CIA TOOL

Milestone MS4.3 of the WP4. Tools development and models application. Project 101081304 – ReMAP – EMFAF-2021-PIA-MSP

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TABLE OF CONTENTS

1 ADAPTATIONS FROM THE CONCEPTUAL MODULE

The Cumulative Impact Assessment (CIA) conceptual module aimed to provide the methodology and data requirements for human activities and environmental datasets needed to carry out the analysis foreseen by the module (Shinoda et al, 2023). The module builds on top of the Spatial Pressures and Impact Assessment (SPIA) tool, which draws from Halpern et al (2008) methodology that was initially employed in the first HELCOM holistic assessment (HOLAS) (HELCOM, 2010). This method has since undergone further refinement for subsequent HELCOM assessments, along with the SPIA tool development itself, including the second HELCOM 'State of the Baltic Sea' holistic assessment (HOLAS 2) (HELCOM, 2018a; HELCOM, 2018b) and the third holistic assessment of the Baltic Sea (HOLAS 3) (HELCOM, 2023). The main aim of this module was to develop a tool that supports the easier and more replicable use of SPIA by automating the production of the input raster layers (intermediate layers) for SPIA.

During the development of this tool, several adaptations were identified as necessary due to data availability issues, need to replicate the use of the tool in different sea areas and limited available documentation of the SPIA methodology from its previous application cycles, particularly regarding the geoprocessing steps for human activities datasets required to develop the various pressure layers.

For this reason, an adaptation process was structured in different stages. The process aimed at, first, clarify the steps and standardize the description of geoprocessing rules for both human activities and ecosystem components to ensure their seamless integration into the tool. Second, to adapt the use of the tool across different sea areas and aligned with available data from open data portals and other accessible sources. Below, in Figure 1, is the description of the stages and steps adopted in the methodological adaptation for the tool development that will be further described in this section.

Stage 1 - HELCOM pressure layers
- Compilation of Geoprocessing rules
- Discussion and Clarification
- Tool development
- Tool testing and fine-tuning
- Methodology revision

Stage 2 - HOLAS complementary processes
- Revision of data availability
- Description of geoprocessing rules for pressure layers not available

Stage 3 - Ecosystem Components
- Compilation of Geoprocessing rules
- Discussion and Clarification
- Tool development
- Tool testing and fine-tuning
- Methodology revision

Stage 4 - Sensitivity scores
- Collaborative survey
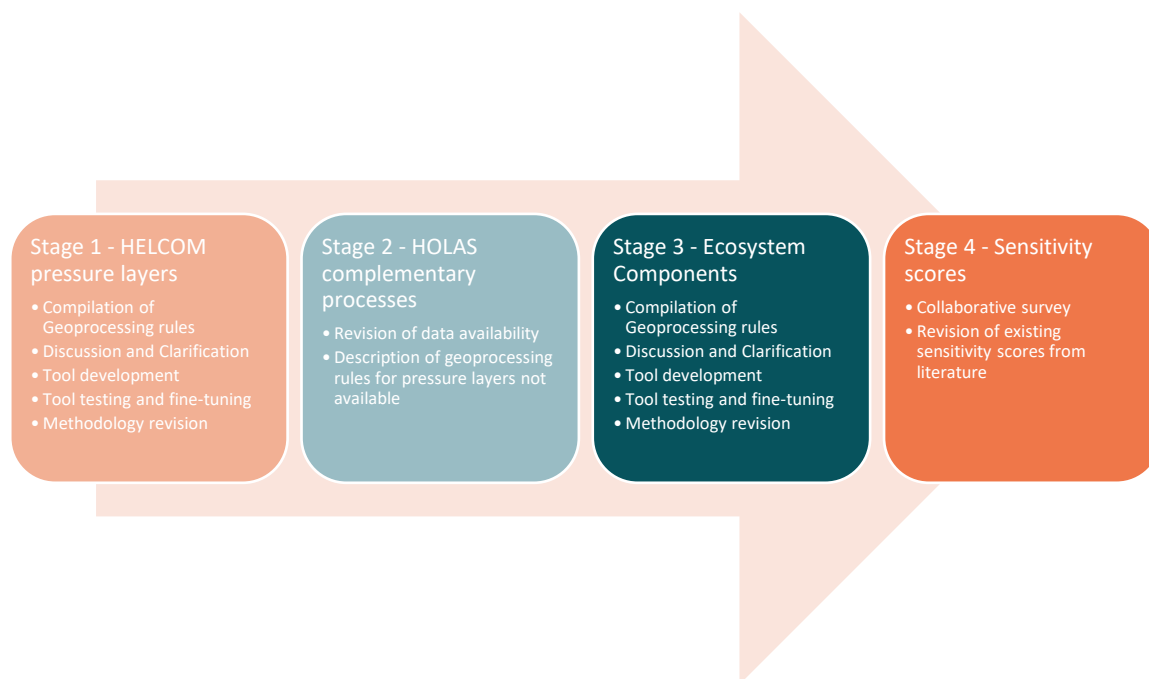- Revision of existing sensitivity scores from literature

Figure 1: Stages and steps of the adaptation of the conceptual module

General information regarding the data collection and availability for the analysis, which needed to be compiled to structure the adaptations, is provided in **Attachment 6**.

1.1 STAGE 1 – HELCOM PRESSURE LAYERS

Stage 1 focused on revising the pressure layers produced by HELCOM in the last HOLAS holistic assessment for the Baltic Sea. List of pressure layers used in HOLAS assessment stems from MSFD Annex III. Several steps were followed within this stage due to limitations in the documentation of SPIA methodology from its previous application cycles. The original documentation allowed for a high degree of discretion in data processing. To standardize and clarify the methodology, all geoprocessing steps were systematically organized into a table (Annex 1) detailing steps for processing each pressure layer.

The process followed the steps:

1. **Compilation of Geoprocessing Rules**: All geoprocessing steps were systematically compiled into a comprehensive set of rules.
2. **Discussion and Clarification**: The compiled geoprocessing rules were revised through a series of collaborative discussions within the HELCOM team responsible for SPIA, with the goal of reaching consensus on the rules' revision and final description to be incorporated in the tool development. This process aimed to ensure consistency and accuracy in the methodological steps and was parallel with the tool development and testing.
3. **Tool Development**: The raster tool was developed as ArcGIS Pro Python toolbox, designed to operationalize the geoprocessing rules.
4. **Tool Testing and Fine-Tuning**: The tool underwent extensive testing, with adjustments made to optimize its functionality.
5. **Methodology Revision**: When necessary, the methodology was revisited and revised to address issues identified during testing, including the need to adapt the tool for the data available via the online validation tool (https://github.com/helcomsecretariat/Validation-tool---ReMAP) (Shinoda et al., 2024) and open access data collected by HELCOM from different data portals.

Regarding the data collection mentioned in step 5, further information on the open access data collected by HELCOM and the necessary adaptations is provided in **Attachment 1**. The adaptations related to the data submitted via online validation tool are available in **Attachment 2**, these were defined in collaboration with the data providers from the different sea areas, based on meetings discussing data availability and the available formats.

The final compilation of adaptations to the geoprocessing rules methodology for Stage 1 is provided in **Attachment 3**.

1.2 STAGE 2 – HOLAS COMPLEMENTARY PROCESSES

Stage 2 aimed to address the pressure layers that are produced through other processes within HOLAS, such as the HOLAS integrated assessments (e.g. hazardous substances) or thematic analysis (e.g. input of continuous anthropogenic sound). Since these pressure layers are a result from complex analyses involving

the application of specialized tools and are developed by experts in their respective fields, ReMAP prioritized the use of already produced pressure layers when they were available.

All datasets used, their sources and the adaptations applied to their use are listed in **Attachment 4**.

1.3 STAGE 3 – ECOSYSTEM COMPONENTS

Similarly to stage 1, stage 3 focused on revising the geoprocessing rules for ecosystem components production, all geoprocessing steps were systematically organized into a table (Annex 1).

The process followed the steps:

1. **Compilation of Geoprocessing Rules**: All geoprocessing steps were systematically compiled into a comprehensive set of rules.
2. **Discussion and Clarification**: The compiled rules were reviewed through a series of collaborative discussions within the HELCOM team responsible for SPIA, with the goal of reaching consensus on the rules' revision and final description to be incorporated in the tool development. This process aimed to ensure consistency and accuracy in the methodological steps and was parallel with the tool development and testing.
3. **Tool Development**: The raster tool was developed, designed to operationalize the geoprocessing rules.
4. **Tool Testing and Fine-Tuning**: The tool underwent extensive testing, with adjustments made to optimize its functionality.
5. **Methodology Revision**: When necessary, the methodology was revisited and revised to address issues identified during testing.

No adaptations were applied on the data provided via the online validation tool. Details on the adaptations applied in the open access data collected from data portals is provided in **Attachment 5**.

1.4 STAGE 4 – SENSITIVITY SCORES

To adapt the SPIA methodology to other sea areas, the sensitivity scores required revision to account for the different ecosystem components present in those areas. This process began with the revision of available ecosystem components data, conducted in collaboration with data providers. Based on the identified data availability, a survey (Annex 2) was jointly developed by the ReMAP, MSP4BIO and MSP4Biodiversity projects to collect sensitivity scores from experts in the Northwestern Mediterranean identified during the development of the module (Shinoda et al., 2023). However, due to a low response rate, 3 out of 33, a literature review for sensitivity scores was also conducted and, as a result, the sensitivity scores from Korpinen et al. (2019) will be adopted in the analysis.

2 TOOL AND USER INSTRUCTIONS

The SPIA intermediate layers tool was developed to automatically rasterize input datasets representing the spatial distribution of human uses and ecosystem components, or intermediate layers, within the area of analysis. Its objective is to simplify the use of the SPIA tool, by incorporating all the geoprocessing steps applied to each input dataset, as well as the aggregation processes into an automated process. Furthermore, this tool allows the replication of the methodology to different sea areas by providing a template with the data format used by the tool.

The tool was conceptualized to be applied in three different sea areas covering different scales, the Baltic Sea Region, the Northwest Mediterranean and Galicia. The requirements for the different datasets are based on the characteristics of those areas, however, the tool can be adapted to be applied in any location, given that local characteristics (e.g. species, habitats) are incorporated in the tool.

The tool and related information are available on GitHub and can be accessed by this link (https://github.com/helcomsecretariat/SPIA-intermediate-layers-tool---ReMAP), which contains:

- SPIA intermediate layers ArcGIS Pro toolbox with Python source code
- Configuration files containing geoprocessing rules for pressure layers and ecosystem components
- Data template folder
- Table with detailed description of the geoprocessing rules incorporated in the tool for both human activities and ecosystem components
- Report with user instructions

Below, the instructions are divided into two sections. Section 2.1 provides the structure for the input data needed for the tool, which is fundamental to ensure its correct functioning. Section 2.2 provides user instructions to use the SPIA intermediate layer tool. Detailed technical information for the tool can be found on Attachment 8.

2.1 INPUT DATA STRUCTURE

A template for the data structure to feed the tool is provided together with the tool in GitHub. We strongly recommend its use for SPIA intermediate layer tool, as the structure, including required attributes used for analysis, is needed to carry out the analysis. The template is composed of ESRI file geodatabases for each one of the main elements needed in this analysis and the datasets and format information are listed in detail in **Attachment 7**. Datasets used in the tool derive from Stage 1 (section 1.1) and 3 (section 1.3) described above.

Please note that the input dataset name codes, attributes and values must be strictly followed to ensure the tool correctly processes the dataset. Additionally, all datasets included in the provided template, including raster format, must be available in the respective ESRI file geodatabase for a successful tool processing.

The data is structured into 3 main elements, which are provided in the template as file geodatabase:

1. **background.gdb**: An ESRI file geodatabase containing background datasets for the study area, which are all mandatory for the analysis. The geodatabase contains the following datasets:
    a. Study area borders in vector polygon format (dataset name: study_area)
    b. 1 square km grid of the study area in vector polygon format (dataset name: grid_vector)
    c. 1 square km grid of the study area in raster format (dataset name: grid_raster)
    d. Bathymetry of the study area with the highest available resolution in raster format (dataset name: bathymetry)
    e. National areas from the EEZ to the land borders of the study area in vector polygon format (dataset name: EEZ_and_land_borders_poly)
    f. Rivers polylines within the study area (dataset name: rivers_polyline)
2. **Human_activities_and_pressures.gdb**: An ESRI file geodatabase containing human activities and pressures datasets, a detailed list with all required attributes is provided on **Attachment 7**.
3. **Ecosystem_components.gdb**: An ESRI file geodatabase containing ecosystem components datasets, a detailed list with all required attributes is provided on **Attachment 7**.

2.2 SPIA INTERMEDIATE LAYERS TOOL

The SPIA intermediate layers tool is an ArcGIS Pro toolbox developed for ArcGIS Pro version 3.x, consisting of two primary scripts (Figure 2):

1. Ecosystem Components – EC: Designed to generate processed ecosystem components.
2. Pressure Layers – PL: Designed to process human activity data into pressure layers.
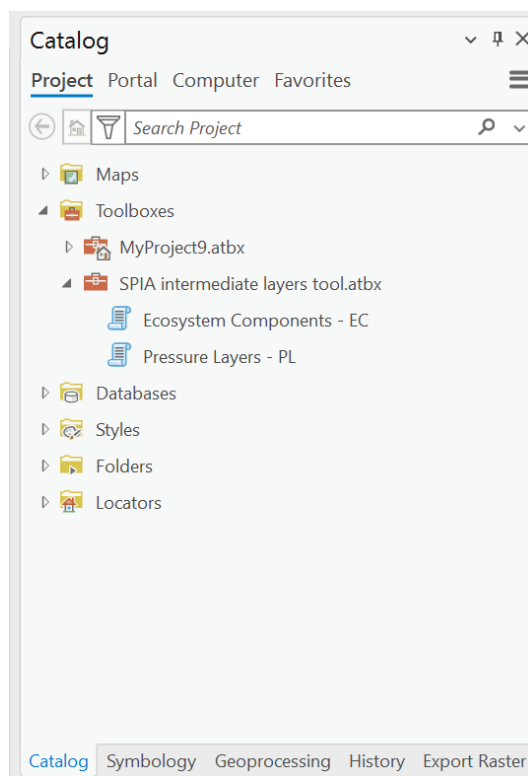
Figure 2: SPIA intermediate layers tool user interface

2.2.1 ECOSYSTEM COMPONENTS

Upon selecting Ecosystem Components in the tool, users need to provide the required input information, as illustrated in Figure 3:

- Configuration file: Specify the path to the EC-config.toml configuration file that was provided with the tool.
- ESRI file geodatabase with input data: Provide the geodatabase containing input datasets for the ecosystem components within the study area.
- ESRI file geodatabase with background data: Provide the geodatabase containing the background datasets for the study area.
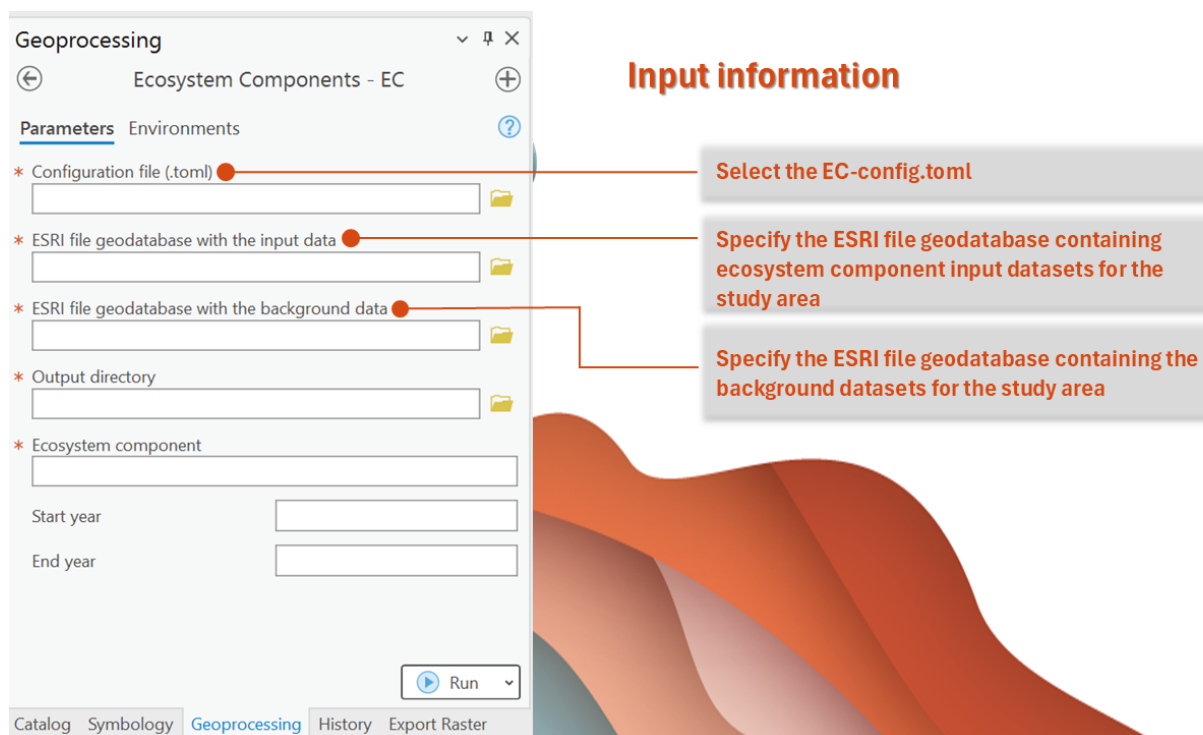
Figure 3: Input information for Ecosystem Components

Following the input information, users will be requested to also define the output data directory where the final processed raster layers will be stored (Figure 4).
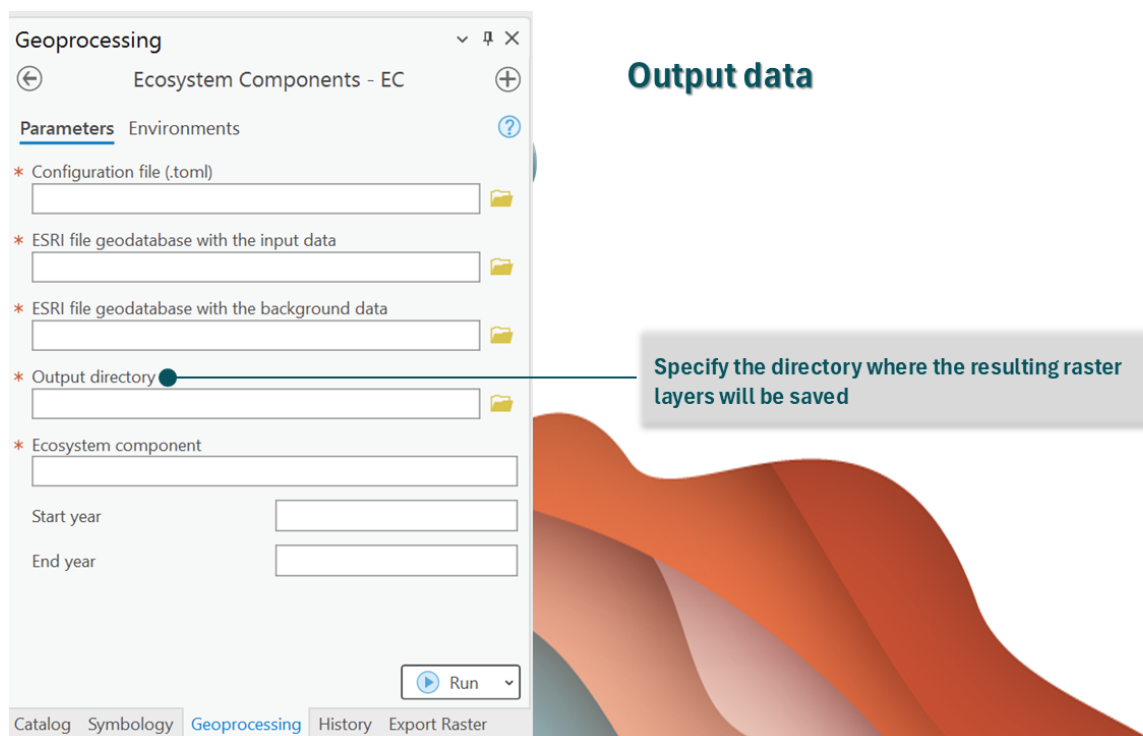

Figure 4: Output directory selection for Ecosystem Components

Additionally, users will select the larger group of ecosystem components to be processed by the tool (Figure 5). The user can choose one of the following options from the dropdown list:

- A specific ecosystem component;
- All, to process all available ecosystem components at once. Please, note that this operation will demand a long processing time.
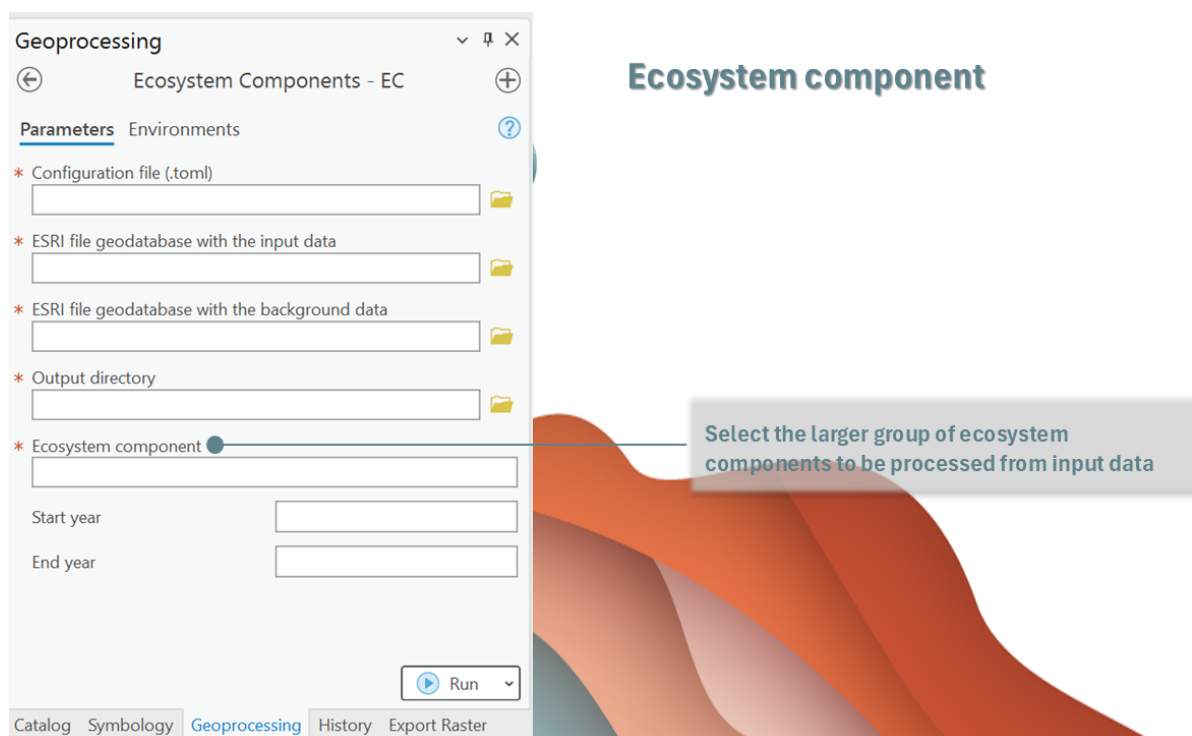
The tool also allows the user to define a specific time period for processing individual ecosystem components, enabling a trend analysis if desired (Figure 6). Users can specify the start and end year for which the ecosystem component group will be generated, provided that temporal information is available on the dataset. Please, note that both fields are not mandatory, and if not specified, all years available on the dataset will be included in the analysis.
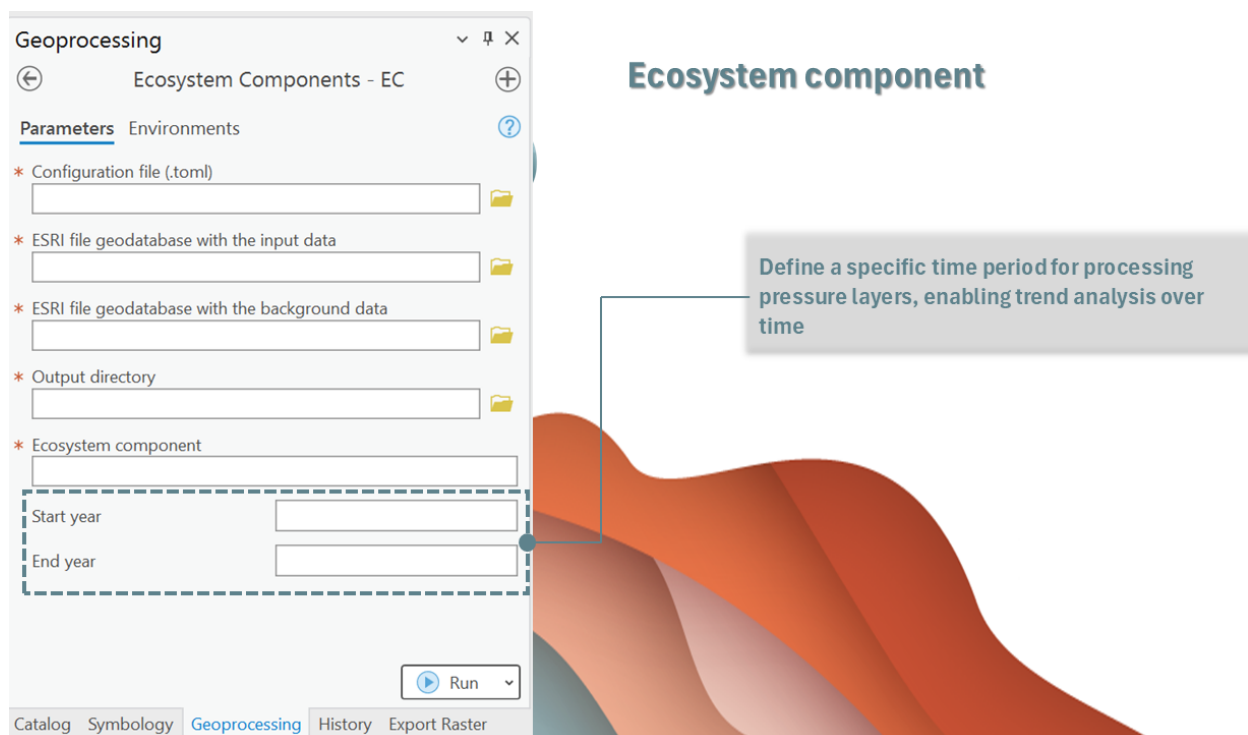
Figure 6: Time period selection for Ecosystem Components

Once executed, the tool generates one raster layer per ecosystem component within the selected group. For instance, if 'Benthic species' is selected, the tool will produce one raster per species. These raster layers represent the processed spatial distribution of each ecosystem component to feed the SPIA tool.

2.2.2 PRESSURE LAYERS

Upon selecting human activities, similarly to ecosystem components, users need to provide the following input information before running the tool (Figure 7):

- Configuration file (.toml): Specify the path to the PL-config.toml configuration file that was provided with the tool.
- ESRI file geodatabase with input data: Provide the geodatabase containing input datasets related to human activities within the study area.
- ESRI file geodatabase with background data: Provide the geodatabase containing the background datasets for the study area.

Figure 7: Input information for pressure layers

Additionally, users will be requested to define the output data directory where the final processed raster layers will be stored (Figure 8).
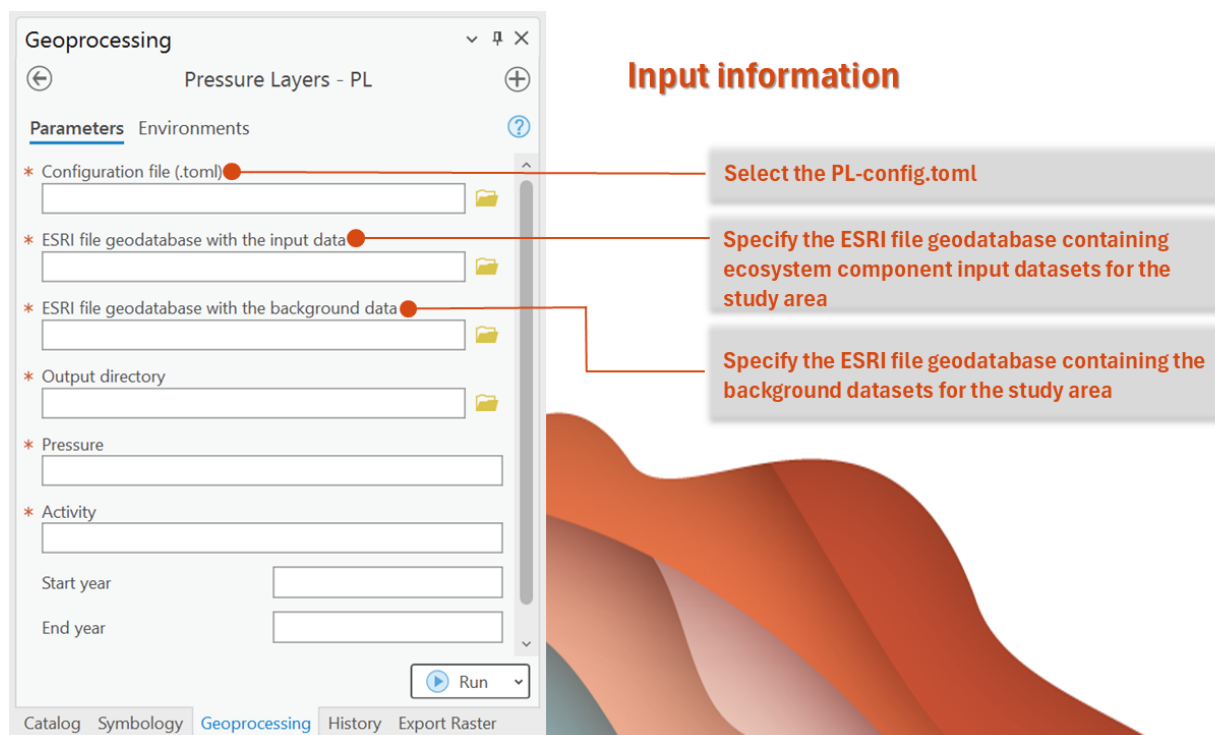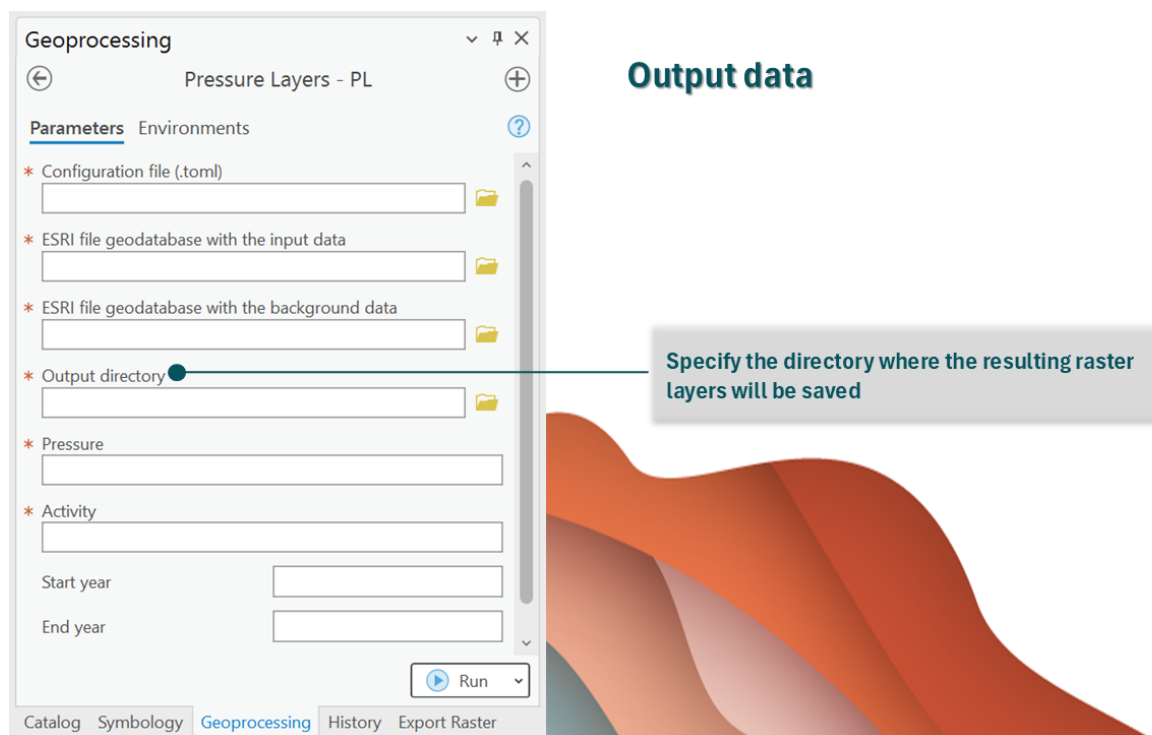

Figure 8: Output directory selection for Pressure Layers

Finally, users will be able to select the pressure layers and human activities for processing (Figure 9).

- Pressure layer – users can choose to process from the dropdown list:
  - All, which generates all available pressure layers. Please, note that this operation will demand a long processing time.
  - A specific pressure layer, which allows the user to also select the related human activity(ies).
- Human activities – users can choose to process from the dropdown list:
  - All, which includes all human activities contributing to the selected pressure layer.
  - A specific human activity, which will provide only the activity selected. Please, note that the corresponding pressure layer will not be generated in this case and a warning sign will be displayed to alert the user.
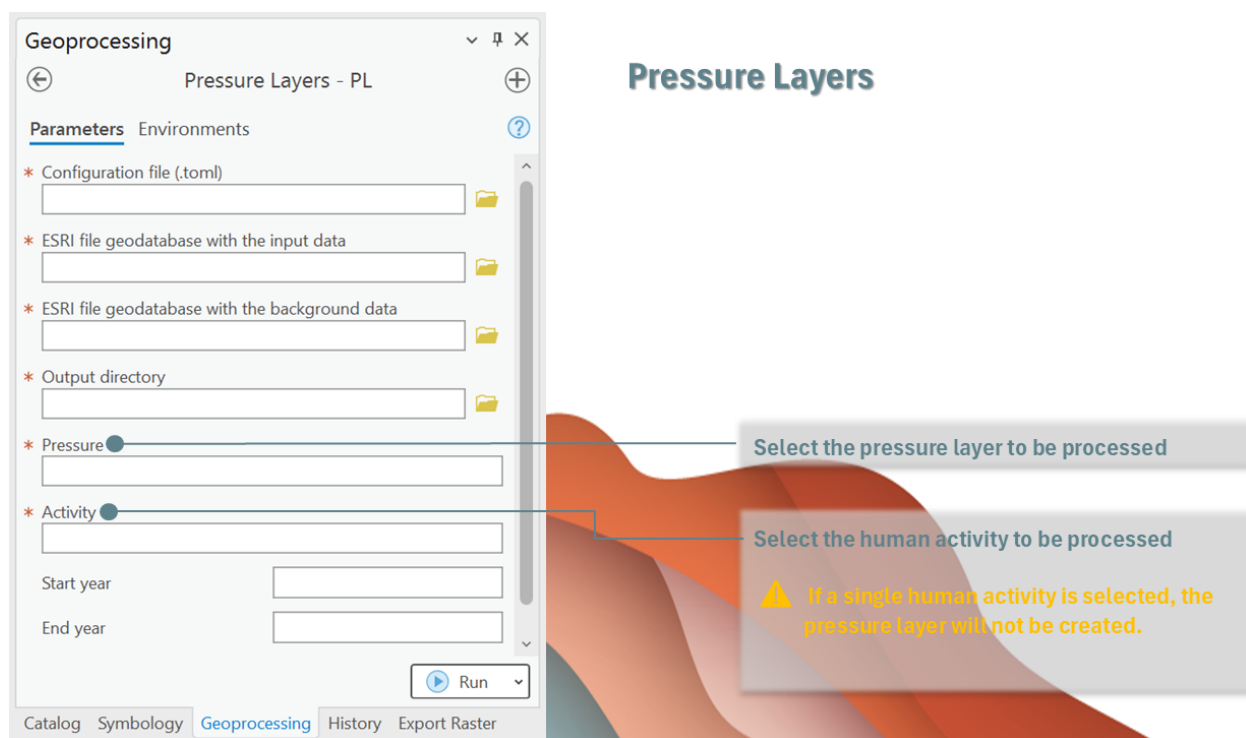
Figure 9: Pressure Layer and Human Activity selection

Similarly to the Ecosystem Components, the tool also allows the user to define a specific time period for processing individual pressure layers, enabling a trend analysis if desired (Figure 10). Users can specify the start and end year for which the pressure layers will be generated, provided that temporal information is available on the dataset. Please, note that both fields are not mandatory, and if not specified, all years available on the dataset will be included in the analysis.
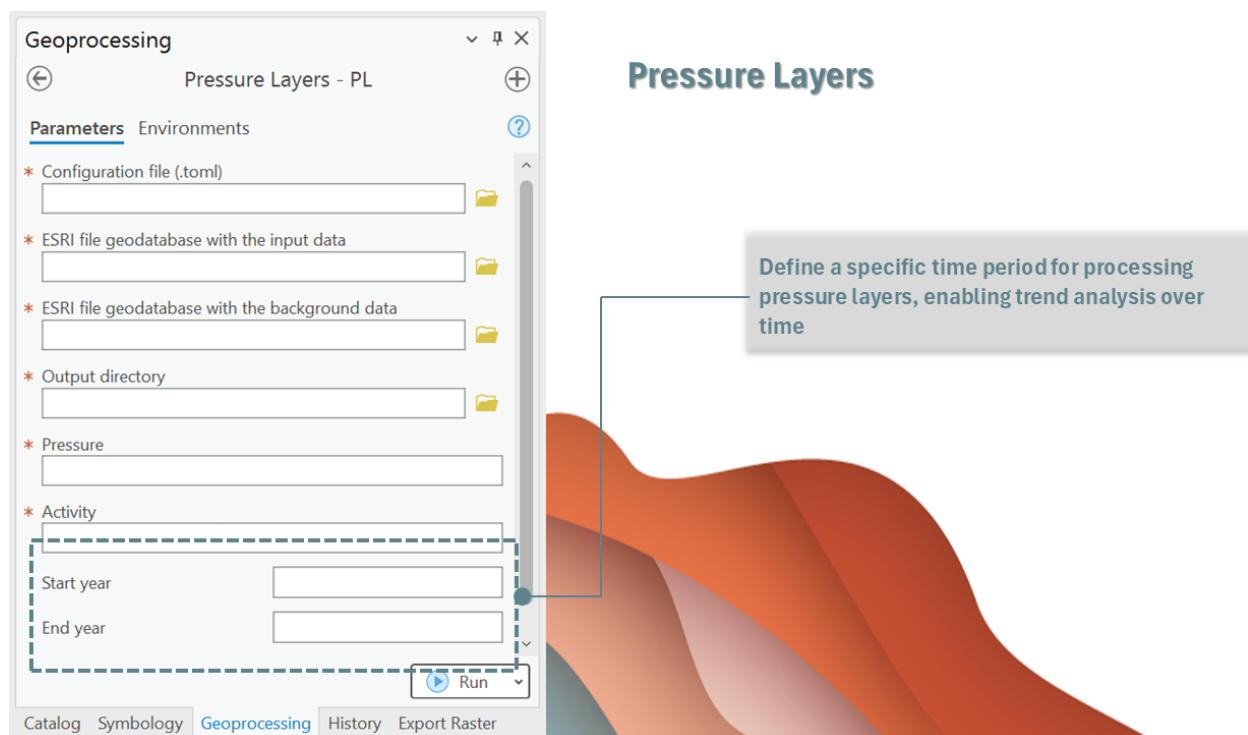
Figure 10: Time period selection for Pressure Layer.

Once executed, the tool generates **raster layers** representing the spatial distribution of selected **pressure layers** over the specified time period (if any selected), as well as raster layers for each human activity used to produce the specific pressure layer.

Please, note that the tool can still process the pressure layer even if not all human activities are available, but all input datasets must still be present in the ESRI file geodatabase.

All raster layers produced by both ecosystem components and pressure layers in the SPIA intermediate layer tool are the input data to run the SPIA tool. Please, note that all data is automatically processed as ETRS 1989 LAEA in the tool for an accurate spatial analysis at EU level.

3 REFERENCES

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Korpinen, S., Klančnik, K., Peterlin, M., Nurmi, M., Laamanen, L., Zupančič, G., Popit, A., Murray, C., Harvey, T., Andersen, J.H., Zenetos, A., Stein, U., Tunesi, L., Abhold, K., Piet, G., Kallenbach, E., Agnesi, S., Bolman, B., Vaughan, D., Reker, J. & Royo Gelabert, E., 2019, Multiple pressures and their combined effects in Europe's seas. ETC/ICM Technical Report 4/2019: European Topic Centre on Inland, Coastal and Marine waters, 164 pp.

Shinoda D., Kaitaranta J., Ahvo A., Milos A., Delaroche E. .2023. D2.3 ReMAP report: Cumulative Impact Assessment analytical module.

Shinoda D., Kaitaranta J., Ahvo A., Milos A., Delaroche E. .2024. MS3.2.1 ReMAP report: Data harmonization Baltic use case.

ATTACHMENT 1

Processing rules for the human activity data collected in open data portals for Stage 1.

Pressure	Human activity	Source	Original data	Adaptation
Physical loss	Extraction of sand and gravel	https://ows.emodnet-humanactivities.eu/wfs?SERVICE=WFS&REQUEST=GetCapabilities&VERSION=2.0.0	Point data available	Buffer for points included in the tool
	Dredging (capital)		Point data available	Buffer for points included in the tool
	Oil platforms			No modification applied, except selection within area
	Wind farms (operational)		Status values not correspondent to code list	Test and approved sites were considered as operational
	Cables (operational)		Status values not correspondent to code list	Status 1 and empty values were considered operational, status 2 and 4 were considered not operational
	Harbours			No modification applied, except selection within area
	Finfish mariculture		Polygon data available	No buffer applied for polygons
	Shellfish mariculture			No modification applied, except selection within area
Physical Disturbance	Bathymetry	https://erddap.emodnet.eu/erddap/files/bathymetry_2022/	Resolution not correspondent to the analysis	Aggregation incorporated in the tool
	Fishing intensity	https://ows.emodnet-humanactivities.eu/geonetwork/srv/api/records/d57fbdea-489e-4e11-9ff1-f0f706cfe783/attachments/EMODnet_HA_Fisheries_Fishing_Intensity_20230508.zip	No yearly quarter available	
	Shipping density	https://ows.emodnet-humanactivities.eu/wms	All types in EMODnet included	Min-Max normalised
Changes to hydrological conditions	Wind farms (operational)	https://ows.emodnet-humanactivities.eu/wfs?SERVICE=WFS&REQUEST=GetCapabilities&VERSION=2.0.0	Status values not correspondent to code list	Test and approved sites were considered as operational
	Oil platforms	https://ows.emodnet-humanactivities.eu/wfs?SERVICE=WFS&REQUEST=GetCapabilities&VERSION=2.0.0		No modification applied, except selection within area

	Rivers	https://joint-research-centre.ec.europa.eu/scientific-tools-databases/catchment-characterisation-and-modelling-ccm_en		No modification applied, except selection within area
Disturbance of species due to human presence	Bathing sites, beaches	https://www.eea.europa.eu/en/datahub/datahubitem-view/c3858959-90da-4c1b-b9ca-492db0e514df		No modification applied, except selection within area
	Recreational boating and sports	https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/0f2f3ff1-30ef-49e1-96e7-8ca78d58a07c	Values ranging between 0-5, recreational layers from shipping density selected (sailing, pleasure craft, high speed craft)	Min-Max normalised
	Urban land use	https://land.copernicus.eu/en/products/corine-land-cover/clc2018#download		No modification applied, except selection within area
	Military training and operations	https://ows.emodnet-humanactivities.eu/wfs?VERSION=2.0.0		Selection within sea area. As the area is overestimated for the analysis, only type 'underwater exercise' was collected for the analysis
Extraction of, or mortality/injury of fish		https://sdi.eea.europa.eu/catalogue/geoss/eng/catalog.search#/metadata/e99610ad-8fdb-44f2-a671-ccf9ec13c252	tonnes/year/km^2	No modifications applied, except selection of group of target species and area

ATTACHMENT 2

Processing rules for the human activity data collected via online validation tool for Stage 1.

Human activity	Adaptation
Coastal defence and flood protection	For missing attributes, the following values were adopted: status = operational, year = 1111
Bridges and other constructions	For missing attributes, the following values were adopted: year = 1111
Marinas and leisure harbours	When specific attribute not available, use type 'marina'
Pipelines	For missing attributes, the following values were adopted: status = operational, year = 1111
Diving	For missing attributes, the following values were adopted: dives/year = 99999
Discharge of warm water from nuclear power plants	Data for energy (GWh)

ATTACHMENT 3

Compilation of adaptations in the geoprocessing rules methodology on Stage 1.

Group	Dataset name	Dataset code	Sub-dataset name	Sub-dataset code	Description of adaptation in the methodology
Pressures	Physical loss	PL_01	Land claim	HA_01	Coastal areas clipped in the aggregation process, not per Human Activity.
			Watercourse modification	HA_02	
			Coastal defence and flood protection	HA_03	
			Extraction of sand and gravel	HA_04	
			Dredging (capital)	HA_05	Coastal areas clipped in the aggregation process, not per Human Activity. Empty values in data received average of volume, not automatic 50m buffer (precautionary approach). Empty or other values considered as capital.
			Oil platforms	HA_06	
			Pipelines (operational)	HA_07	Coastal areas clipped in the aggregation process, not per Human Activity.
			Wind farms (operational)	HA_08	
			Cables (operational)	HA_09	Coastal areas clipped in the aggregation process, not per Human Activity. Removal of duplicates added in the tool.
			Harbours	HA_10	Coastal areas clipped in the aggregation process, not per Human Activity.
			Marinas and leisure harbours	HA_11	
			Bridges	HA_12	
			Finfish mariculture	HA_13	
			Shellfish mariculture	HA_14	
	Changes to hydrological conditions	PL_03	Watercourse modification	HA_29	Addition of coastal clipping.
			Wind farms (operational)	HA_30	Addition of coastal clipping. Step 1 was altered from sum to the highest value in the overlap.
			Oil platforms	HA_31	Addition of coastal clipping. Step 1 was altered from sum to the highest value in the overlap.
			Hydropower dams	HA_32	River buffer adjusted to 2m.
	Input of heat	PL_06	Discharge of warm water from nuclear power plants	HA_35	Addition of coastal clipping. Distribution per area was not calculated.
			Fossil fuel energy production	HA_36	Addition of coastal clipping. Step 1 was altered from sum to the highest value in the overlap.
	Oil slicks and spills	PL_10	Illegal oil discharges	HA_40	Median and not mean was given due considerable differences in values. Note that values (area and volume) need to be verified in the database.

			Polluting ship accidents	HA_41	Median and not mean was given due considerable differences in values. Note that values (area and volume) need to be verified in the database.
	Disturbance of species due to human presence	PL_11	Recreational boating and sports	HA_42	For Galicia, sum of high speed craft, passenger, pleasure craft and sailing was used. Normalized. For EMODnet data, normalization.
			Bathing sites, beaches	HA_43	
			Urban land use	HA_44	
			Military training and operations	HA_55	Added in the original methodology, but no point data available for the area.
			Recreational scuba diving	HA_56	Added in the original methodology.
	Extraction of, or mortality/injury of fish	PL_12	Extraction of fish per species	varies	Normalization in HOLAS included RU data. The consideration of the largest values at the borders may also influence the final results. Additionally, HOLAS3 used a Spatial Join approach (based on the proximity of the first intersection), which does not account for complex overlaps.
	Extraction of, or mortality/injury of seabirds - Bird hunting	PL_15	Game hunting of seabirds	HA_49	For HOLAS3, the log+c method was used instead of log10+c. The grid area was applied rather than the real area. A disclaimer regarding the country calculation method (Euclidean Approach) is included. Values such as -99999 will need to be manually checked before processing the data. Additionally, the coastal area data is less refined.
			Predator control of seabirds	HA_50	
	Extraction of, or mortality/injury of mammals - Mammals	PL_16	Extraction per species	varies	No division of average value by area was applied. A value for "illegal" hunting has been added. The aggregated version of the data is used instead of the county-level reported data. Normalization was performed prior to aggregation, with sum being used in the aggregation process instead of average.
Ecosystem Components	Turtle		Turtle distribution	EC_03	Added in the original methodology.
	Coral		Coral distribution	EC_04	Added in the original methodology.
	Natura 2000		Biotope's name based on code list	varies	
	Birds		Birds' distribution (change name based on the value (column I)	EC_16	Seasonality not included in the tool.
	Mammals		Mammal species based on code list	varies	
	BHT		Broad Habitat Types based on code list	varies	
	Benthic species		Benthic species based on code list	varies	
	Fish		Abundance of fish per species based on code list	varies	

ATTACHMENT 4

Processing rules for the human activity data collected in open data portals for Stage 2. Please, note that all pressure layers were converted to the 1km^2 grid.

Pressure	Source	Original data	Adaptation
Input of continuous anthropogenic sound	https://sdi.eea.europa.eu/catalogue/geoss/eng/catalog.search#/metadata/0ab524a2-fd09-4185-adc8-58998efe8f23	Shipping data as a proxy for sound	Min-Max normalised and area selection
Input of impulsive anthropogenic sound	https://sdi.eea.europa.eu/catalogue/geoss/api/records/a86f0051-c971-4492-84b2-eb42aaab5fa9	Pulse block days (number of days in a calendar year when impulsive noise was detected) logarithmically transformed to 0-3. Data available only for Mediterranean	Min-Max normalised and area selection
Inputs of hazardous substances	https://www.eea.europa.eu/en/datahub/datahubitem-view/eab57bb2-dbe0-47bb-aa29-903d2cc1e841	CHASE+ results for biota, seawater and sediment	Value used for analysis was the lowest of three
Relative distribution of nutrient concentration - TN / Eutrophication	https://www.eea.europa.eu/en/datahub/datahubitem-view/7a6f335f-97c4-4eaf-820c-8b4a091047ce	HEAT+ results	Min-Max normalised and area selection
Introduction of NIS and translocations	https://sdi.eea.europa.eu/catalogue/geoss/eng/catalog.search#/metadata/cc8c0653-59e7-4f20-aa05-5f8ecb720fee	Sum of all the invasive species occurring in 10x10km squares	Min-Max normalised and area selection

ATTACHMENT 5

Processing rules for ecosystem components data collected in open data portals in Stage 2.

Ecosystem component	Dataset	Source	Original data	Adaptation
Broad Habitat Type (BHT)		https://ows.emodnet-seabedhabitats.eu/geoserver/emodnet_open/wfs? SERVICE=WFS&REQUEST=GetCapabilities &VERSION=2.0.0		No modification applied, except area selection per habitat type
Bathymetry		https://ows.emodnet-bathymetry.eu/wfs?SERVICE=WFS&REQUEST= GetCapabilities&VERSION=2.0.0		No modification applied, except area selection
Natura habitats	1150 Coastal lagoons	https://ows.emodnet-seabedhabitats.eu/geoserver/emodnet_open/wfs?		No modification applied, except area selection
	1110 Sandbanks			
	1120 Posidonia beds			
	1180 Submerged or partially submerged sea caves			
	1170 Reefs			
	1130 Estuaries			
	1160 Large shallow inlets and bays			
Productive surface waters (Chl-a) – satellite based		https://data.marine.copernicus.eu/products?facets=mainVariables%7EPlankton--sources%7ESatellite+observations--areas%7EGlobal+Ocean	Raster data provided on a different range	Min-Max normalised and area selection
Cetaceans, coral		https://shiny.obis.org/distmaps/	Current band, Ensemble model, value from 0-100 in raster	Normalized for EU comparability and area selection

ATTACHMENT 6

Table with datasets collection information for the Northwest Mediterranean countries and Galicia. Baltic Sea data was all available at HELCOM Metadata Catalogue. NA refers to not relevant in the location or no data available.

Datasets	Italy	France	Spain	Galicia
Bridges and other constructions	Downloaded from data portal	Datasets shared in project cloud	Downloaded from data portal	Downloaded from data portal
Bathymetry	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Benthic species	NA	NA	NA	NA
Birds wintering and breeding areas	NA	NA	NA	NA
Bottom-water habitats not influenced by permanent anoxia	NA	NA	NA	NA
Bridges and other constructions	NA	Datasets shared in project cloud	NA	NA
Coastal defence and flood protection	NA	NA	Reported via validation tool	To be reported via validation tool
Cables	Reported via validation tool	Datasets shared in project cloud	Downloaded from data portal	NA
Continuous anthropogenic sound	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Deposit of dredged materials	Downloaded from data portal	Datasets shared in project cloud	Downloaded from data portal	Downloaded from data portal
Diving	NA	Datasets shared in project cloud	Reported via validation tool	To be reported via validation tool
Discharge of warm water	NA	NA	Reported via validation tool	NA
Dredging	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Data shared via email
EMODnet Broad habitat types (BHT)	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Eutrophication	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Extraction of target fish species in commercial fisheries (landings + effort)	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Extraction of, or mortality/injury to, wild species - seabirds	NA	NA	NA	NA
Extraction of, or mortality/injury to, wild species - mammals	NA	NA	NA	NA
Extraction of, or mortality/injury to, wild species - turtles	NA	NA	NA	NA

Extraction of, or mortality/injury to, wild species - corals	NA	NA	NA	NA
Extraction of minerals	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Fish abundance	NA	NA	NA	NA
Fishing intensity	NA	NA	NA	Downloaded from data portal
Fossil fuel energy production	NA	NA	Reported via validation tool	NA
Harbours / Ports	Downloaded from data portal	Datasets shared in project cloud	Downloaded from data portal	Downloaded from data portal
Hazardous substances	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Impulsive sound events	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Illegal oil discharging	NA	NA	NA	NA
Land claim	NA	NA	Datasets shared in project cloud	NA
Land use / Urban land use	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Mammals distribution	Downloaded from data porta	Downloaded from data porta	Downloaded from data porta	Downloaded from data porta
Marinas and leisure harbours	Reported via validation tool	Downloaded from data portal	Downloaded from data portal	To be reported via validation tool
Natura 2000 habitats	Downloaded from data portal	Downloaded from data portal	Reported via validation tool	Downloaded from data portal
Pipelines	NA	Datasets shared in project cloud	Reported via validation tool	NA
Polluting ships accidents	NA	Datasets shared in project cloud	NA	NA
Productive surface waters (Chl-a)	NA	NA	NA	NA
Recreational boating and sports	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Data shared via email
Rivers	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Seaweed harvesting and farming/cultivation	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Shipping intensity	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal	Downloaded from data portal
Turtle distribution	NA	NA	NA	NA
Watercourse modification	NA	NA	NA	NA
Wind farms	Downloaded from data portal	Downloaded from data portal	NA	Downloaded from data portal

ATTACHMENT 7

CIA TOOL INPUT DATA

Important notes

- The input dataset name codes must be strictly followed to ensure the tool correctly processes the dataset.
- All datasets included in the provided template must be present in the ESRI file geodatabase for successful tool execution.
- All datasets in the background geodatabase are mandatory and must be included.
- For Human_activities_and_pressures and Ecosystem_components geodatabases, if certain data is unavailable, the corresponding dataset must still be maintained in the geodatabase, but it can be left empty.

Background geodatabase

Dataset	Input dataset name code	Geometry	Attribute name	Attribute description	List of mandatory values
Study area	study_area	polygon		NA	
1km² grid	grid_vector	polygon		NA	
	grid_raster	raster			
Bathymetry	bathymetry	raster			
National area	EEZ_and_land_borders_poly	polygon		NA	
Rivers	rivers_polyline	polyline		NA	

Human_activities_and_pressures geodatabase

Dataset	Input dataset name code	Preferred geometry	Attribute name	Attribute description	List of mandatory values
Bathing sites	bathing_sites_point	point		NA	
Bridges	bridges_polyline, bridges_polygon	line	year	Year of construction	
Cables	cables_polyline	line	year	Year of construction	

			status	status	operational, under construction, planned, out of use
Coastal defence and flood protection	coastal_defence_and_flood_protection_point, coastal_defence_and_flood_protection_polygon, coastal_defence_and_flood_protection_polyline	polygon	year	Year of construction	
			status	status	operational, under construction, planned, out of use
Deposit of dredged materials	deposit_of_dredged_materials_polygon	polygon	year	Year of deposit	
Discharge of warm water	discharge_of_warm_water_point	point	val_2010 (...) val_2023	heat load (TWh per year)	
Diving (Recreational scuba diving)	diving_recreational_scuba_diving_point	point	val_2010 (...) val_2023	dives/year	
Dredging	dredging_point, dredging_polyline, dredging_polygon	polygon	year	year	
			type	type	capital, maintenance
			value	Dredged volume (m³)	
Extraction of target fish species in commercial fisheries[1]	extraction_of_fish_polygon	polygon	ICESNAME	ICES statistical rectangles	
			species	species	
			landing2010 (...) landing2023	Total landings (tonnes) per species per year	
	extraction_of_fish_eu_polygon	polygon	trgt_ss	Target species 3 letter code	
			icesnam	ICES statistical rectangles	
			cscode	C-squares code	
			ttsfhdy	Total fish days	
			year	Year reported	

[1] Either 'extraction_of_fish' or 'extraction_of_fish_eu' can be added as input data for the calculation

			quarter	Yearly quarter reported	
Extraction of or mortality of species – seabird	extraction_of_or_mortality_injury_seabirds_polygon	polygon	year	Year of collection	
			value	Number of individuals extracted	
			origin	Nature of extraction	game hunting, predator control, NULL
			species	species	
Extraction of or mortality of species – mammals	extraction_of_or_mortality_injury_mammals_polygon	polygon	year	Year of collection	
			value	Number of individuals extracted	
			species	species	
			quota	Quota per species in case of hunting	
			area	Name of the area relative to the quota	
Extraction of minerals	extraction_of_minerals_point, extraction_of_minerals_polyline, extraction_of_minerals_polygon	polygon	year	year	
			type	type	sand, gravel, sand/gravel
Fishing intensity[2]	fishing_intensity_polygon	polygon	ICESsq	ICES C-squares	text
			val_2010 (…) val_2023	Total swept area ratio per c-square per year for all gear types	
	fishing_intensity_ICES_polygon	polygon	year	Year reported	
			quarter	Yearly quarter reported	

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[2] Either 'fishing_intensity_polygon' or 'fishing_intensity_ICES_polygon' can be added as input data for the calculation

			c_square	C-squares code	
			sur_sar	surface swept area ratio	
Fishing_effort	fishing_effort_polygon	polygon	year	year	
			c_square	C-squares code	
			kwfhr	Kw fishing hours	
Fossil fuel energy production	fossil_fuel_energy_production_point	point	val_2010 (…) val_2023	heat load (TWh per year)	
Harbours	harbours_polygon, harbours_point	polygon		NA	
Hydropower dams	hydropower_dams_point	point		NA	
Illegal oil discharging	illegal_oil_discharging_point	point	year	year	
			s_vol	spill volume (m^3)	
			s_area	Spill area (km^2)	
Land claim	land_claim_point, land_claim_polyline, land_claim_polygon	polygon		NA	
Mariculture	mariculture_point, mariculture_polygon	Polygon	year	year	
			type	type	finfish, shellfish
Marinas and leisure harbour	marinas_and_leisure_harbours_point	point	type	type	marina, leisure harbour, pier, mooring, anchoring
Military training and operations	military_training_and_operations_polygon	polygon		NA	
Oil platforms	oil_platforms_point	point	year	Year of construction	
			status	status	operational, under construction, planned, out of use
Pipelines	pipelines_polyline, pipelines_polygon	Line, polygon	year	Year of construction	
			status	status	operational, under construction, planned, out of use
		point	year	year	

Polluting ship accidents	polluting_ship_accidents_point		s_area	Spill area (km²)	
			s_vol	spill volume (m³)	
Recreational boating and sports	recreational_boating_and_sports_raster_tif	Raster with total fuel consumption of recreational boats			
Rivers	rivers_polyline	line		NA	
Shipping density	shipping_density	Raster with the intensity of all IMO registered ships operating per year			
Urban land use	urban_land_use_polygon	polygon	class	class	CLC "artificial surfaces" classes 1.1 to 1.4 (class = '111' OR '112' OR '121' OR '122 ' OR '123' OR '124' OR '131' OR '132' OR '133' OR '141' OR '142' OR '1' (OSM data)
Watercourse modification	watercourse_modification_point, watercourse_modification_polyline, watercourse_modification_polygo	polygon	year	Year of construction	
Wind turbines	wind_turbines_point	point	status	status	operational, under construction, planned, out of use
			year	Year of construction	

Ecosystem components geodatabase

Dataset	**Input dataset name code**	**Geometry**	**Attribute name**	**Attribute description**	**List of mandatory values**
Natura 2000 habitats	natura_2000_habitats_polygon	polygon	biotope	Biotope	Sandbanks (1110), Estuaries (1130), Mudflats and sandflats (1140), Coastal lagoons (1150), Large shallow inlets and bays (1160), Reefs (1170), Posidonia beds (1120), Submerged or partially submerged sea caves (8330), Reefs (1170), Baltic Esker islands (1610), Submarine structures made by leaking gas (1180), Boreal Baltic islets and small islands (1620)

			year	Year collected	
Benthic species distribution	benthic_species_distribution_polygon	polygon	species	Species	
			year	Year	
			presence	Presence	Value from 0 to 1
Fish abundance (data for same species as the one listed and found on section 1)	fish_abundance_polygon	polygon	ICES	ICES subdivision	
			CPUE	CPUE values per ICES subdivision	
			m_CPUE	Mean CPUE	
			species	species	
			landings	landings	
			year	Year	
Bird distribution	bird_distribution_polygon	polygon	presence	Presence	Value from 0 to 1
			season	Season	Wintering areas, Breeding areas
Mammal distribution	mammal_distribution_polygon	polygon	presence	Presence	Value from 0 to 1
			species	Species	
Reptile distribution	caretta_caretta_distribution_polygon	polygon	presence	Presence	Value from 0 to 1
			species	Species	
Coral distribution	corallium_rubrum_distribution_polygon	polygon	presence	Presence	Value from 0 to 1
			species	Species	
Broad Habitat Type	Bht_polygon	polygon	BHT	EMODnet Seabed Habitats	

ATTACHMENT 8

SPIA intermediate layers tool.atbx is an *ArcGIS Pro Toolbox*. It contains 2 tools: Ecosystem Components - EC tool and Pressure Layers - PL. Both tools are created with Python. Two Python source code files EC-processing.py and PL-processing.py are provided with the toolbox. Both tools use TOML configuration files. Two configuration files EC-config.toml and PL-config.toml are provided with the toolbox.

The *ArcGIS Pro* software with the *Spatial Analyst and Image Analyst* extensions is required to open the toolbox and run tools. Python scripts use a*rcpy* , n*umpy, tomli and few other Python* site packages. Toolbox was tested in ArcGIS Pro 3.1.x and 3.3.x environments on Windows OS.