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Relative impact of multiple human stressors to ecosystems in Black Sea Romanian coastal, transitional and shelf waters (EcoImpactMapper tool)

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NIMRD “Grigore Antipa”

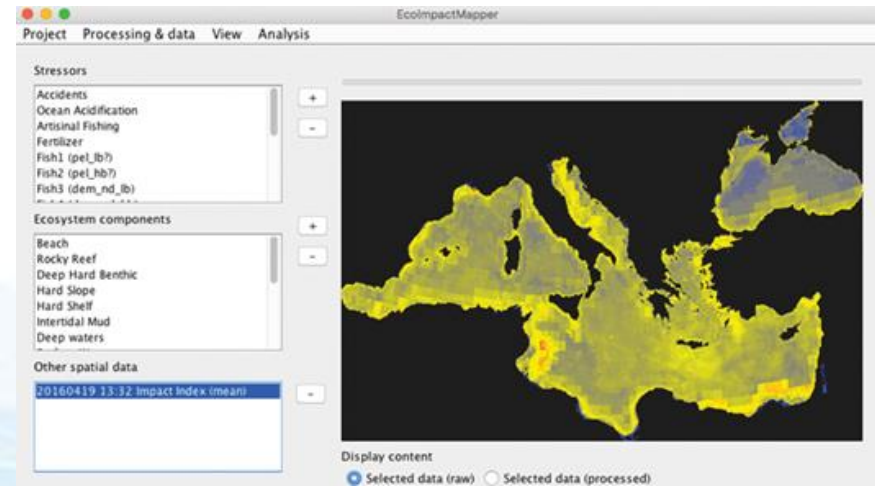
**Final Meeting - ANEMONE Project
4th – 5th of March 2021, On-line Meeting**

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The EcolmpactMapper is an open source software for **Mapping Human Impacts on Marine Ecosystems** with an **Additive Model** (Halpern et al., *Science*, 2008)

The model evaluates where **human stressors** (e.g. fishing with different gear types, shipping lanes, water pollution with different substances) **overlap spatially** with **ecosystem types** (e.g. seagrass meadows, soft material sea bottom) or **important species** that are sensitive to these stressors and it calculates a **human impact index**.

By now, the model has also been used for regional human impact assessments for e.g. the northern Hawaiian islands, the California Current region, the waters of British Columbia, the Baltic Sea, the waters off Massachusetts, the eastern North Sea and the Mediterranean.



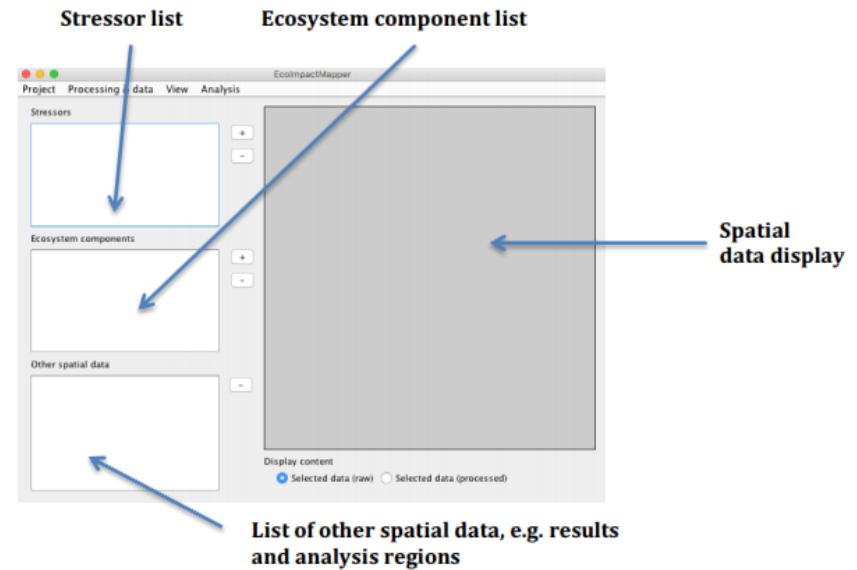
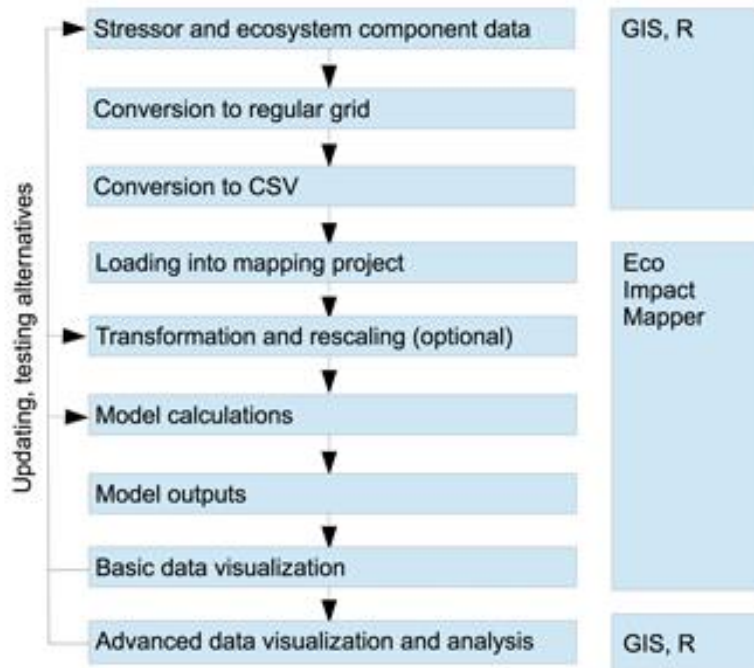
The window contains a list of stressors, a list of ecosystem components, a list of model outputs, and a graphics panel displaying the spatial data (model inputs or outputs) selected by the user

The **additive model** as suggested by Halpern et al. uses three kinds of input data:

- D_i : **Spatial distribution of stressors**, such as fishing effort or shipping intensity, as regular grids. Stressor data are $\log(x+1)$ -transformed and rescaled so that the maximum is 1. This transformation and rescaling can optionally take place in the EcoImpactMapper.
- e_j : **Spatial distribution of ecosystem components** as regular grids, e.g. continental slope soft bottom habitat either as presence (1) and absence (0) or, in some cases continuous data like probabilities of presence.
- $\mu_{i,j}$: **Sensitivity weights** numerically representing the sensitivity of ecosystem component j to stressor i . These weights are typically derived by expert judgment.

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Workflow for creating human impact maps with the EcoImpactMapper



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The EcolImpactMapper tool spatial outputs

- **Ecological diversity index** – The index is simply the sum of all ecosystem component data layers
- **Ecological sensitivity index** - The index is like an ecological diversity index, but each ecosystem component is weighted with the mean of its sensitivity weights for all stressors. A high ecological sensitivity index means that there are many ecosystem components that are sensitive to many stressors.
- **Unweighted stressor index** - The index is the simple sum of all processed stressor data layers
- **Weighted stressor index** - is also a sum of processed stressor data layers, but each stressor is weighted with the mean of all ecosystem components' sensitivity weights for this stressor
- **Human impact index and stressor/ecosystem component contributions** - it supports:
 - different ***models for aggregating the effects of multiple stressors*** on a given ecosystem component:
 - Additive effect: For each ecosystem component, the impacts from each stressor simply add up, as in Halpern et al.'s original paper
 - Dominant effect: For each ecosystem component, only the stressor having the largest impact on that ecosystem component is considered in each grid cell (i.e. the dominant stressor can be a different one in different places).
 - Antagonistic effect: For each ecosystem component, the impacts from all stressors add up, but each additional stressor is multiplied with a smaller weight.
 - different ***ways to aggregate the impacts on several ecosystem components***.
 - As sum of impacts on all ecosystem components in a grid cell,
 - As mean of impacts on all ecosystem components in a grid cell



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ROMANIAN STUDY CASE

!!! Work in progress !!!

The objectives of this exercise are:

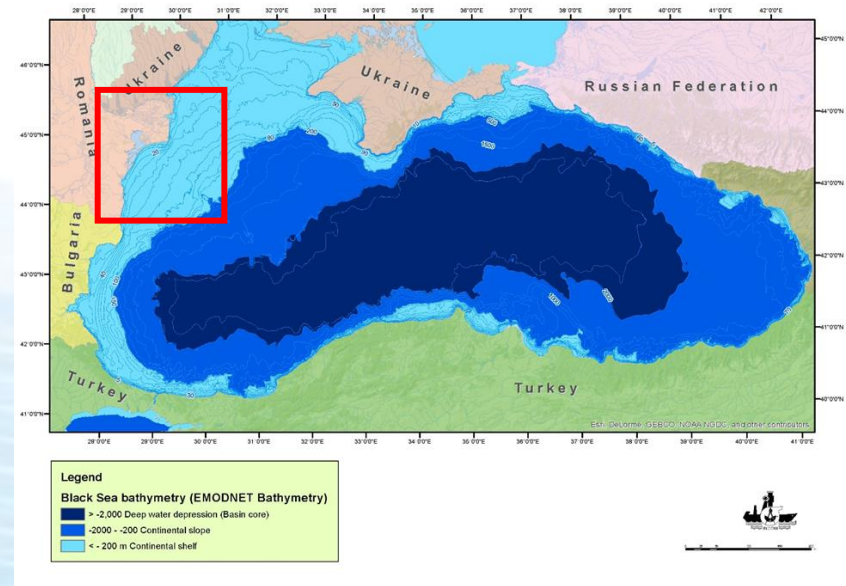
- To test the functionality of the EcoImpactMapper tool and how it can be applied in the Black Sea region
- To select and process the data (data format, their coverage, representation and type – biological, chemical, human activities etc) we need to calculate the ecological indices and the cumulative impact
- to map the potential cumulative impacts of multiple human activities and stressors on the ecosystems in the western parts of the Black Sea



Step 1: Establishing the study area boundaries and the size of grid cell

The study area:

- overlapping to Romanian **territorial sea, contiguous zone** and partial to **economic exclusive zone**.
- The *geomorphological conditions* – the study area is located between 0-200 m depth on the **continental shelf** - in the Northwestern largest extension of the entire basin of the Black Sea due to large amounts of sediments from the river system and configuration basin and it narrows from north to south. It is characterized by a uniform relief, with gently slopes and is covered with terrigenous deposits.

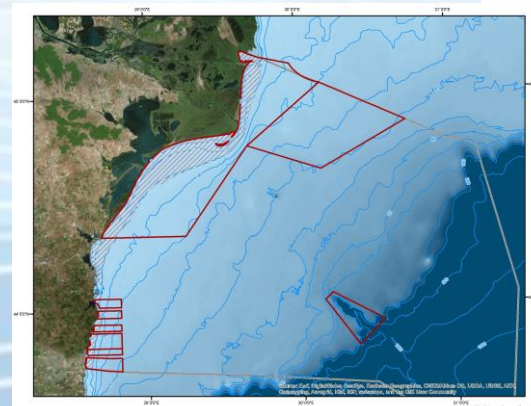
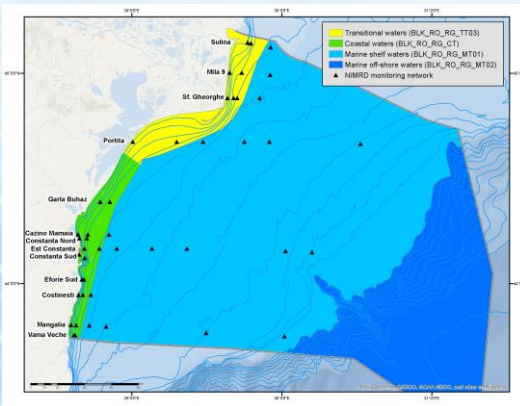
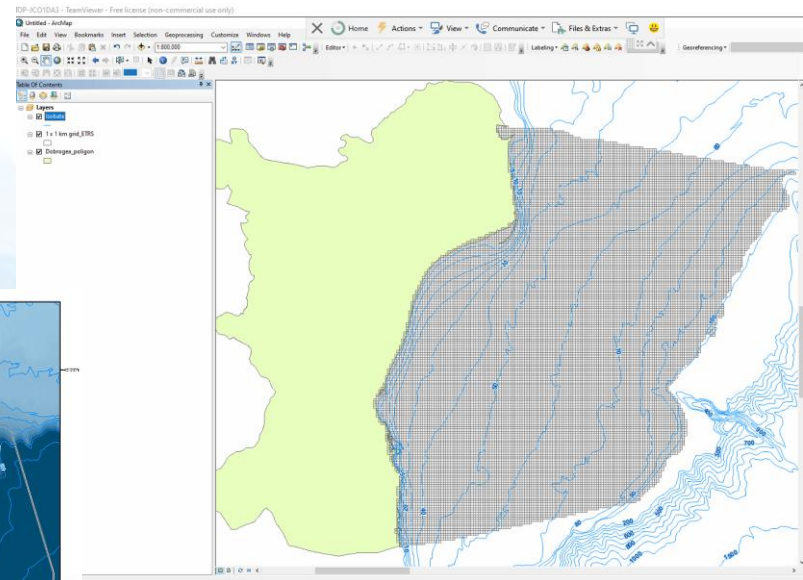


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- MSFD marine reporting units – **coastal, transitional and shelf waters**
- The hydrological conditions are variable, caused by a large part of the East European drainage basin entering the north – west part of Black Sea
- The area is affected by activities taking place, both on land and in the marine and coastal waters
- ~ 30% of case study area consists of Natura 2000 sites

The EcolImpactMapper reads all data as **regular grids** from comma-separated value (CSV)

- Cell size - 1 x 1 km grid
- ETRS_1989_LAEA projection system



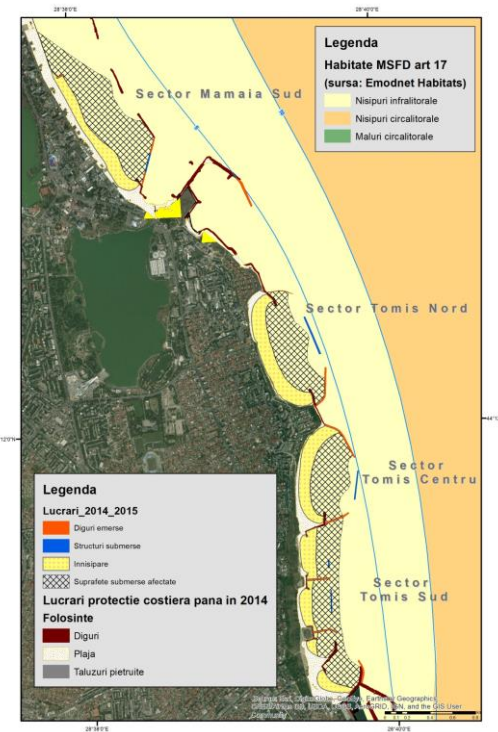
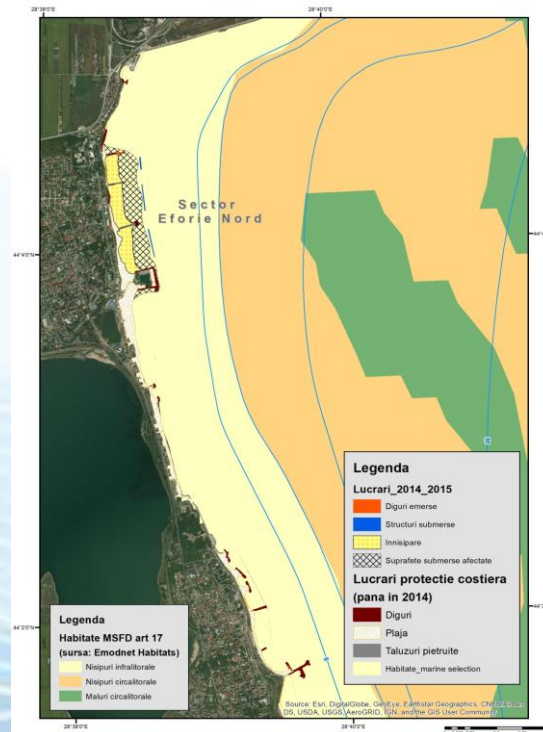
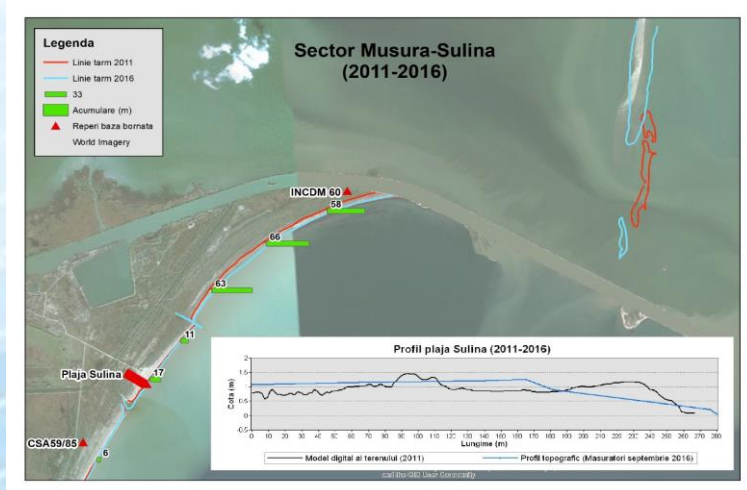
Step 2 – Identify the stressors in the study area

Code	Stressors	Stressors1	Pressures	Representation	MSFD activities	Observations
1	Canalisation	Canalisation	Physical disturbance	Presence/absence	Physical restructuring of rivers, coastline or seabed (water management)	Includind disturbed area based on expert judgment
2	Coastal_protection_works	Coastal_protection_works	Physical disturbance	Presence/absence	Physical restructuring of rivers, coastline or seabed (water management)	Include just disturbed areas based on expert judgment (dikes, damms, other constructions, beach nourishment considered "sealed")
3	Disposal sites for dredged material	Disposal sites for dredged material	Physical disturbance	Presence/absence	Physical restructuring of rivers, coastline or seabed (water management)	
4	Sediment extraction sites	Sediment extraction sites	Physical disturbance	Presence/absence	Physical restructuring of rivers, coastline or seabed (water management)	
5	Trawling (pelagic and beam trawl)	Trawling (pelagic and beam trawl)	Physical disturbance	Trawling intensity (3-High, 2- Medium, 1- Low)	Extraction of living resources	estimations based on partial VMS data
6		Stationary uncovered pound nets	Physical disturbance	Presence/absence	Extraction of living resources	estimations based on partial data
7	Small-scale fishing	Set gillnets	Physical disturbance	Presence/absence	Extraction of living resources	estimations based on partial data
8		Small-scale fishing (traps, seine, manual fishing etc)	Physical disturbance	Presence/absence	Extraction of living resources	estimations based on partial data
9	Off-shore oil and gaz installation	Off-shore oil and gaz installation	Physical disturbance	Presence/absence	Theme Extraction of non-living resources	
10	Drilling	Drilling	Physical disturbance	Presence/absence	Theme Extraction of non-living resources	
11	Oil and gas pipelines	Oil and gas pipelines	Physical disturbance	Presence/absence	Theme Extraction of non-living resources	
12	Industrial and commercial ports	Industrial and commercial ports	Physical disturbance	Presence/absence	Transport	Includind disturbed area based on expert judgment
13	Anchorage areas	Anchorage areas	Physical disturbance	Presence/absence	Transport	
14	Shipping intensity	Shipping intensity	Multipressures (physical disturbance/contaminants/nutrients etc)	Intensity	Transport	
15	Contaminants in sediments	CHASE	Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events	Integrated assessment of the combined effects of multiple chemical substances using a multi-metric indicator-based assessment tool (CHASE in sediments) - points data interpolation, 5 classes (1-High, 2-Good, 3-Moderate, 4-Poor, 5-Bad)	Urban and industrial uses	2017-2019
16		DIP				
17		DIN				
18		CBO5				
19	Nutrients (DIP, DIN, CBO5, Porg, TOC, TN, TSS)	Porg	Input of nutrients — diffuse sources, point sources	Points data interpolation	in-situ data	2017-2019
20		TOC				
21		TN				
22		TSS				
23		Cu				
24		Cd				
25	Heavy metals (Cu, Cd, Pb, Ni, Cr)	Pb	Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events	Points data interpolation	in-situ data	2017-2020
26		Ni				
27		Cr				
28	Total petroleum hydrocarbons (TPH)	TPH				
29	Touristic activities (nautical sports, diving, fishing etc)	Touristic activities (nautical sports, diving, fishing etc)	Multipressures (physical disturbance/contaminant/nutrients, marine litter etc)	Presence/absence and intensity (3 -High, 2-Medium, 1 - Low) based on number of tourists, LAU level (0-5 m depth)	Tourism and leisure	Includind disturbed area based on expert judgment
30	Touristic infrastructures (marinas)	Touristic infrastructures (marinas)	Physical disturbance	Presence/absence	Tourism and leisure	Includind disturbed area based on expert judgment
31	Input of water	Input of water	Contaminants/ nutrients/heavy metals/fresh water/ organic matter	presence/absence/intensity (3 -High, 2-Medium, 1 - Low)	Urban and industrial uses	Includind disturbed area based on expert judgment

1. Physical restructuring of rivers, coastline or seabed (water management)

Pressure - Physical disturbance - Include just disturbed areas based on expert judgment (dikes, damms, other constructions, beach nourishment considered "sealed")

- Canalisation
- Coastal_protection_works
- Disposal sites for dredged material
- Sediment extraction sites

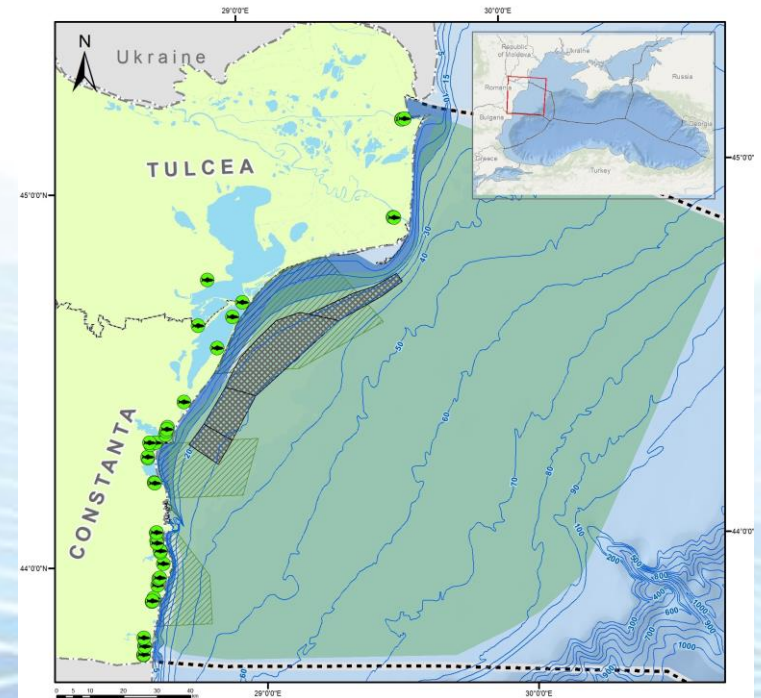
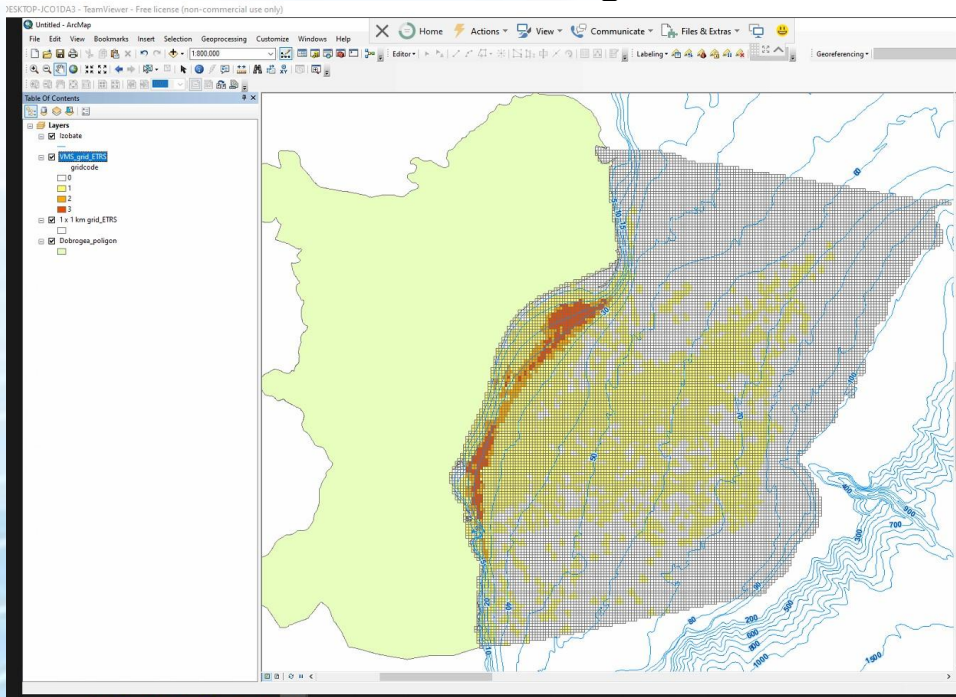


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2. Extraction of living resources

Pressure - Physical disturbance

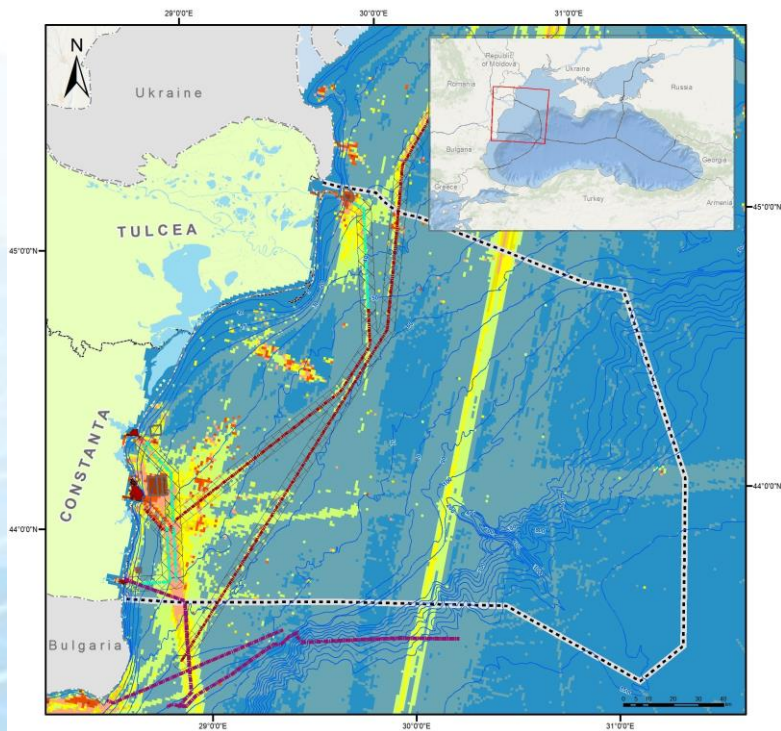
- Trawling (pelagic and beam trawl) - Trawling intensity (3-High ,2- Medium,1- L-low) estimations based on partial VMS data
- Small-scale fishing



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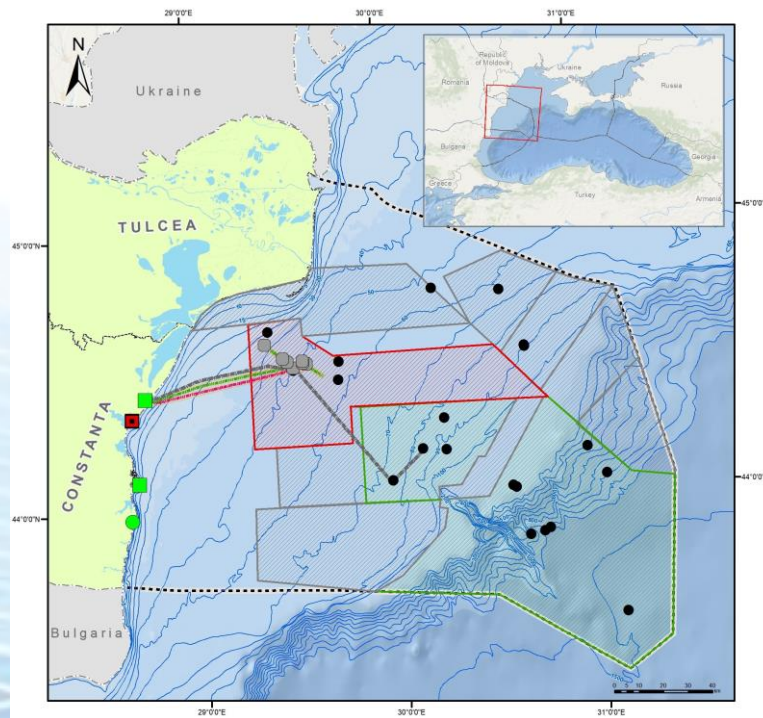
2. Transport

Pressure - Multipressures (physical disturbance/contaminants/nutrients etc) – industrial and commercial ports, anchorages areas, shipping intensity)



3. Extraction of non-living resources

Pressure - Physical disturbance – Drilling, off-shore oil and gas installation, oil and gas pipelines

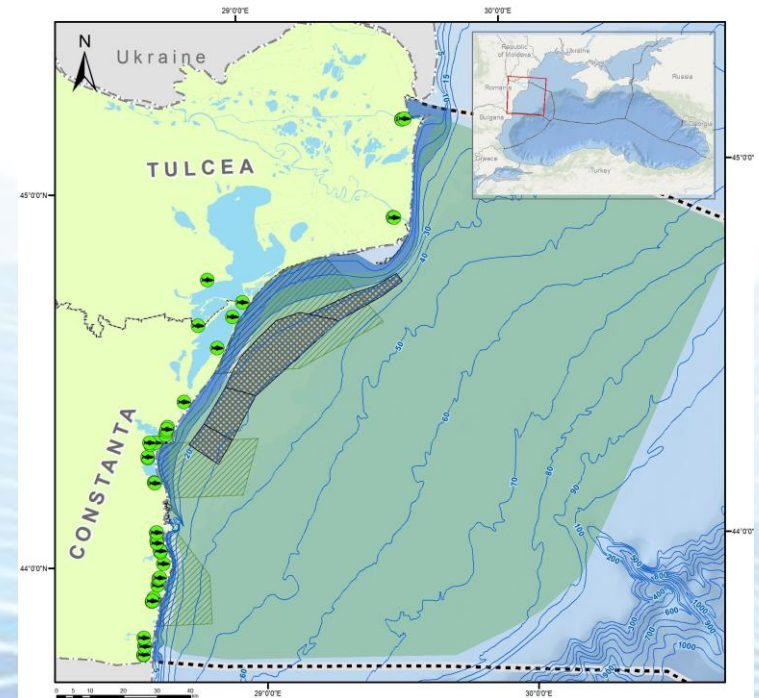
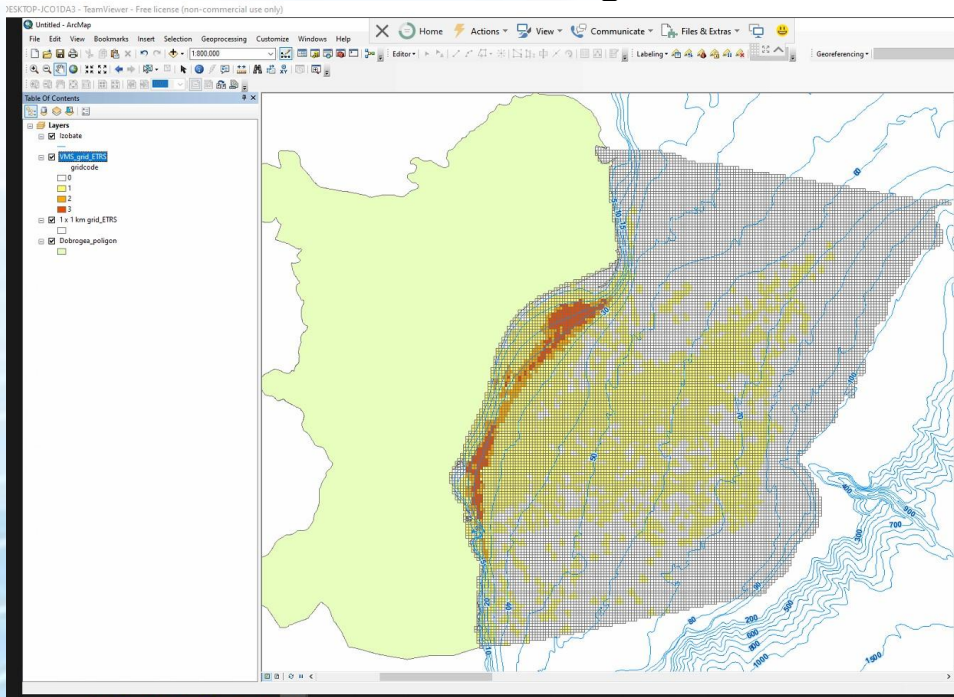


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2. Extraction of living resources

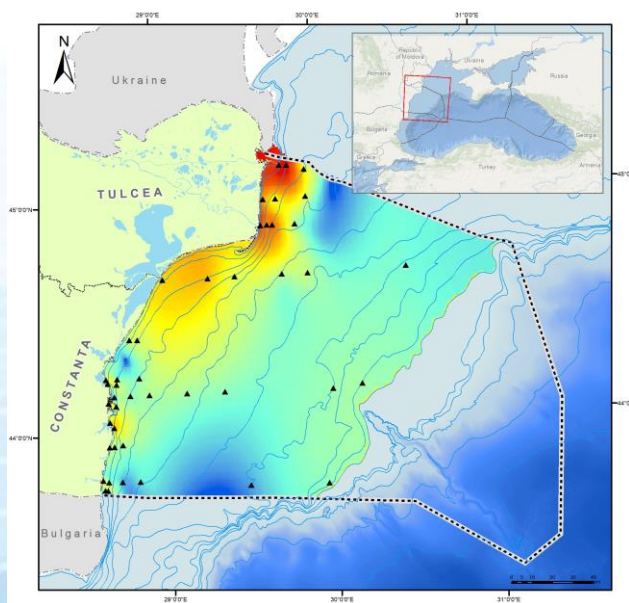
Pressure - Physical disturbance

- Trawling (pelagic and beam trawl) - Trawling intensity (3-High ,2-Medium,1- L-low) estimations based on partial VMS data
- Small-scale fishing



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- Input of nutrients — diffuse sources, point sources
- Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events



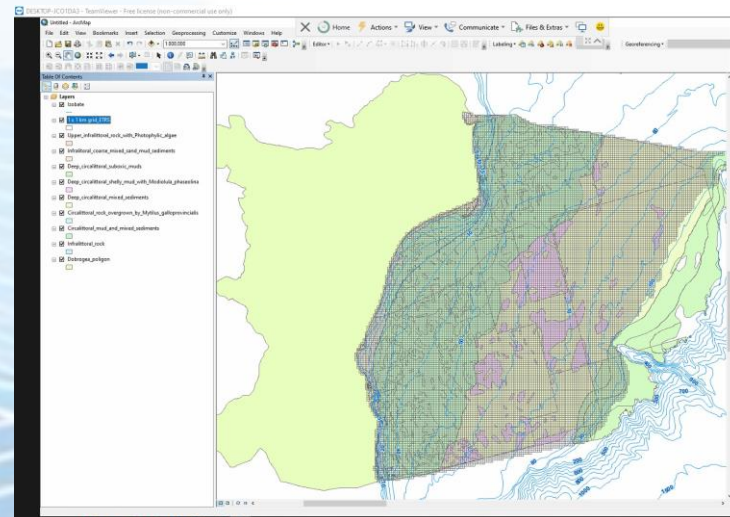
Contaminants in sediments	CHASE
Nutrients (DIP, DIN, CBO5, Porg, TOC, TN, TSS)	DIP
	DIN
	CBO5
	Porg
	TOC
	TN
Heavy metals (Cu, Cd, Pb, Ni, Cr)	TSS
	Cu
	Cd
	Pb
Total petroleum hydrocarbons (TPH)	Ni
	Cr
	TPH

Step 3 – Identify the ecosystem compounds

- Benthic habitats

Code	Ecosystem component	Representation	Data sources
1	Infralittoral rock (1-18m)	presence/absence	EuSeaMap 2019, NIMRD database
2	Upper_infralittoral_rock_with_Photophylic_algae	presence/absence	EuSeaMap 2019, NIMRD database
3	Infralittoral coarse, mixed, sand, mud sediment (1-20m)	presence/absence	EuSeaMap 2019, NIMRD database
4	Circalittoral rock overgrown by Mytilus galloprovincialis	presence/absence	EuSeaMap 2019, NIMRD database
5	Circalittoral_mud_and_mixed_sediments	presence/absence	EuSeaMap 2019, NIMRD database
6	Deep circalittoral shelly mud with Modiolula phaseolina (60-120m)	presence/absence	EuSeaMap 2019, NIMRD database
7	Deep_circalittoral_mixed_sediments	presence/absence	EuSeaMap 2019, NIMRD database
8	Deep circalittoral suboxic muds	presence/absence	EuSeaMap 2019, NIMRD database

- Pelagic habitats
- Phytoplankton/Zooplankton/
Macrophytes
- The most important fish species
- Marine mammals
- Birds distribution

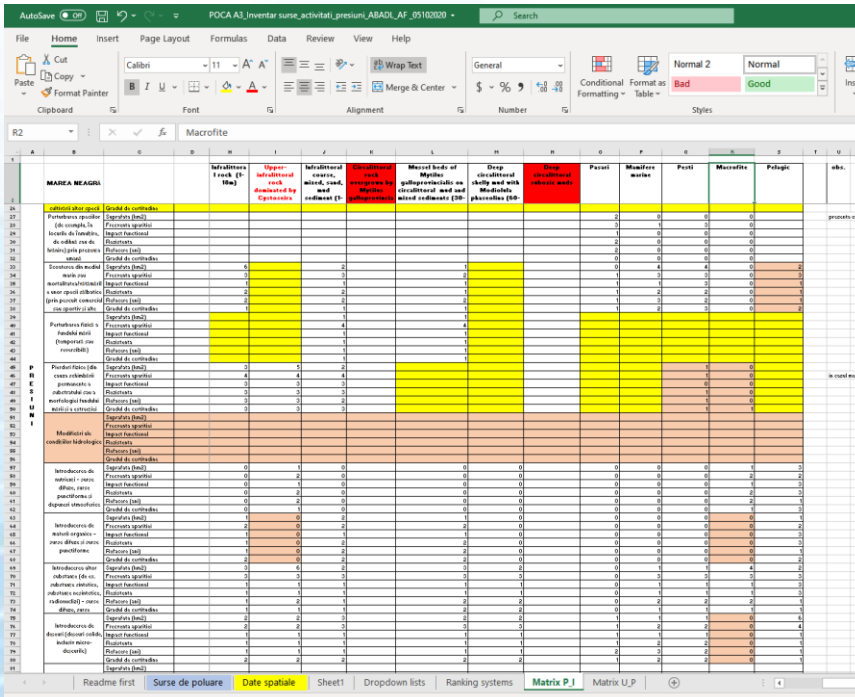


Step 4 – Preparing the sensitivity weights matrix - representing the sensitivity of each ecosystem component to each stressor (Based on Halpern et al.'s model)

- The vulnerability measure rank for each stressor/ ecosystem compound was established based on expert opinion

Table 2. Ranking systems for each vulnerability measure used to assess how threats affect marine ecosystems.

Vulnerability measure	Category	Rank	Descriptive notes	Example
Scale (km ²)	no threat	0		
	<1	1		anchor damage
	1-10	2		single trawl drag
	10-100	3		sediment run-off from deforestation
	100-1,000	4		land-based pollution from run-off of large rivers
	1,000-10,000 > 10,000	5 6		an invasive species sea surface temperature change
Frequency	never occurs	0		
	rare	1	infrequent enough to affect long-term dynamics of a given population or location	large oil spill
	occasional annual or regular	2 3	frequent but irregular in nature frequent and often seasonal or periodic in nature	toxic algal blooms runoff events due to seasonal rains
	persistent	4	more or less constant year-round, lasting through multiple years or decades	persistent hypoxic zones
Functional impact	no impact	0		
	species (single or multiple)	1	one or more species in a single or different trophic levels	ship strikes on whales
	single trophic level	2	multiple species affected; entire trophic level changes	overharvest of multiple species within the same trophic guild
	> 1 trophic level	3	multiple species affected; multiple trophic levels change	overharvest of key species from multiple trophic guilds
entire community	4	cascading effect that alter the entire ecosystem	ocean temperature increase and fatal bleaching of coral reefs	
Resistance	no impact	0		
	high	1	no significant change in biomass, structure, or diversity until extreme threat levels	trawling on soft-sediment communities
	medium	2	moderate intensities or frequencies of a threat lead to change	effects of industrial pollution run-off on coastal species
Recovery time (years)	low	3	slightest occurrence of a threat causes a change, or all-or-nothing threats	blast fishing in coral reefs
	no impact	0		
		<1	1	help recovery after disturbance
1-10		2	runoff from episodic toxic pollution	run-off on coastal species
Certainty	10-100	3	long-lived species recovery from overfishing	deep sea coral recovery after trawl damage
	> 100	4		
	none	0		
very high	low	1	very little or no empirical work exists	
	medium	2	some empirical work exists or expert has some personal experience	
	high	3	body of empirical work exists or the expert has direct personal experience	
	very high	4	extensive empirical work exists or the expert has extensive personal experience	



The screenshot shows an Excel spreadsheet with the following columns: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The rows are labeled with stressors and ecosystem components. The spreadsheet is titled 'POCA A3_Inventar surse activitati_presiuni_ABADI_AF_05102020'. The status bar at the bottom indicates 'Readme first', 'Surse de poluare', 'Date spatiale', 'Sheet1', 'Dropdown lists', 'Ranking systems', 'Matrix P.J', 'Matrix U.P'.

Step 5 - Loading stressor and ecosystem component data

- The EcolImpactMapper reads all stressor and ecosystem component data as **regular grids** from **comma-separated value (CSV)** files.
- Spatial data are interpreted as tables and must have at least three columns:
 - ✓ X coordinate of grid cell center
 - ✓ Y coordinate of grid cell center
 - ✓ One or more columns representing stressor intensities or ecosystem components.
- Data can be uploaded like presence/absence (1/0) or continuous data

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1	OBJECTID	X	Y	nfraltritoral_san	nfraltritoral_muc	Circulartritoral	mgagic_hab_var	sal_lagic_hab_coas	elagic_hab_she	Shape_Length	Shape_Area			
2	1	2658307.479	5845787.401	0	0	0	0	1	0	4000	1000000			
3	2	2658307.479	5846787.401	0	0	0	0	1	0	4000	1000000			
4	3	2658307.479	5847787.401	1	0	0	0	1	0	4000	1000000			
5	4	2658307.479	5848787.401	1	0	0	0	1	0	4000	1000000			
6	5	2658307.479	5849787.401	1	0	0	0	1	0	4000	1000000			
7	6	2657307.479	5845787.401	1	0	0	0	1	0	4000	1000000			
8	7	2657307.479	5846787.401	1	0	0	0	1	0	4000	1000000			
9	8	2657307.479	5847787.401	1	0	0	0	1	0	4000	1000000			
10	9	2657307.479	5848787.401	1	0	0	0	1	0	4000	1000000			
11	10	2657307.479	5849787.401	1	0	0	0	1	0	4000	1000000			
12	11	2657307.479	5850787.401	1	0	0	0	1	0	4000	1000000			
13	12	2657307.479	5851787.401	1	0	0	0	1	0	4000	1000000			
14	13	2657307.479	5852787.401	1	0	0	0	1	0	4000	1000000			
15	14	2657307.479	5853787.401	1	0	0	0	1	0	4000	1000000			
16	15	2657307.479	5854787.401	1	0	0	0	1	0	4000	1000000			
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23	22	2657307.479	5861787.401	1	0	0	0	1	0	4000	1000000			
24	23	2657307.479	5862787.401	1	0	0	0	1	0	4000	1000000			
25	24	2657307.479	5863787.401	1	0	0	0	1	0	4000	1000000			
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27	26	2657307.479	5865787.401	0	0	0	0	1	0	4000	1000000			
28	27	2657307.479	5866787.401	0	0	0	0	1	0	4000	1000000			
29	28	2657307.479	5867787.401	0	0	0	0	1	0	4000	1000000			
30	29	2657307.479	5868787.401	0	0	0	0	1	0	4000	1000000			
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61	60	2658307.479	5849787.401	1	0	0	0	1	0	4000	1000000			
62	61	2658307.479	5850787.401	0	0	0	0	1	0	4000	1000000			
63	62	2658307.479	5849787.401	1	0	0	0	1	0	4000	1000000			
64	63	2658307.479	5850787.401	1	0	0	0	1	0	4000	1000000			
65	64	2658307.479	5851787.401	1	0	0	0	1	0	4000	1000000			
66	65	2658307.479	5852787.401	1	0	0	0	1	0	4000	1000000			
67	66	2658307.479	5853787.401	1	0	0	0	1	0	4000	1000000			

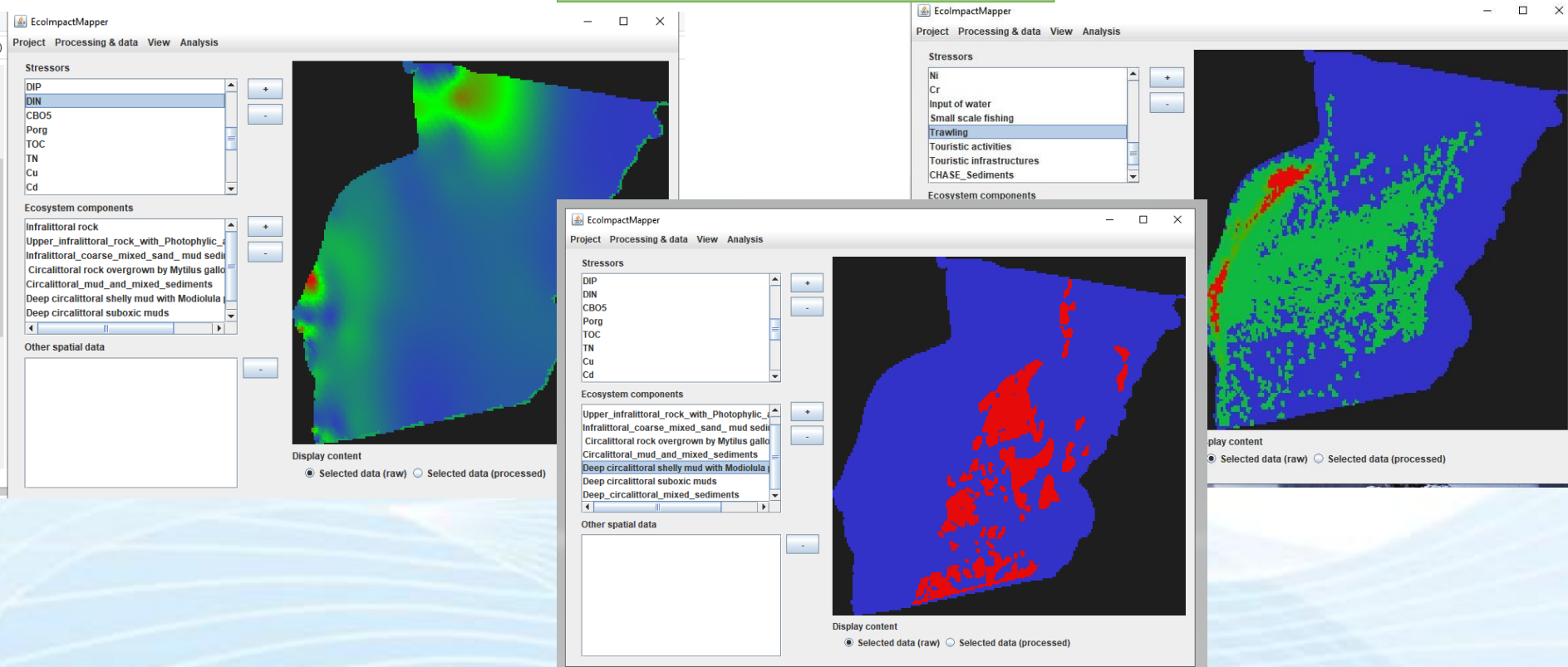
Step 6 - Loading sensitivity weights

- from a CSV file where columns represent ecosystem components and rows represent stressors

	A	B	C	D	E	F	G	H	I	J
1	SensitivityScores									
2										
3		Benthic habitats	Infralittoral rock (1-18m)	Upper infralittoral rock with Photophylic algae	Infralittoral coarse, mixed, sand, mud sediment (1-20m)	Circalittoral rock overgrown by Mytilus galloprovincialis	Circalittoral mud and mixed sediments	Deep circalittoral shelly mud with Modiolula phaseolina (60-120m)	Deep circalittoral mixed sediments	Deep circalittoral suboxic muds
4	Stressors	CODE	1	2	3	4	5	6	7	8
5	Canalisation	1	5	5	3	1	1	0	0	0
6	Coastal protection works	2	5	5	3	3	3	0	0	0
7	Disposal sites for dredged material	3	4	4	4	4	4	0	0	0
8	Sediment extraction sites	4	5	5	4	4	4	0	0	0
9	Trawling (pelagic and beam trawl)	5	0	0	5	5	5	1	1	0
10	Stationary uncovered pound nets	6	1	1	3	1	3	0	0	0
11	Set gillnets	7	1	1	2	2	2	0	0	0
12	Small-scale fishing (traps, seine, manual fishing etc)	8	2	2	1	1	1	0	0	0
13	Off-shore oil and gaz installation	9	0	0	0	4	4	4	4	4
14	Drilling	10	0	0	0	4	4	4	4	4
15	Oil and gas pipelines	11	2	2	2	2	2	2	2	2
16	Industrial and commercial ports	12	5	5	5	5	5	0	0	0
17	Anchorage areas	13	5	5	5	5	5	0	0	0
18	Shipping intensity	14	2	2	2	2	2	2	2	2
19	CHASE	15	2	2	2	2	2	2	2	2
20	DIP	16	2	2	2	2	2	1	1	0
21	DIN	17	2	2	2	2	2	1	1	0
22	CBOS	18	2	2	2	2	2	1	1	0
23	Porg	19	2	2	2	2	2	1	1	0
24	TOC	20	2	2	2	2	2	1	1	0
25	TN	21	2	2	2	2	2	1	1	0
26	TSS	22	2	2	2	2	2	1	1	0
27	Cu	23	2	2	2	2	2	2	2	2
28	Cd	24	2	2	2	2	2	2	2	2
29	Pb	25	2	2	2	2	2	2	2	2
30	Ni	26	2	2	2	2	2	2	2	2
31	Cr	27	2	2	2	2	2	2	2	2
32	TPH	28	2	2	2	2	2	2	2	2
33	Touristic activities (nautical sports, diving, fishing etc)	29	3	3	3	3	3	0	0	0
34	Touristic infrastructures (marinas)	30	3	3	3	3	3	0	0	0
35	Input of water	31	5	5	5	3	3	0	0	0

Common borders. Common solutions.

EcoImpactMapper interface



The image displays three overlapping screenshots of the EcoImpactMapper software interface, illustrating the spatial data preprocessing step. Each window shows a map of the Black Sea region with a color-coded stressor distribution. The left window shows 'Selected data (raw)' with a green and yellow map. The middle window shows 'Selected data (processed)' with a red and blue map. The right window shows 'Selected data (processed)' with a green and blue map. Each window has a 'Stressors' list on the left and an 'Ecosystem components' list on the right.

Stressors

- DIP
- DIN
- CBO5
- Porg
- TOC
- TN
- Cu
- Cd

Ecosystem components

- Infralittoral rock
- Upper_infralittoral_rock_with_Photophylic_...
- Infralittoral_coarse_mixed_sand_mud_sedi
- Circaillitoral_rock_overnown_by_Mytilus_gallo
- Circaillitoral_mud_and_mixed_sediments
- Deep_circaillitoral_shelly_mud_with_Modiola
- Deep_circaillitoral_suboxic_muds

Other spatial data

Display content

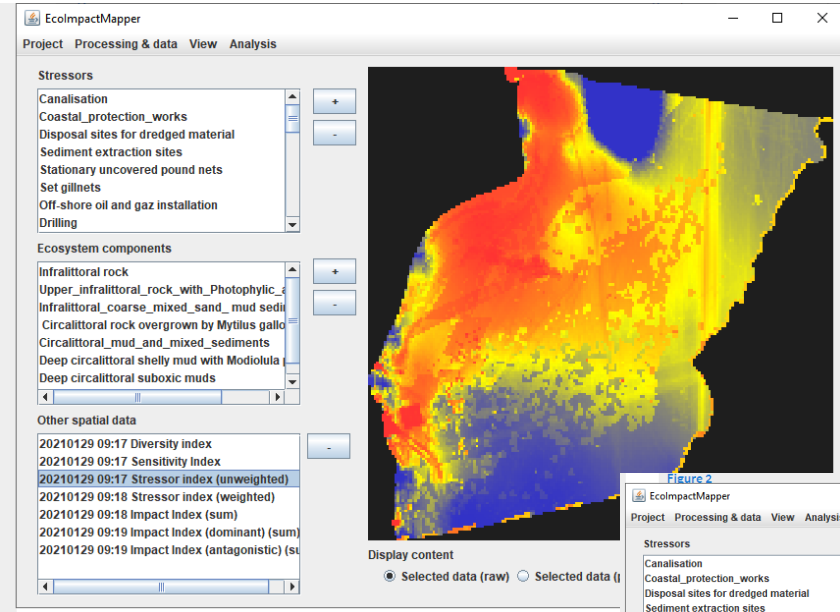
Selected data (raw) Selected data (processed)

Step 7 - Spatial data preprocessing

- all stressor data layers were $\log(X+1)$ -transformed and rescaled so that the maximum of each layer is 1

Common borders. Common solutions.

Step 8 - Calculate the spatial outputs



EcolmpactMapper
Project Processing & data View Analysis

Stressors

- Canalisation
- Coastal_protection_works
- Disposal sites for dredged material
- Sediment extraction sites
- Stationary uncovered pound nets
- Set gillnets
- Off-shore oil and gaz installation
- Drilling

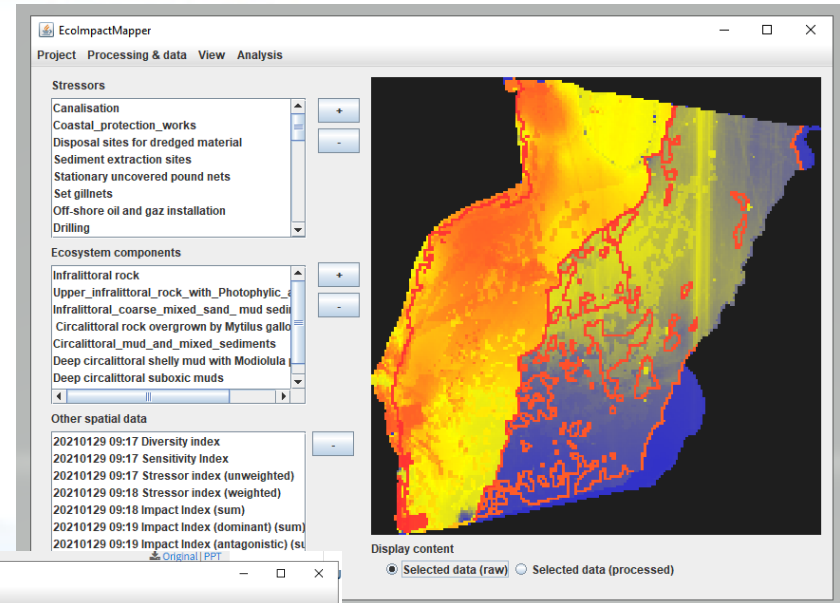
Ecosystem components

- Infralittoral rock
- Upper_infralittoral_rock_with_Photohylic_...
- Infralittoral_coarse_mixed_sand_mud sedi...
- Cirralittoral rock overgrown by Mytilus gallo...
- Cirralittoral_mud_and_mixed_sediments
- Deep cirralittoral shelly mud with Modiolula
- Deep cirralittoral suboxic muds

Other spatial data

- 20210129 09:17 Diversity index
- 20210129 09:17 Sensitivity Index
- 20210129 09:17 Stressor index (unweighted)**
- 20210129 09:18 Stressor index (weighted)
- 20210129 09:18 Impact Index (sum)
- 20210129 09:19 Impact Index (dominant) (sum)
- 20210129 09:19 Impact Index (antagonistic) (sum)

Display content
 Selected data (raw) Selected data (processed)



EcolmpactMapper
Project Processing & data View Analysis

Stressors

- Canalisation
- Coastal_protection_works
- Disposal sites for dredged material
- Sediment extraction sites
- Stationary uncovered pound nets
- Set gillnets
- Off-shore oil and gaz installation
- Drilling

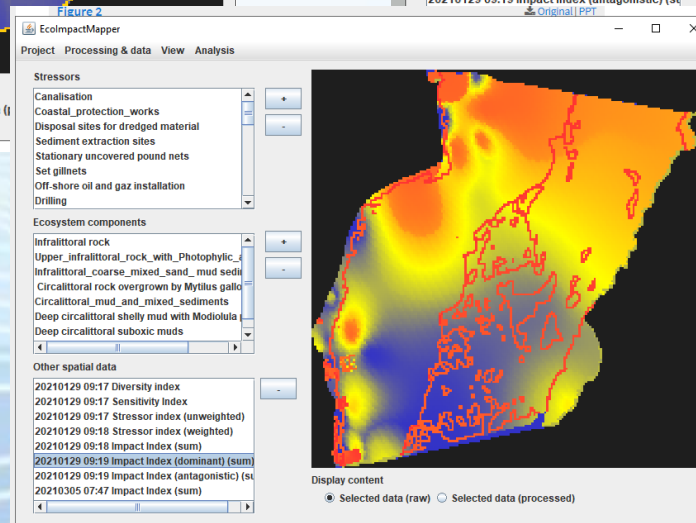
Ecosystem components

- Infralittoral rock
- Upper_infralittoral_rock_with_Photohylic_...
- Infralittoral_coarse_mixed_sand_mud sedi...
- Cirralittoral rock overgrown by Mytilus gallo...
- Cirralittoral_mud_and_mixed_sediments
- Deep cirralittoral shelly mud with Modiolula
- Deep cirralittoral suboxic muds

Other spatial data

- 20210129 09:17 Diversity index
- 20210129 09:17 Sensitivity Index
- 20210129 09:17 Stressor index (unweighted)
- 20210129 09:18 Stressor index (weighted)
- 20210129 09:18 Impact Index (sum)
- 20210129 09:19 Impact Index (dominant) (sum)
- 20210129 09:19 Impact Index (antagonistic) (sum)

Display content
 Selected data (raw) Selected data (processed)



EcolmpactMapper
Project Processing & data View Analysis

Stressors

- Canalisation
- Coastal_protection_works
- Disposal sites for dredged material
- Sediment extraction sites
- Stationary uncovered pound nets
- Set gillnets
- Off-shore oil and gaz installation
- Drilling

Ecosystem components

- Infralittoral rock
- Upper_infralittoral_rock_with_Photohylic_...
- Infralittoral_coarse_mixed_sand_mud sedi...
- Cirralittoral rock overgrown by Mytilus gallo...
- Cirralittoral_mud_and_mixed_sediments
- Deep cirralittoral shelly mud with Modiolula
- Deep cirralittoral suboxic muds

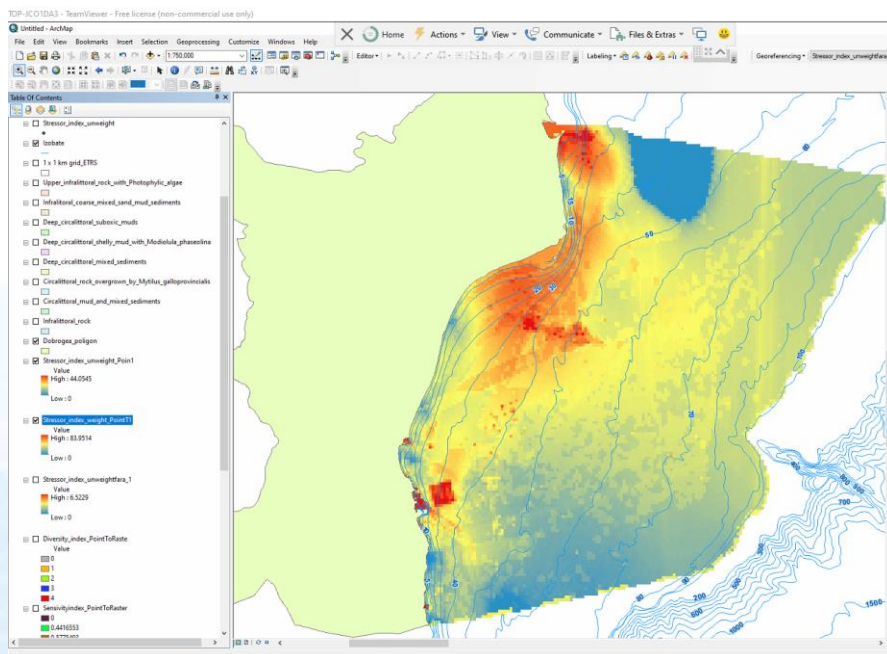
Other spatial data

- 20210129 09:17 Diversity index
- 20210129 09:17 Sensitivity Index
- 20210129 09:17 Stressor index (unweighted)
- 20210129 09:18 Stressor index (weighted)
- 20210129 09:18 Impact Index (sum)
- 20210129 09:19 Impact Index (dominant) (sum)
- 20210129 09:19 Impact Index (antagonistic) (sum)
- 20210305 07:47 Impact Index (sum)

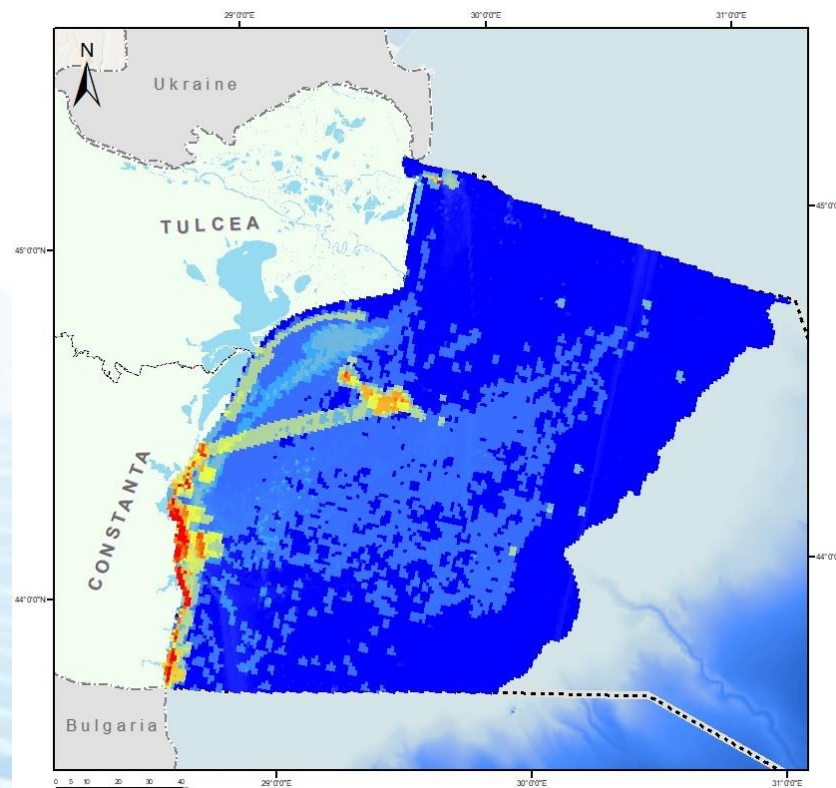
Display content
 Selected data (raw) Selected data (processed)

Common borders. Common solutions.

Step 8 - Export the results and visualization in a GIS program



Stressor index (unweighted)
based only on human activities

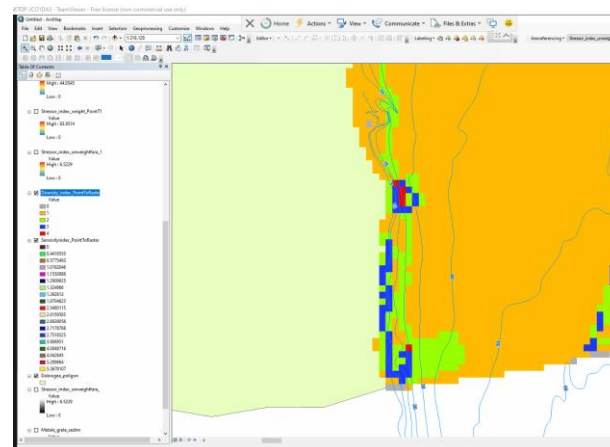
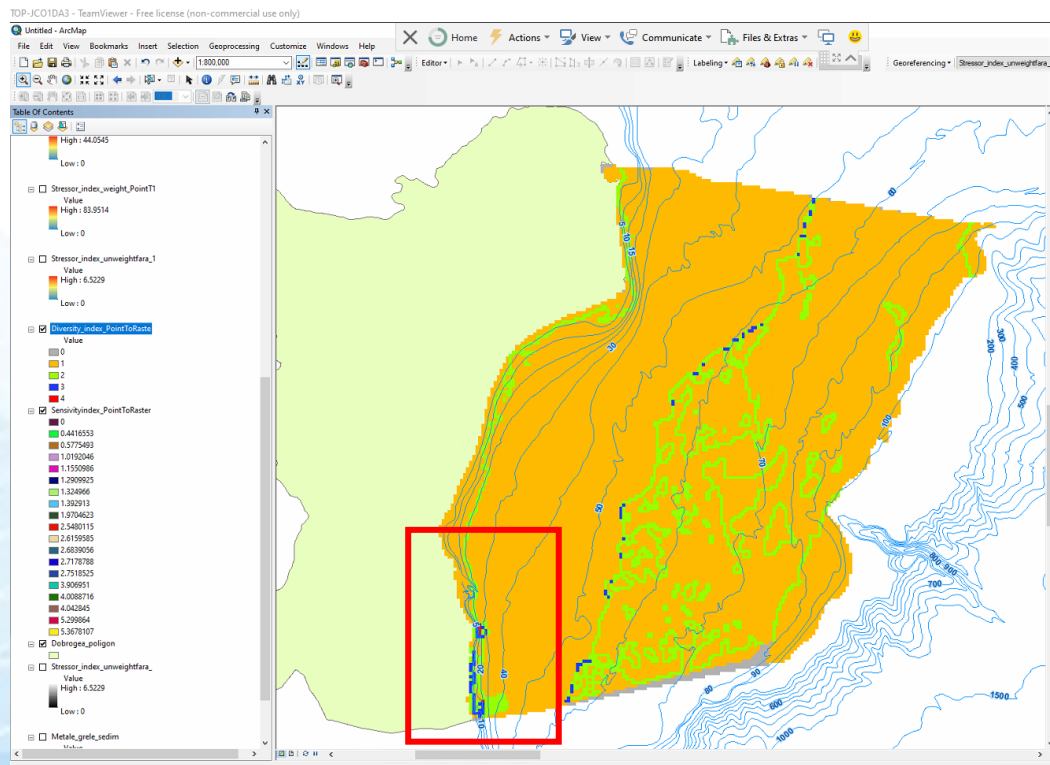




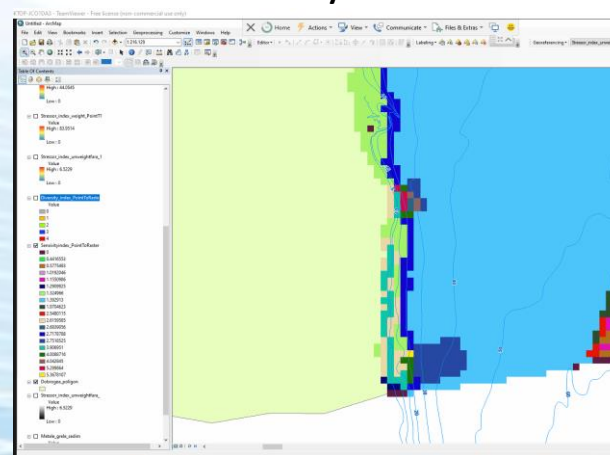
Common borders. Common solutions.



Diversity index

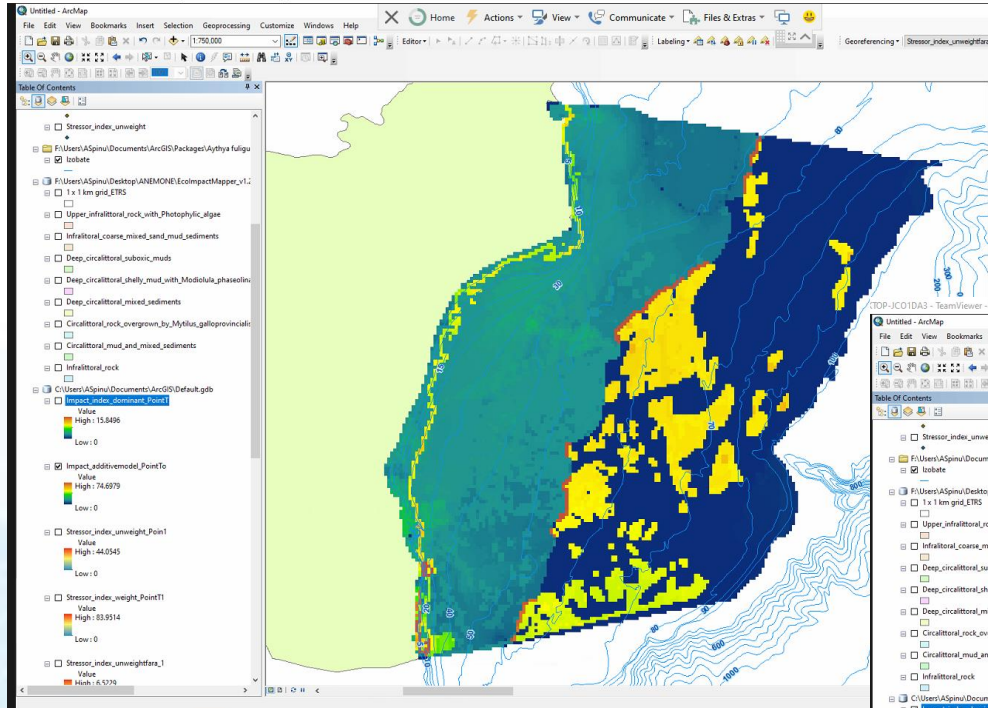


Sensivity index

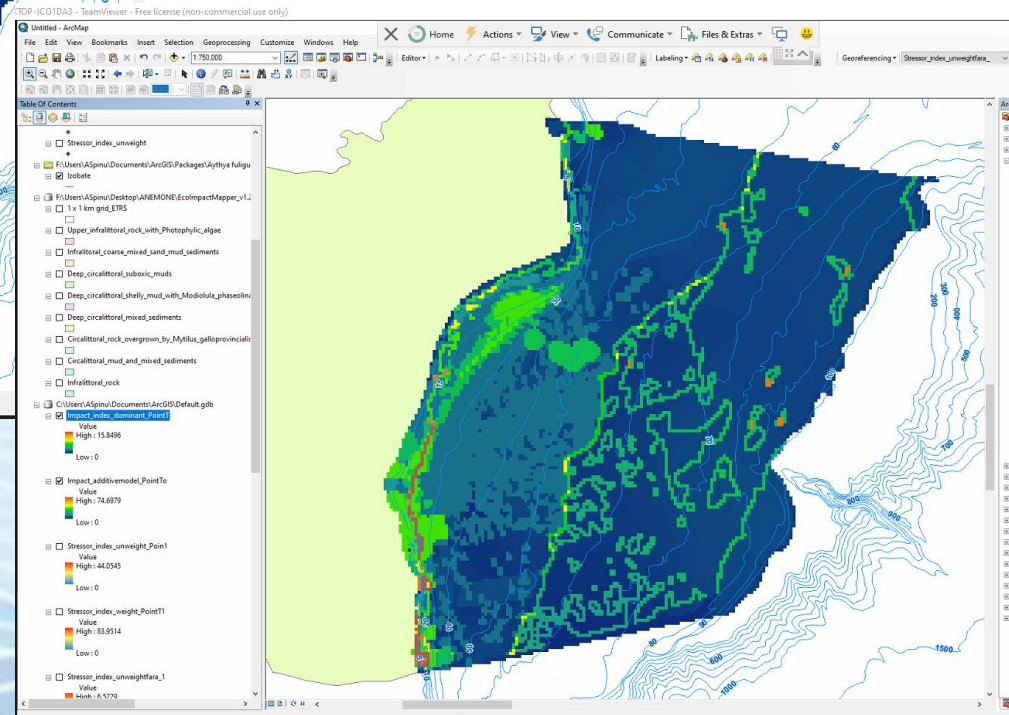


Common borders. Common solutions.

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Impact index using dominant
stressor model (sum)



Impact index using additive model (sum)

CONCLUSIONS

- EIM tool can not replace general-purpose Geographical Information System (GIS) software or support the whole mapping process from raw data acquisition to publication-quality visualization
- can handle only one input data format (CSV) that should be obtain before in another GIS program. All spatial input data must have the same spatial resolution, extent and coordinate reference system and EIM is **very sensitive** to data format
- Have only basic visualization functions and no other functionalities (zoom-in, zoom-out, select, query, labelling etc)

BUT

- once all data are correct uploaded – is very easy to calculate diversity and impact indexes
- EcoImpactMapper simplify a time-consuming and difficult part of producing human impact maps

The EcoImpactMapper is thus not a stand-alone tool, but must be used in combination with other software for data preparation and for creating high quality maps



Common borders. Common solutions.

While the EcolmpactMapper makes it easier to use Halpern et al.'s model, considerable technical skills, scientific understanding are needed for data preparation. Original stressor and ecosystem component data come in many formats: Presence-absence or continuous; raster data or points, lines and polygons; they may cover the whole study area (e.g. sea surface temperature anomalies) or only exist in small, isolated locations (e.g. offshore oil platforms). Some data sets may have gaps that must be filled.

- EIM achieves better results with a greater amount of data for both stressors and ecosystem components and for a larger area of interest
- For better results, the input data should be represented by continuous distribution or ranking (classify) rather than absence/presence (if they can be represented in this way)
 - ✓ ex: ecosystem components (fish/ mammals/phytoplankton/ birds) etc should be represented like biomass/ no of individuals rather than only absence/presence

The tool could be a very useful instrument for authorities/ stakeholders in the process of planning and decision making (ex. maritime spatial planning, designation of MPA, ICZM etc)



Common borders. Common solutions.

WHAT'S NEXT ?

- To complete the data both for pressures/stressors and ecosystem components - ideally we should have all the data
- To develop a methodology and algorithm in order to calculate and integrate the sensitivity scores weight based on Halpern model instead of “expert judgment scores” and raking the pressures intensity
- To extend the study area for entire Black Sea or at least for a regional part
 - EMODNET network (Human activities) has some data but not complete for BS basin