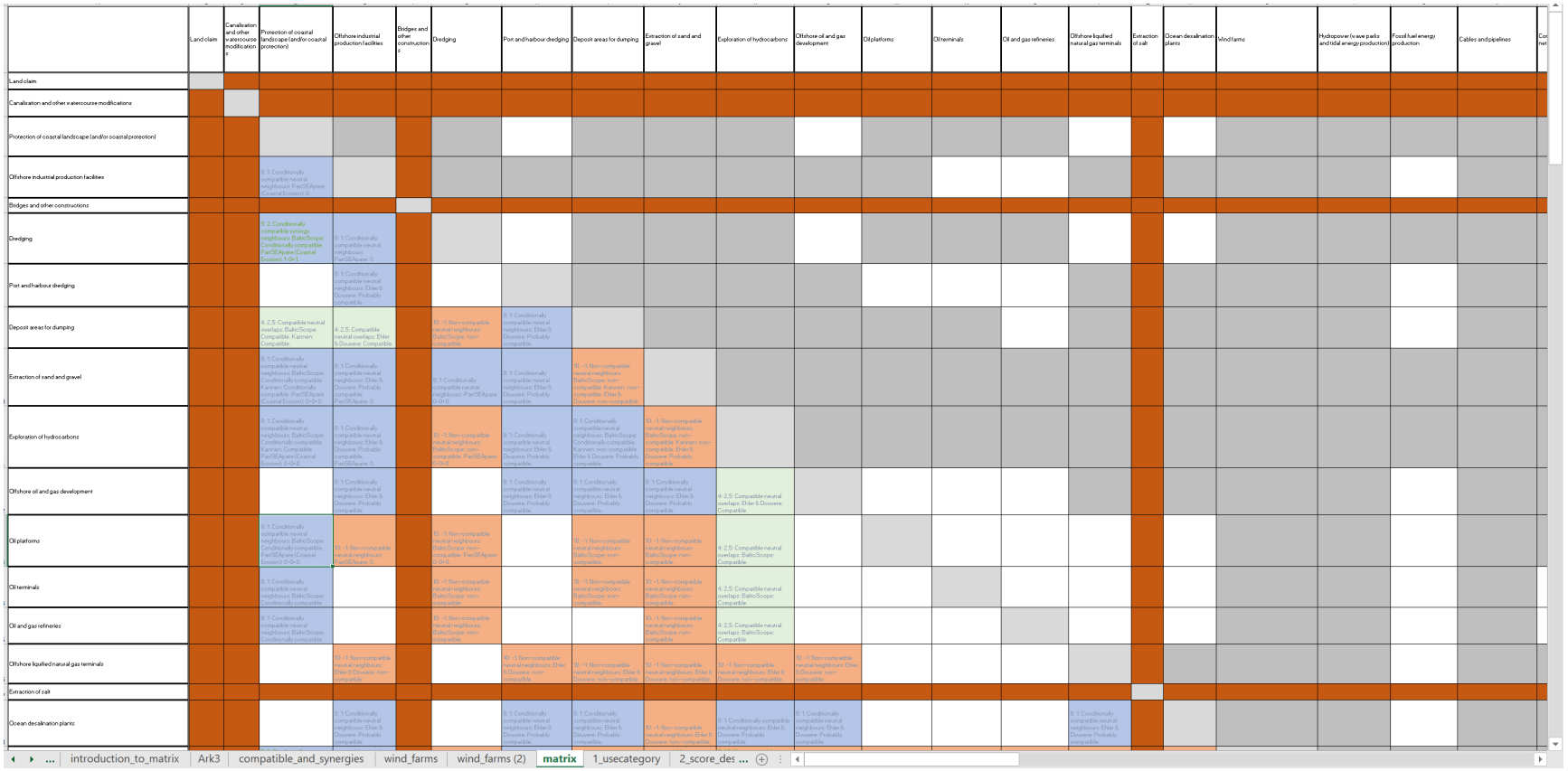
A glimpse of how the matrix currently looks like:



Creating a synergy-conflict matrix

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The **colours** represent **12 classes** that have been deduced based on a combination of

- Degree of compatibility (non-compatible, probably compatible, compatible)
- The number of synergies and the number of conflicts mentioned in literature

ID of synergy-conflict class	synergy-conflict class name	Synergy-conflict class description:	potentiel score defined by Ida
1	Compatible synergy overlaps over time.	Potential replacement of uses no longer needed thus optimising the use of space (synergies through spatial overlaps over time).	
2	Compatible synergy overlaps.	Compatible spatial overlaps with synergies and no conflicts (suggested score: 3)	3
3	*Compatible synergy overlaps.*	Compatible spatial overlaps with more synergies than conflicts (suggested score: 2.75)	*2,75*
4	Compatible neutral overlaps	Compatible neutral spatial overlaps (suggested score: 2.5)	2,5
5	Conditionally compatible synergy neighbours	Conditionally compatible uses with neighbourhood synergies and no neighbourhood conflicts (suggested score: 2)	2
6	*Conditionally compatible synergy neighbours*	Conditionally compatible uses with more neighbourhood synergies than neighbourhood conflicts (suggested score: 1.75).	*1,75*
7	Non-compatible synergy neighbours	Non-compatible uses with neighbourhood synergies and no neighbourhood conflicts (suggested score: 1.5).	1,5
8	Conditionally compatible neutral neighbours	Conditionally compatible uses with neutral neighbourhood relations (suggested score: 1).	1
9	*Conditionally compatible neutral neighbours*	Conditionally compatible uses (a few conflicts exist but just as many synergies exist) with neutral neighbourhood relations (suggested score: 0.5).	*0,5*
10	Non-compatible neutral neighbours	Non-compatible uses with neutral neighbourhood relations (suggested score: -1).	-1
11	Conditionally compatible conflicting neighbours	Conditionally compatible uses with conflicting neighbourhood relations (only a few conflicts) (suggested score: -2).	-2
12	Non-compatible conflicting neighbours	Non-compatible uses with conflicting neighbourhood relation (suggested score: -3). .	-3

Using the synergy-conflict matrix

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What can the matrix be used for?

1. A **map-based screening** of potential conflicts and potential synergies in an area (test is ongoing on HELCOM data) + combine it with cumulative impact maps.

2. A **catalogue** and **survey-based** methodology for evaluating actual conflicts and synergies in an area through improving the matrix with specific, local knowledge.

A wish to make the synergy-conflict-maps interactive – similar to how MYTILUS is turning interactive

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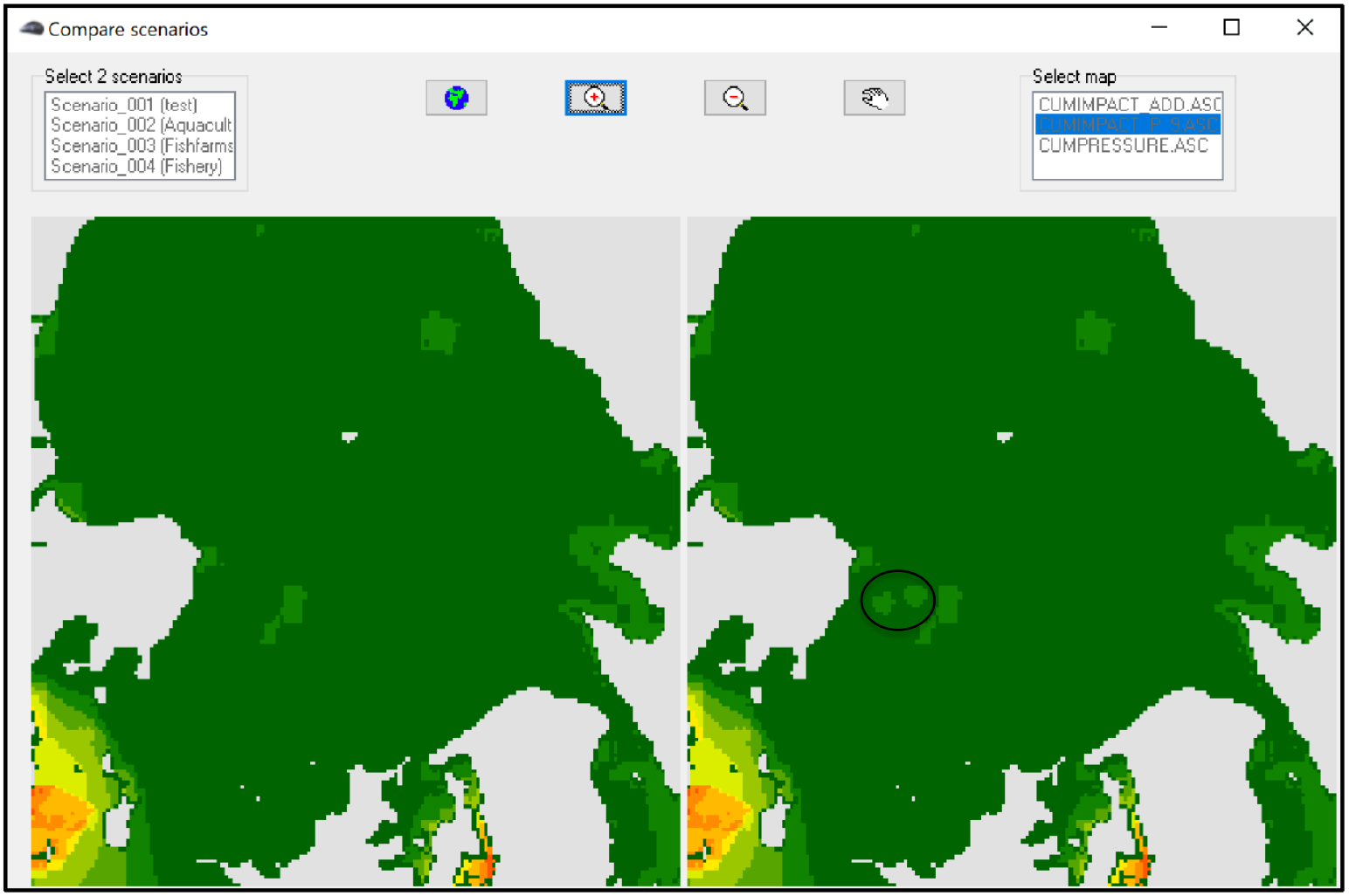

MYTILUS [2019c]: Left: Status-quo scenario – right: new fish farms

Interactive how?

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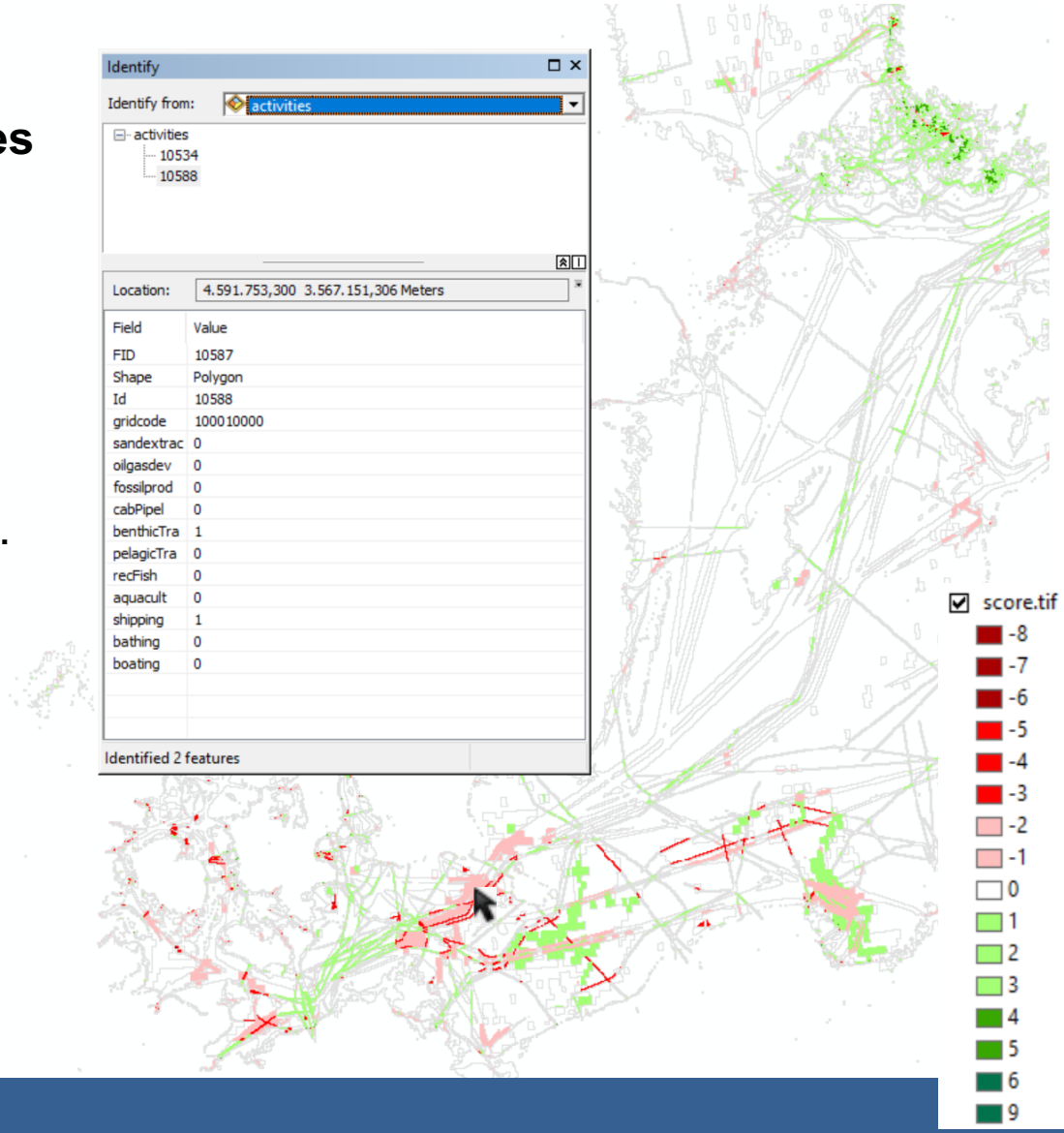
- Choosing **all uses or some uses** to base the synergy-and/or-conflict map on.
- Choosing **category maps or scoring maps**.
- Comparing **different scenarios**.
- Options to **browse through** the matrix content.



Challenges and considerations

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- **How to consider mobile and temporally dependent uses?**
- **How to consider horizontal neighborhood interactions?**
- **Other methods than asking experts?**
  → Public participatory GIS (PPGIS) methods.

Thank you!

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A picture to end my presentation: Tourism and aquaculture join forces in Maine, USA in 2014:

https://www.aquaculturenorthamerica.com/news/tourism-and-aquaculture-join-forces-in-maine-1683

Litterature

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Litterature

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