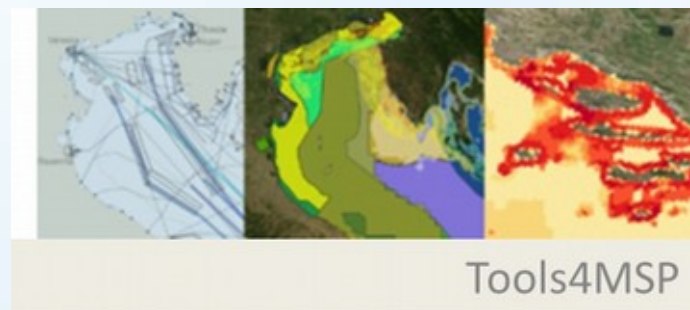


Cumulative Impact Assessment tool developed during ADRIPLAN project (... and further advancements)

Stefano Menegon, Daniel Depellegrin, Alessandro Sarretta, Elena Gissi

CNR-ISMAR Venice, Italy

University IUAV of Venice



A work in progress



EU Project **ADRIPLAN**

ADRIatic Ionian maritime spatial
PLANning, (DG-MARE 2013-2015)

Scale: Adriatic-Ionian macroregion

Software: experimental



Italian National Flagship Project

RITMARE

Ricerca Italiana per il Mare
(2012 – **2016** – **2017**)

Scale: local/regional high resolution

Software: Tools4MSP



EU Project **SUPREME**

Supporting maritime spatial
Planning in the Eastern
Mediterranean

(DG-MARE EASME 2017-2018)

Scale: regional / transboundary

Software: tools4MSP



Portodimare

EU Project **Portodimare**

geoPORtal of TOols & Data for
sustainable Management of coAstal
and maRine Environment

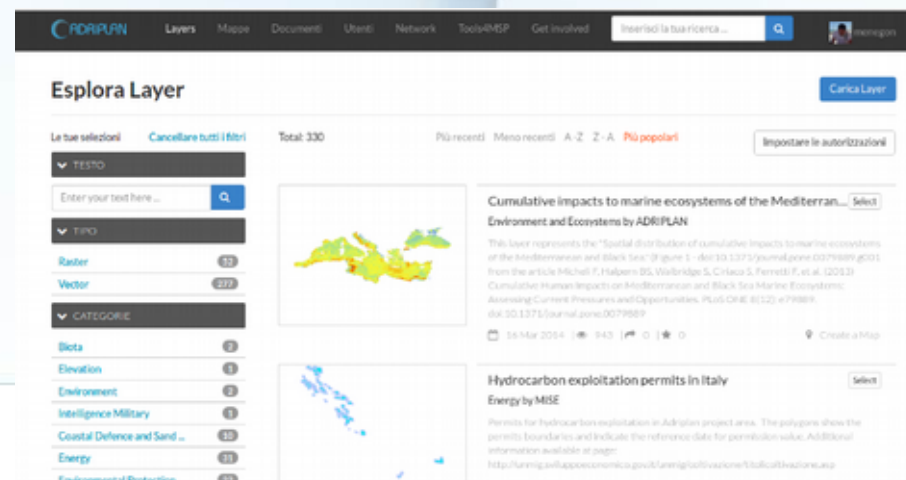
(ADRION 2018-2019)

Tools4MSP: an MSP-driven web platform

- A community-based and open-source collaborative platform
- Based on GeoNode software for sharing geospatial information and for developing Spatial Data Infrastructure (SDI)
- **Implements multi-objective tools for MSP:** Sea Use Conflict analysis (COEXIST methodology), Cumulative Effects Assessment, Ecosystem services
- Pre-processing **pipelines** for data preparation
- A webtool and a standalone library

ADRIPLAN Portal

<http://data.adriplan.eu>



Esplora Layer

Le tue selezioni: Cancellare tutti i filtri

Total: 330

Mostra recenti: Meno recenti: A-Z: Z-A: Più popolari

Impostare le autorizzazioni

TESTO

Enter your text here...

TIPO

Raster: 33

Vector: 277

CATEGORIE

Biota: 2

Elevation: 1

Environment: 2

Intelligence Military: 1

Coastal Defence and Sand...: 13

Energy: 11

Environmental Protection: 1

Cumulative impacts to marine ecosystems of the Mediterranean... Environment and Ecosystems by ADRIPLAN

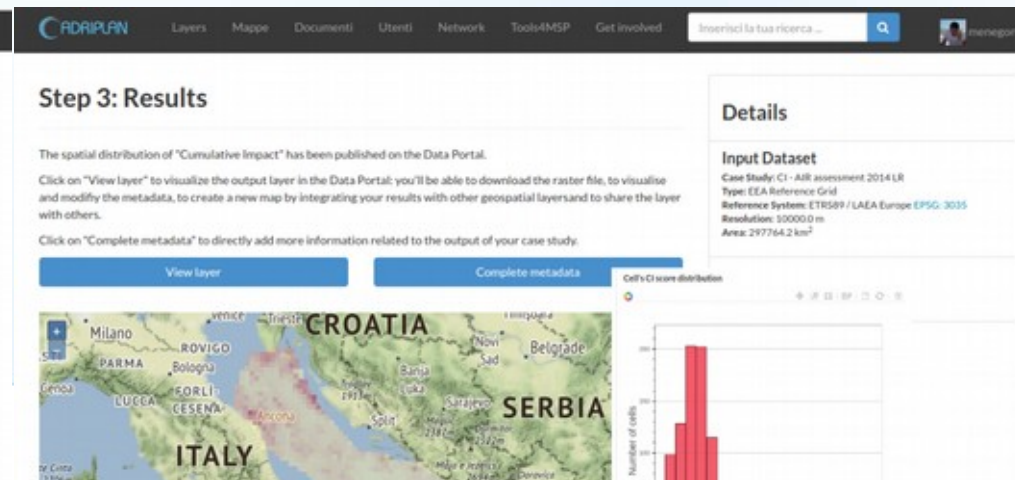
This layer represents the "Spatial distribution of cumulative impacts to marine ecosystems of the Mediterranean and Black Sea" (Figure 1 - doi:10.1371/journal.pone.0079889.g001) from the article: Michael P. Halpern, B.S. Walbridge, S. Crespo, S. Ferrel, F. et al. (2013) Cumulative Human Impacts on Mediterranean and Black Sea Marine Ecosystems: Assessing Current Pressures and Opportunities. PLoS ONE 8(12): e79889. doi:10.1371/journal.pone.0079889

18-Mar-2014 | 943 | 1 | 0 | 0

Create a Map

Hydrocarbon exploitation permits in Italy Energy by MSE

Permits for hydrocarbon exploitation in Adriatic project area. The polygons show the permits boundaries and indicate the reference data for permit value. Additional information available at page: <http://univg.it/rapporti-economici/geografia/pubblicazioni/italy/italy-environment.asp>



Step 3: Results

The spatial distribution of "Cumulative Impact" has been published on the Data Portal.

Click on "View layer" to visualize the output layer in the Data Portal: you'll be able to download the raster file, to visualise and modify the metadata, to create a new map by integrating your results with other geospatial layers and to share the layer with others.

Click on "Complete metadata" to directly add more information related to the output of your case study.

View layer **Complete metadata**

Details

Input Dataset

Case Study: C1 - All assessment 2014 LR

Type: EEA Reference Grid

Reference System: ETRS89 / LAEA Europe EPSG: 3035

Resolution: 10000.0 m

Area: 297764.2 km²

Cell's CI score distribution

Number of cells

Map showing the spatial distribution of "Cumulative Impact" in the Adriatic region, including labels for Italy, Croatia, and Serbia.

Tools4MSP: webtool workflow

Step 0: tool selection

CEA - Cumulative Effects Assessment
SUC - Sea Use Conflict
ES – Ecosystem Services Capacity

Step 1: case study selection

Case study: a pre-configured, complete and consistent set of input data. Spatial domain, time reference, resolution.

Step 2: configuration

Dataset configuration: select uses, environmental components and pressures.
Study area selection

Step 3: results

Geospatial results: automatic republishing
Statistical outputs

Step 2: configuration

Tools4MSP / Step1 / Step2

Step 2: Case Study Setup

a) Configure the list of "Activities and uses" and "Environmental Components" to be included in your case study. (NOTE: By default the case study runs with all Activities/Uses and Environmental Components).

b) Select the area of interest for your scenario analysis on the map interface: click with your mouse to define the vertices of the polygon and double click to confirm.

c) Press RUN ANALYSIS.

Activities & Uses

Available: 13 - Selected: 13

Configure

Environmental Comp.

Available: 28 - Selected: 28

Configure

Pressures

Available: 24 - Selected: 24

Configure



Configuration

Input Dataset

Case Study: Italian Adriatic Sea 2017 - Cumulative Impact
Type: EEA Reference Grid
Reference System: ETRS89 / LAEA Europe [EPSG: 3035](#)
Resolution: 1000.0 m
Area: km²

Analysis Area

By default the analyses will be performed for the whole input grid.

The user can draw a new area of analysis (polygon) on the map.

Run Analysis

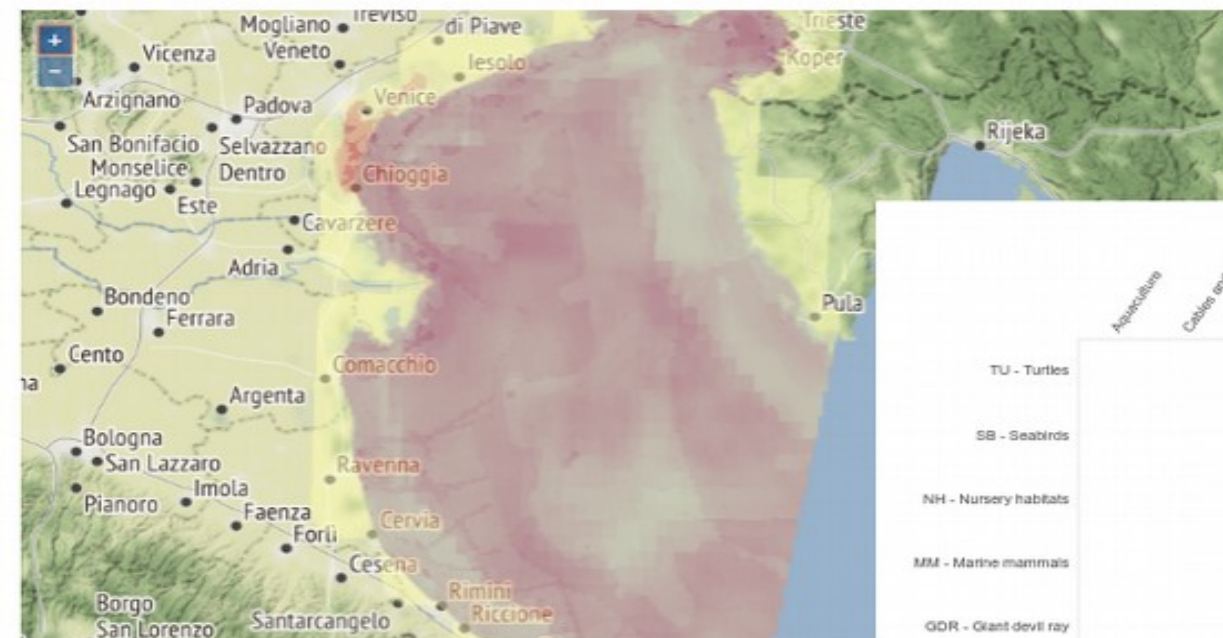
Step 3: results

Step 3: Results

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[View layer](#)
[Complete metadata](#)


Details

Input Dataset

Case Study: Italian Adriatic Sea 2017 - Cumulative Impact
 Type: EEA Reference Grid
 Reference System: ETRS89 / LAEA Europe [EPSG: 3035](#)
 Resolution: 1000.0 m
 Area: km²

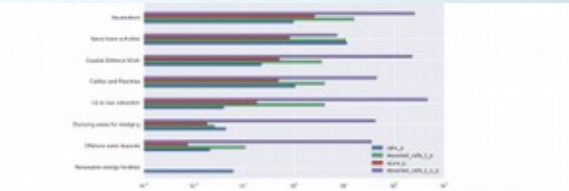
Cumulative Impact Scores

Total score: 58324.852

	Aquaculture	Cables and Pipelines	Coastal Defence Work	Coastal and Maritime Tourism	Fishing	Land based activities	Maritime Transport	Military Areas	Naval base activities	Offshore wind deposits	Oil & Gas extraction	Sum
TU - Turtles					0.33		1.25	1	0.22			0.39
SB - Seabirds			0.95	0.95			0.95	1			0.95	0.95
NH - Nursery habitats					1.45			1				0.31
MM - Marine mammals			0.44	0.33	0.64		1.3	1			0.72	1
GDR - Giant devil ray					0.95			1				

Tools4MSP:

geopython standalone library



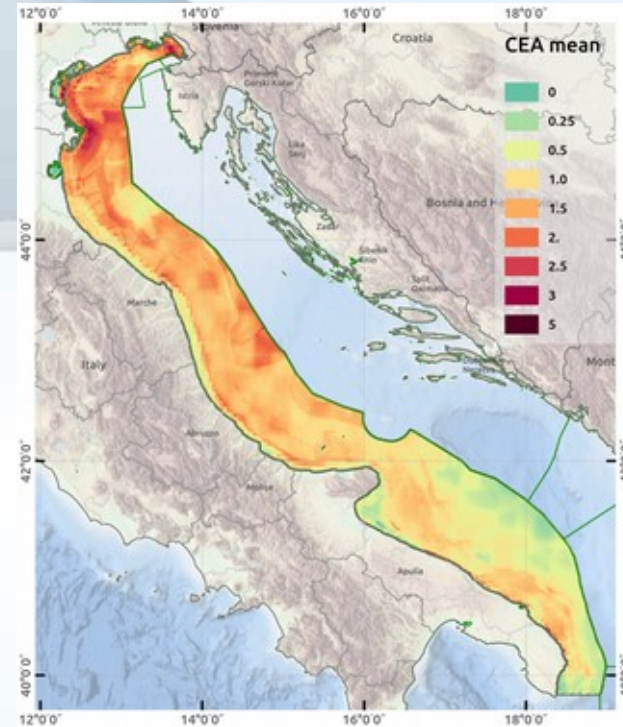
```
In [29]: uses_df.sort('score', ascending=False)[0:5].score.p.sum()
Out[29]: 91.001145435379133

In [30]: uses_df.sort('score', ascending=False)[0:5]
Out[30]:
```

	label	cells	impacted cells	score	score p	cells p	impacted cells p	impacted ce
Threading	Threading	59412.0	152789	3007.76713638	63.369502	32701740	153.674343	50.254118
Maritime	Maritime	73906.0	150304	60037.303457	26.279405	24.937416	198.289312	49.463244
Small	Small	12825.0	68347	19196.726212	8.278365	11.126901	202.060606	22.483063
Coastal	Coastal	78822.0	81560	16225.706253	7.000809	25.270877	106.267504	26.829565
Military	Military	46301.0	81428	14297.941269	6.185128	15.230843	132.672001	20.207044

```
In [31]: fig = plt.figure(figsize=[20,16])
m = draw_map(1, True, logcolor=True, maptype='full', cmap='OrRd')
m.imshow(ADM1PLAN_000,
         layers = ['geomodel:legalstatus line 1'], transparent=True)
plt.savefig('adriplan.html_dir = 'c:\img')
plt.show() # 700: aggiungere valori del grafico precedente anche qui
nrows = int(math.ceil(len(closures) / 3.))
f, axs = plt.subplots(nrows, 3, figsize=[20, 40])
for ax, (u, d) in zip(axs.flat, closures.items()):
    ax.imshow(d, cmap='jet')
    xlabel = casesstudy.layers.loc[u, 'label']
    subtotal = d.sum()
    title = '{ } - { } in ci = { } ({ } %).format(u, xlabel, int(subtotal), round(100 * u
    subtotal/totalcore, 2))
    ax.set_title(title)
```

http://server.arcgisonline.com/ArcGIS/rest/services/ESRI_Imagery_World_2D/MapServer/ex
 port?token=4437000_00002_1527999_99991_5482000_0001_2527999_99994&cache=38355&mapId=3
 915&size=2000,2028&dpi=96&format=png32&f=image



- Advanced analysis
- Rapid prototyping
- Jupyter notebook integration
- Possibility to work on a local copy of the Case Study dataset

<https://github.com/CNR-ISMAR/tools4msp>

Tools4MSP: CEA Model

Implements an advanced CEA model

- 1) **Mecf = Multi effect combination factor**
(additive, dominant and antagonist stressor effects)

$$CEA = \sum_{k=1}^n d(E_k) \left(\overbrace{\sum_{j=1}^m s_{j,k} (1 - mec f_k) eff(P_j, E_k)}^{\text{Additive model}} + \overbrace{\max_{j=1}^m s_{j,k} mec f_k eff(P_j, E_k)}^{\text{Dominant model}} \right)$$

- 2) **effect = Effect exerted by a Pressure**

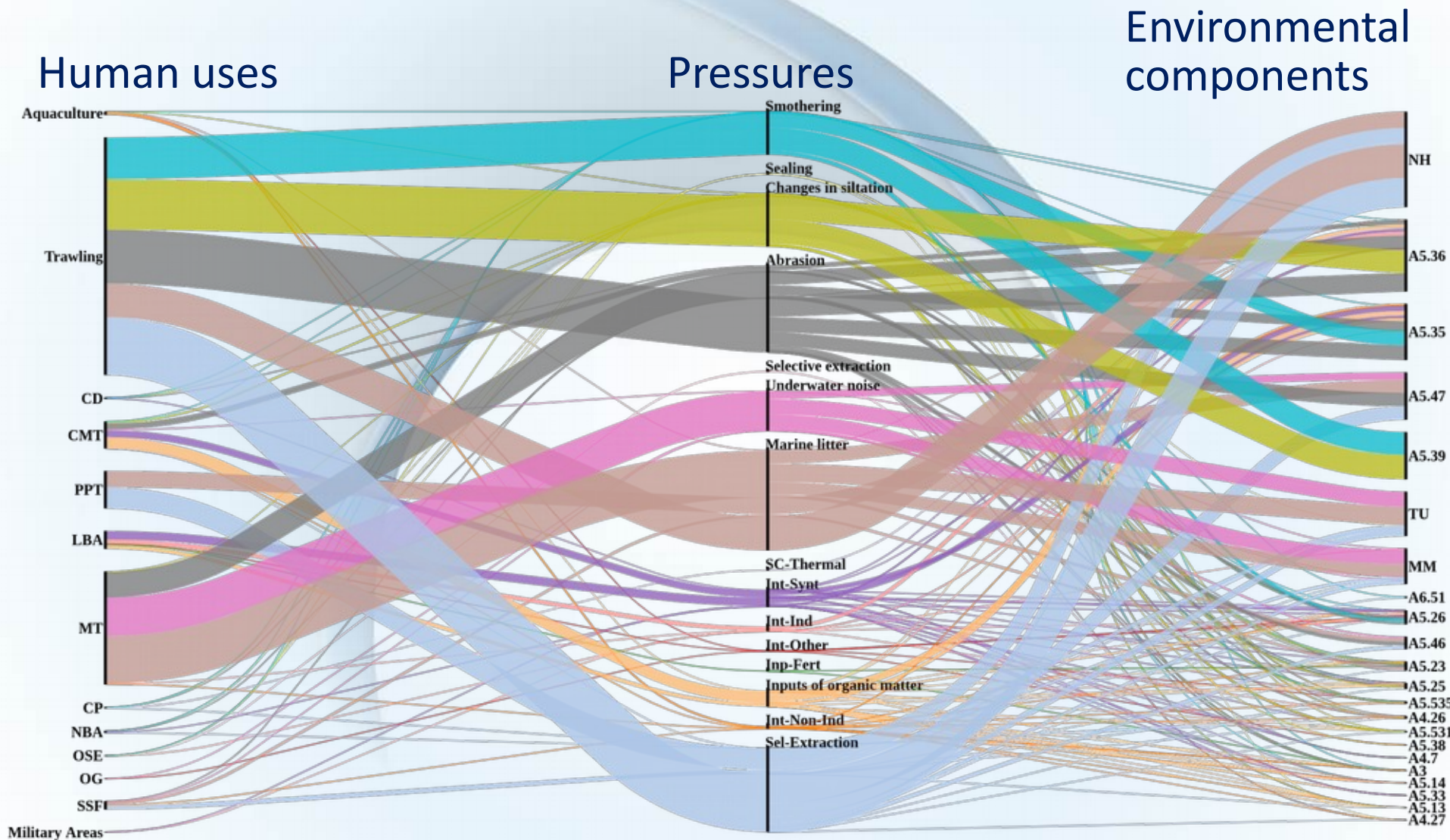
$$eff(P_j, E_k) = rfunc_{j,k} \left(\left(\sum_{i=1}^l w_{i,j,k} i(U_i, M_{i,j,k}) \right)' \right)$$

- 3) **Rfunc = Response function**
(e.g. Linear, non-Linear, Threshold function)

- 4) **i = Distance Model**
(e.g. gaussian convolution)

Tools4MSP: CEA impact chain

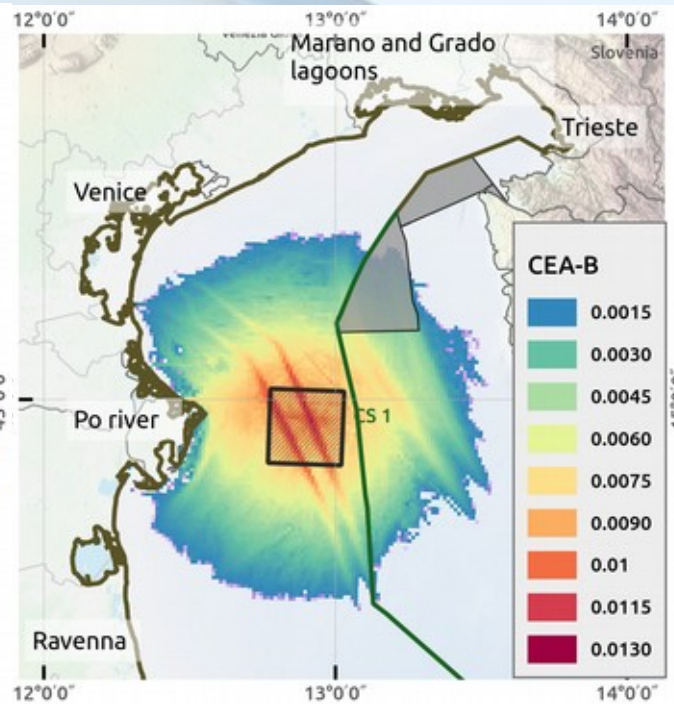
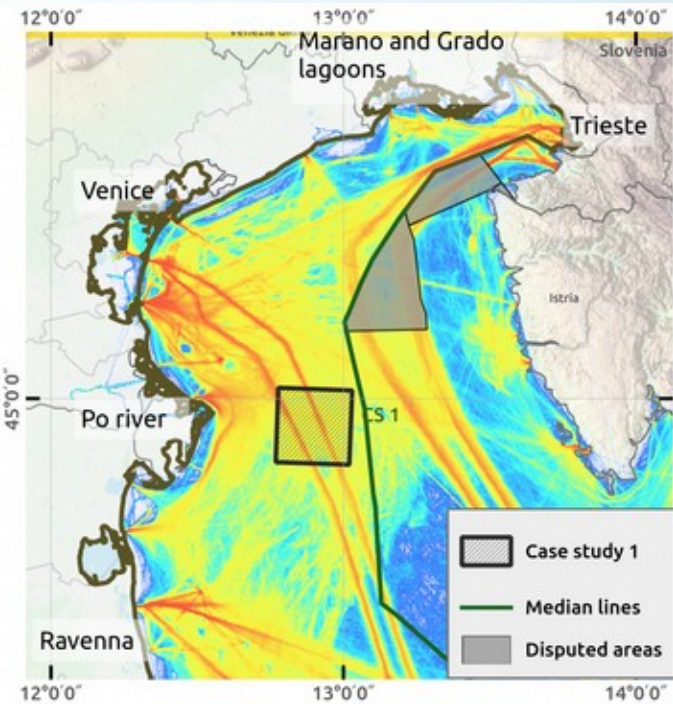
Source-pressure-receptor linkage



CEA impact chain visualization tool (Sankey diagrams)

Tools4MSP: CEA Backsourcing (CEA-B)

CEA-B is an inverse CEA model

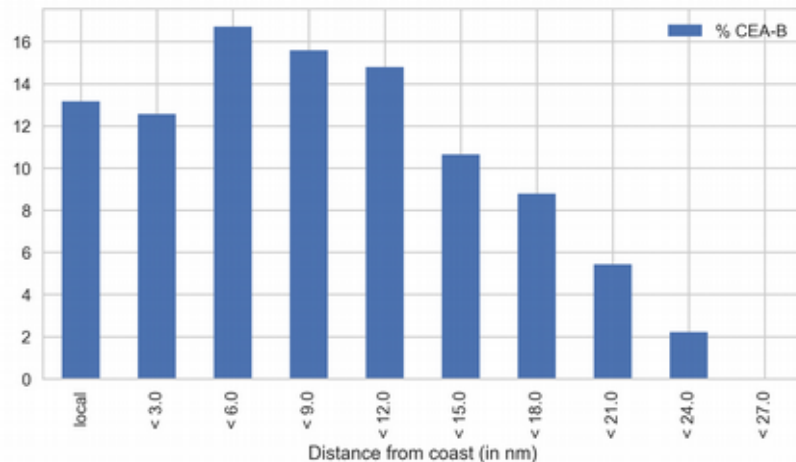


Case Study:

U: Marine traffic

P: Underwater noise

E: Loggerhead
Turtles

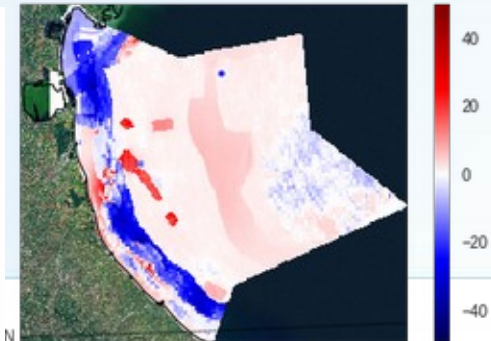
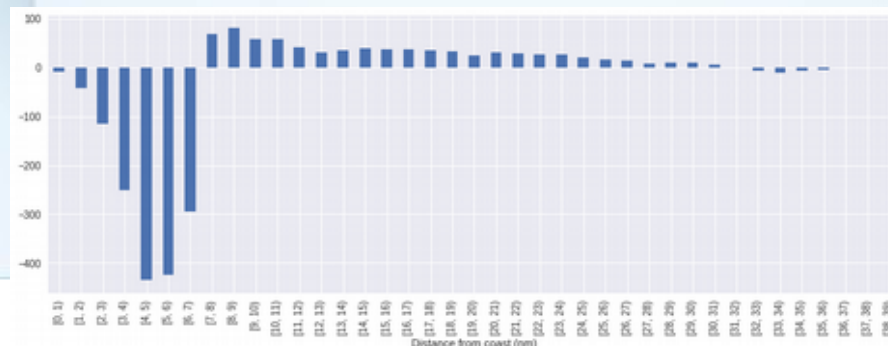


To identify and quantify sources of anthropogenic pressures affecting receptors/environmental components

**Transboundary effects
spatialization**

Tools4MSP: Advantages

- The webtool requires **little technical skills**
- Coupling with **SDI** simplifies the access to datasets and also the publish of spatial outputs
- The **pipeline** approach for data pre-processing offers dynamic instruments to define and combine layers, customize case studies and eases data integration of novel datasets for the re-run
- Moreover, the pre-processing pipeline fosters **transparency** and **replicability**
- The multi-objective Case Studies approach offers core functionalities and could be **easily extended** with new MSP-oriented tools
- Model outputs can be used to **evaluate different management actions or evaluate alternative scenarios** through the comparison of two or more case studies



Tools4MSP: Next steps

Methodological

- ➡ Direct incorporation of uncertainty and sensitivity assessments

 Ecological

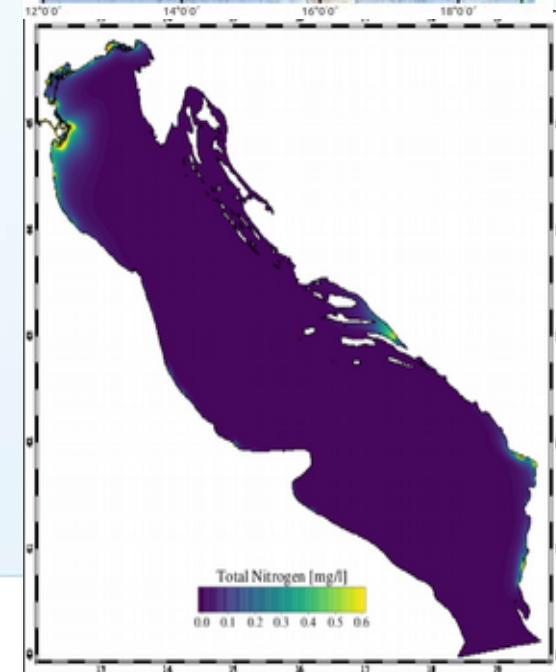
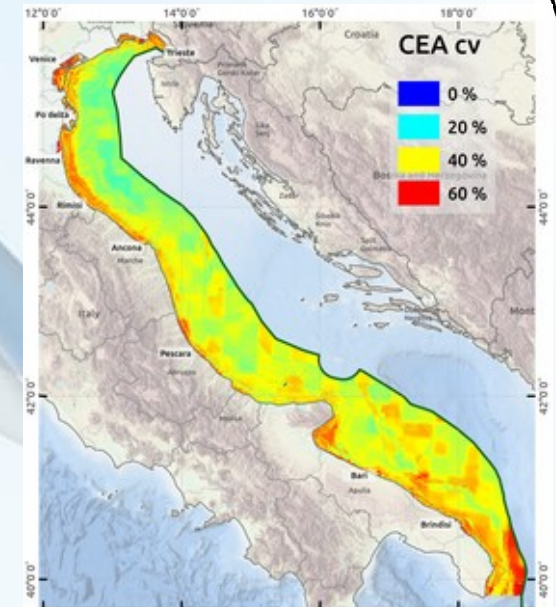
- ## ➡ Improve the Ecosystem Services Capacity analysis

IT Infrastructure (EU Project Portodimare)

- ➡ Implement a full operational platform
- ➡ Address EMODNET, Copernicus, INSPIRE operational linkages

Functionalities

- ➡ Improve the Graphical User Interface
- ➡ Allow analyses of user/custom datasets



Tools4MSP: Open issues

- Deal with **input data heterogeneity**
- Software-design and developing issues
 - ➔ **Flexibility–usability** tradeoff
 - ➔ Performance & scalability
 - ➔ Avoid excessive consumption of resources (for the webtool):
limitation strategies
- Several model inputs (especially sensitivities, multi-effects combination factor and response functions) are **source of uncertainty** with very little knowledge availability
- Account the **baseline conditions** (e.g. Good Environmental Status)
- Related to MSP process
 - ➔ Towards a more integrated and **multi-functional** perspective
 - ➔ Acceptability and usability in the science-policy interface (e.g. Precautionary Principle to inform decision makers)

Developing a modelling framework for MSP-oriented cumulative effects assessment: A case study for the Italian Adriatic Sea

Stefano Menegon^{a,1,*}, Daniel Depellegrin^{a,1}, Giulio Farella^a, Elena Gissi^b, Alessandro Sarretta^a, Chiara Venier^a,
Andrea Barbanti^a

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^bDepartment of Design and Planning in Complex Environments, Università Iuav di Venezia, Venice, Italy

ment 609 (2017) 1627-1639

Available at ScienceDirect

total Environment



journal homepage: www.elsevier.com/locate/scitotenv

Multi-objective spatial tools to inform maritime spatial planning in the Adriatic Sea

Daniel Depellegrin^{a,*,1}, Stefano Menegon^{a,1}, Giulio Farella^a, Michol Ghezzi^a, Elena Gissi^b,
Alessandro Sarretta^a, Chiara Venier^a, Andrea Barbanti^a

^a CNR - National Research Council of Italy, ISMAR - Institute of Marine Sciences, Venice, Italy

^b Department of Design and Planning in Complex Environments, Università Iuav di Venezia, Venice, Italy



RESEARCH ARTICLE

Addressing uncertainty in modelling cumulative impacts within maritime spatial planning in the Adriatic and Ionian region

Elena Gissi^{1,*,}, Stefano Menegon^{2,}, Alessandro Sarretta², Federica Appiotti^{1,†},
Denis Maragno^{1,†}, Andrea Vianello^{2,†}, Daniel Depellegrin^{2,†}, Chiara Venier²,
Andrea Barbanti²

¹ Department of Design and Planning in Complex Environments, Università Iuav di Venezia, Venice, Italy,

² Institute of Marine Sciences, National Research Council, Venice, Italy

PeerJ Preprints

Open source tools to support Integrated Coastal Management and Maritime Spatial Planning

Stefano Menegon¹, Alessandro Sarretta¹, Andrea Barbanti¹, Elena Gissi², and Chiara
Venier¹

¹ Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine (CNR-ISMAR), Arsenale - Tesa 104, Castello
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***Modelers, Data Scientists, Environmental
Engineers, Planners, Marine Ecologists ...***