GES4SEAS

A project funded by the Horizon Europe Programme

Tcl/Tk in environmental science: An example from the European GES4SEAS project

MariLim aquatic research

Torsten Berg (berg@marilim.de)

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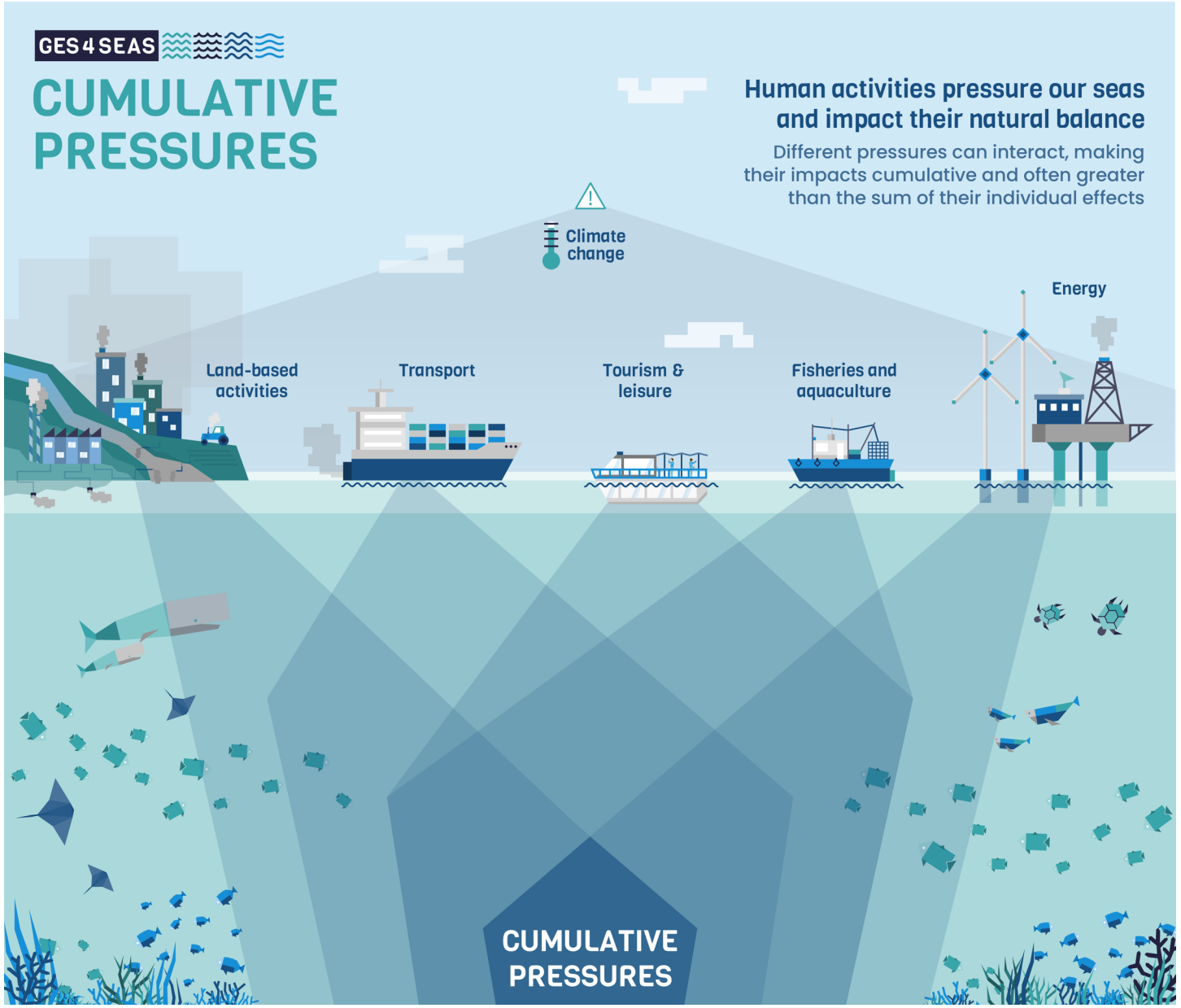
01

What is GES4SEAS about?

Achieving Good Environmental Status FOR maintaining ecosystem SErvices, by ASsessing integrated impacts of cumulative pressures

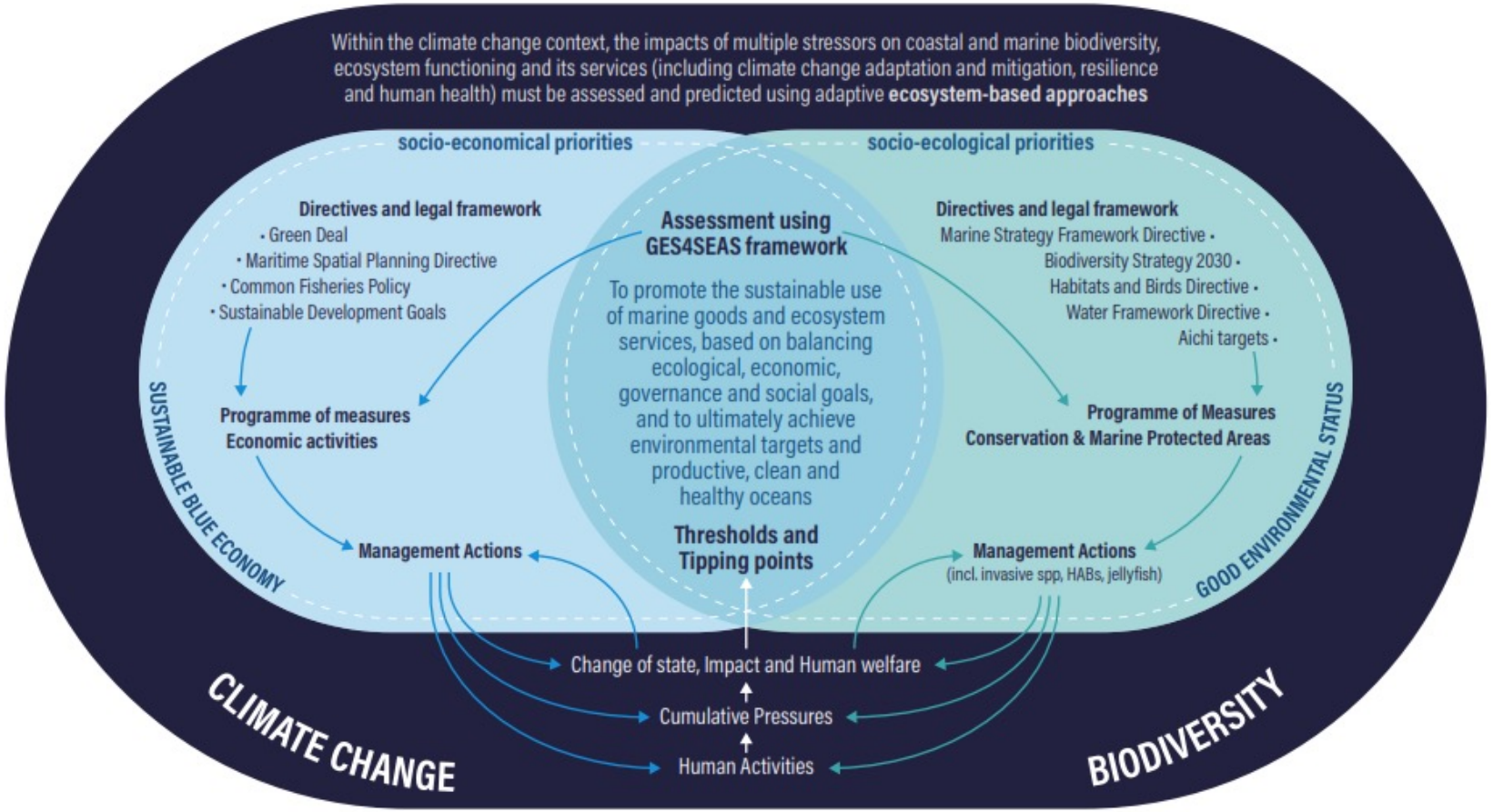


Development of an innovative **toolbox** in the context of an adaptive ecosystem-based management (EBM).

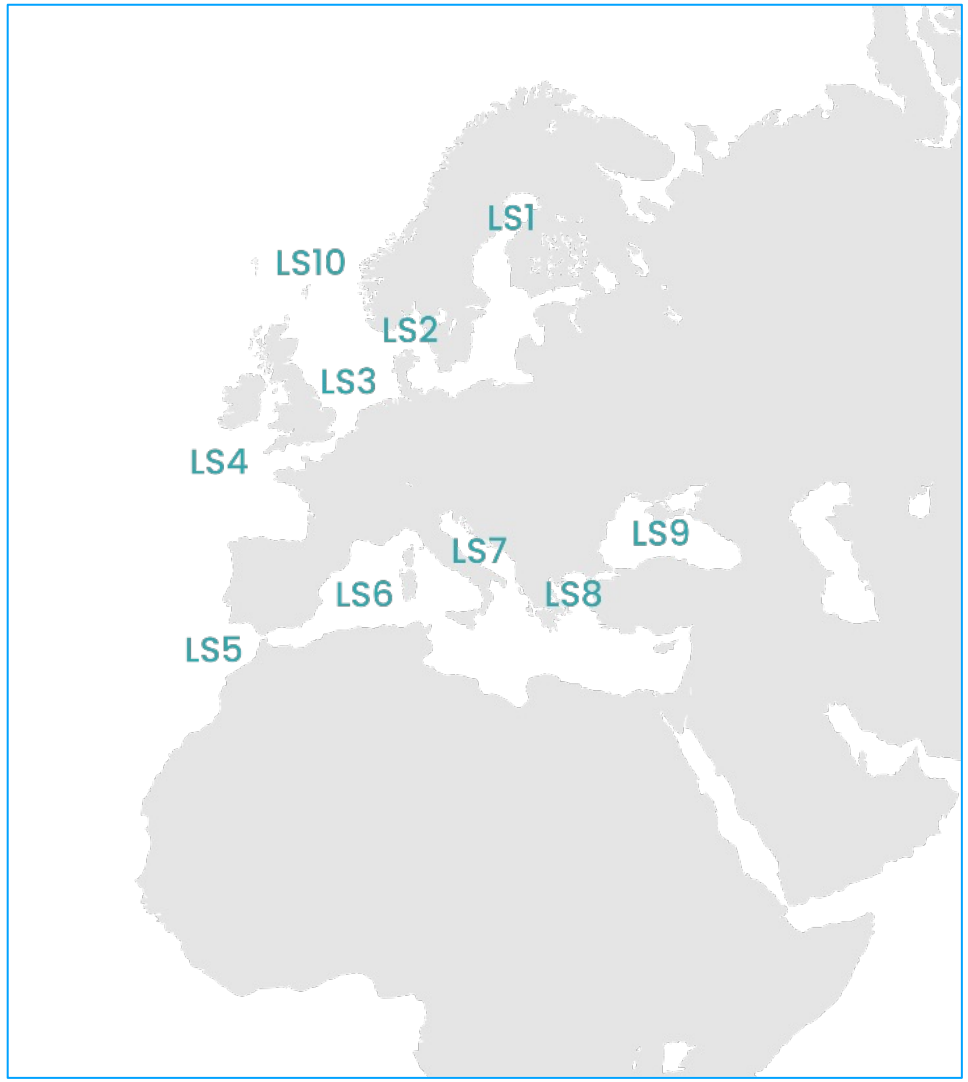
This will allow competent authorities to assess and predict the effect of multiple human pressures (including climate change) at the national, sub-regional, regional and European level.

This will then give guidance for measures needed to achieve Good Environmental Status (GES).

Environmental assessment is complex!



Learning sites – local, regional and European scale (and Pacific)



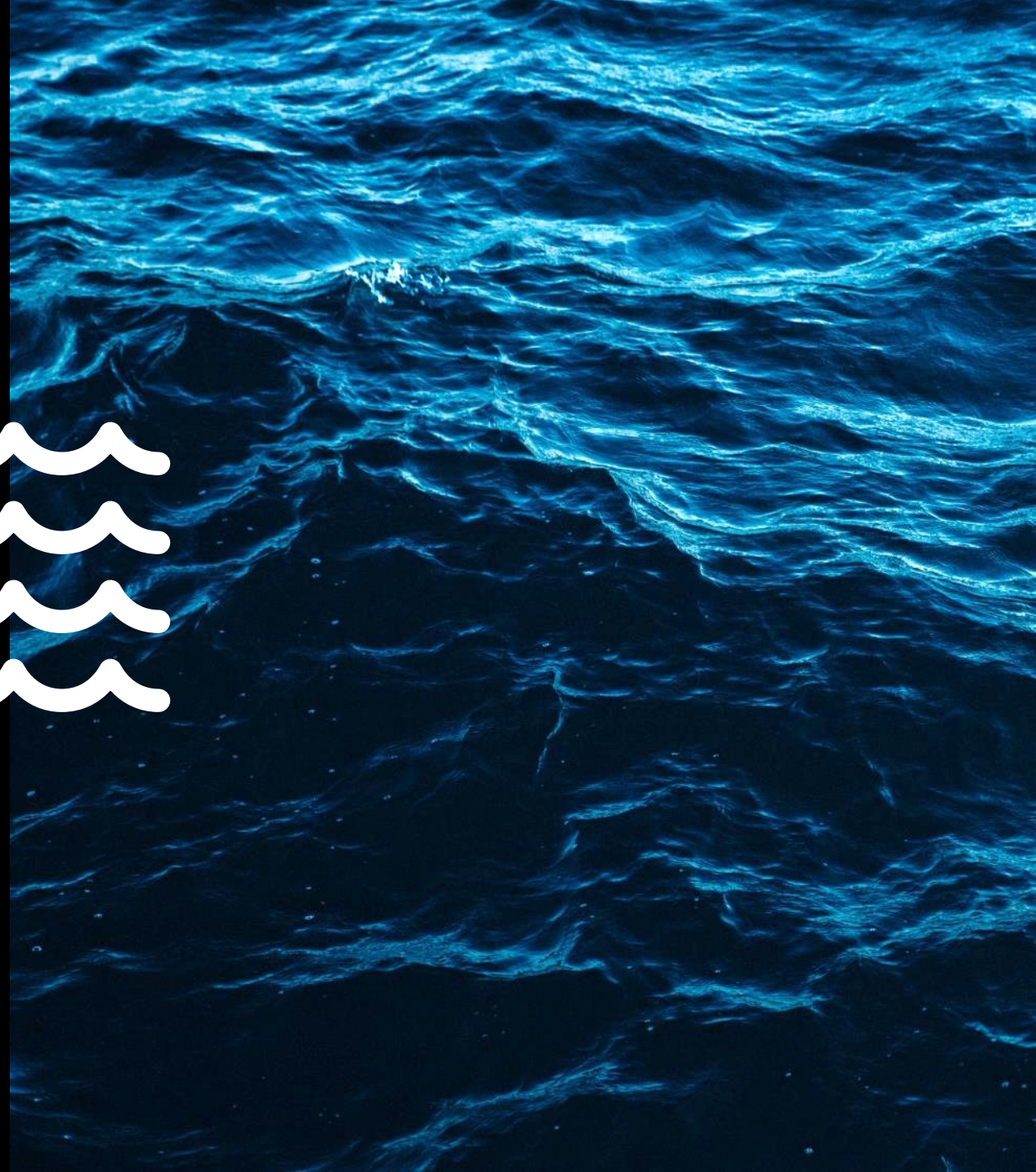
Toolbox … testing, validation, improvement

LS1: Gulf of Bothnia
LS2: Kattegat
LS3: North Sea (Netherlands)
LS4: Celtic Sea
LS5: Deep Atlantic-Mediterranean transition
LS6: Western Mediterranean
LS7: Adriatic Sea
LS8: Aegean Sea
LS9: Black Sea
LS10: Whole Europe’s Seas

LS11: French Polynesia (Pacific)

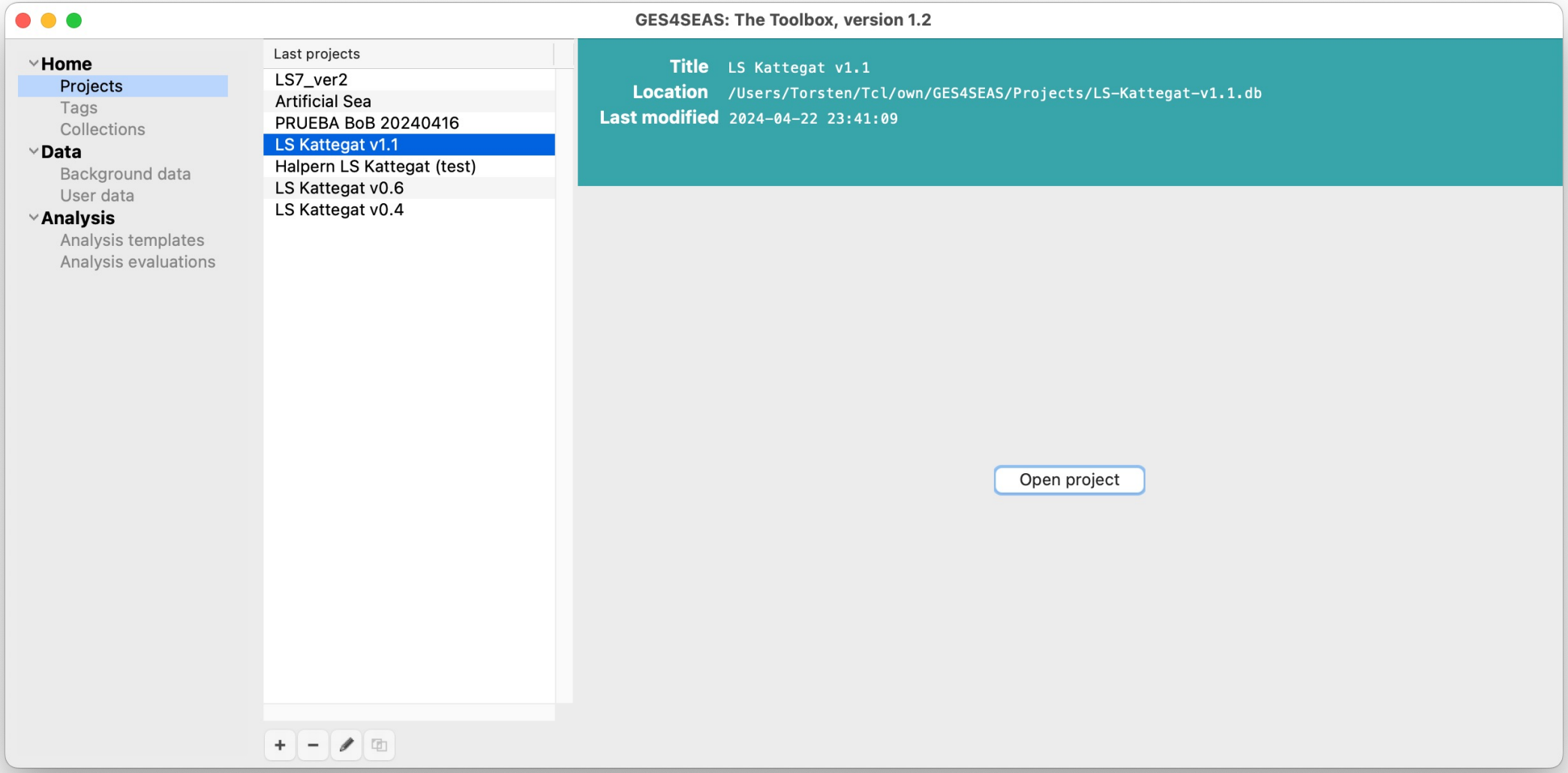
02

The toolbox

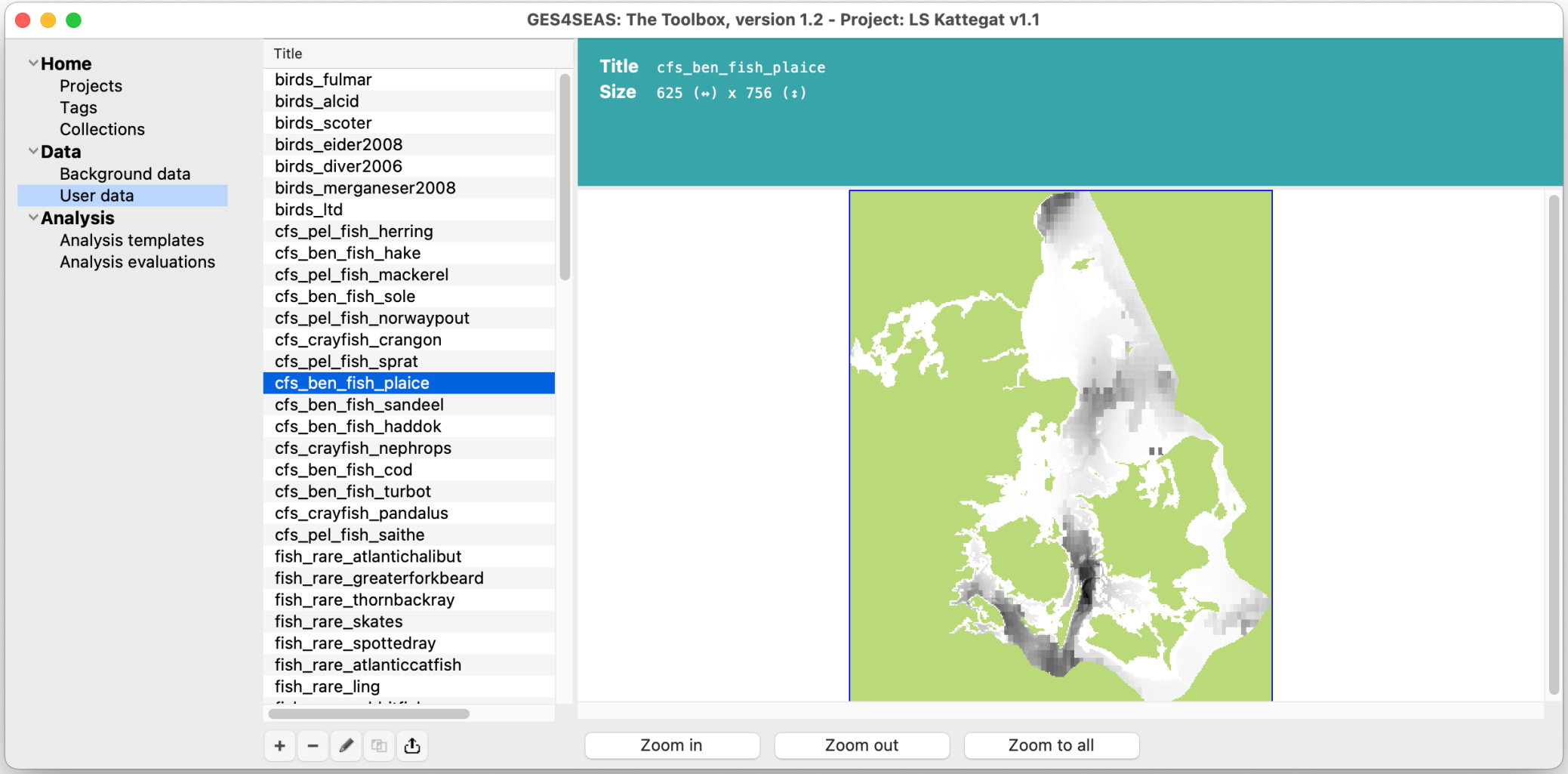


Some facts and numbers …

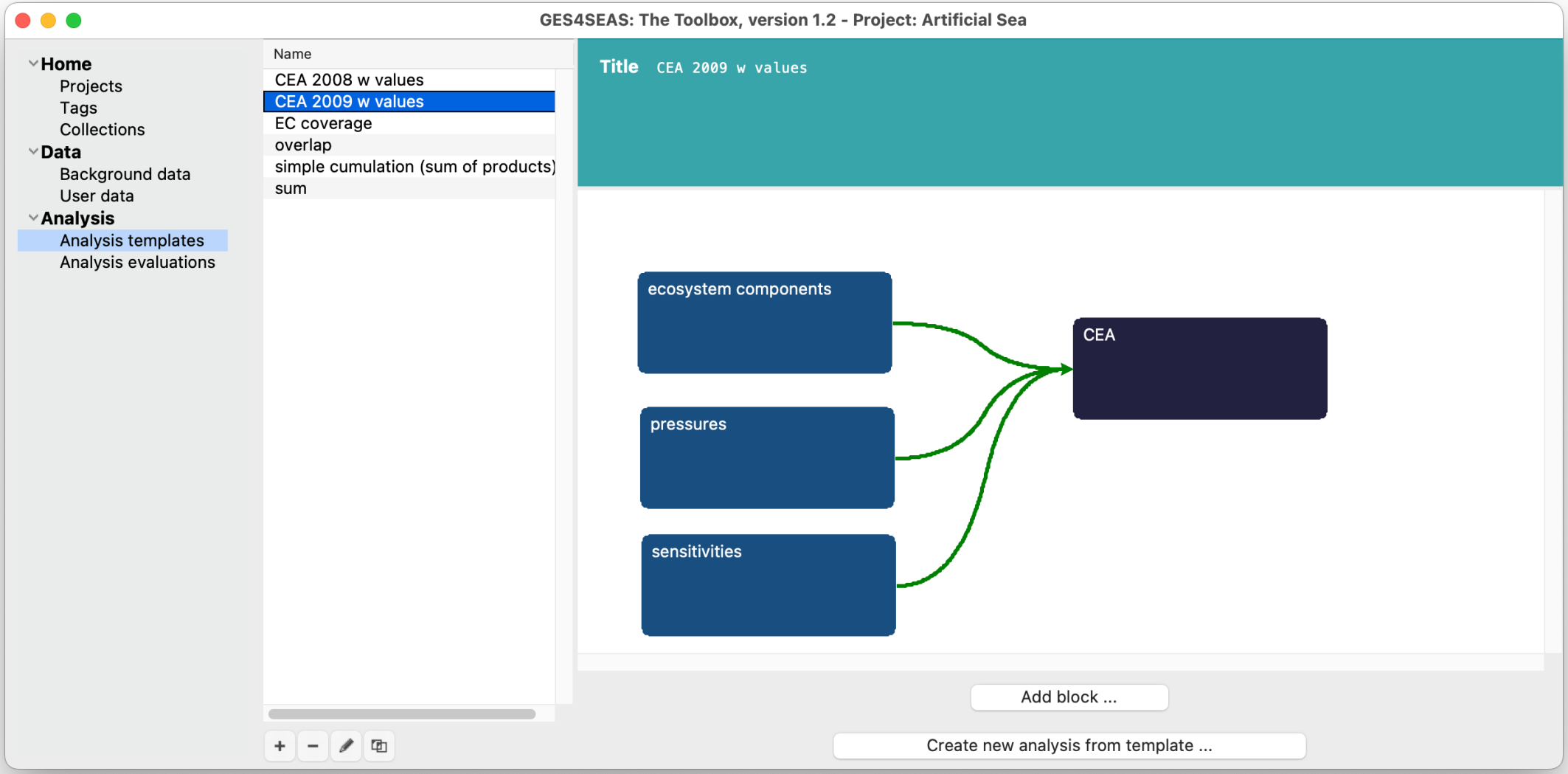
- cross-platform application (Windows, macOS; Linux planned)
- deployment as Mac bundle on macOS, freewrap executable on Windows
- currently ≈ 14,100 lines of Tcl code (14,800 including comments)
- Packages:
  - sqlite3 – application database and storage
  - tablelist – GUI (navigation, table and hierarchy display)
  - ooxml (tdom) – Excel file import & export
  - uuid (from tcllib) – metadata creation



Multiple projects

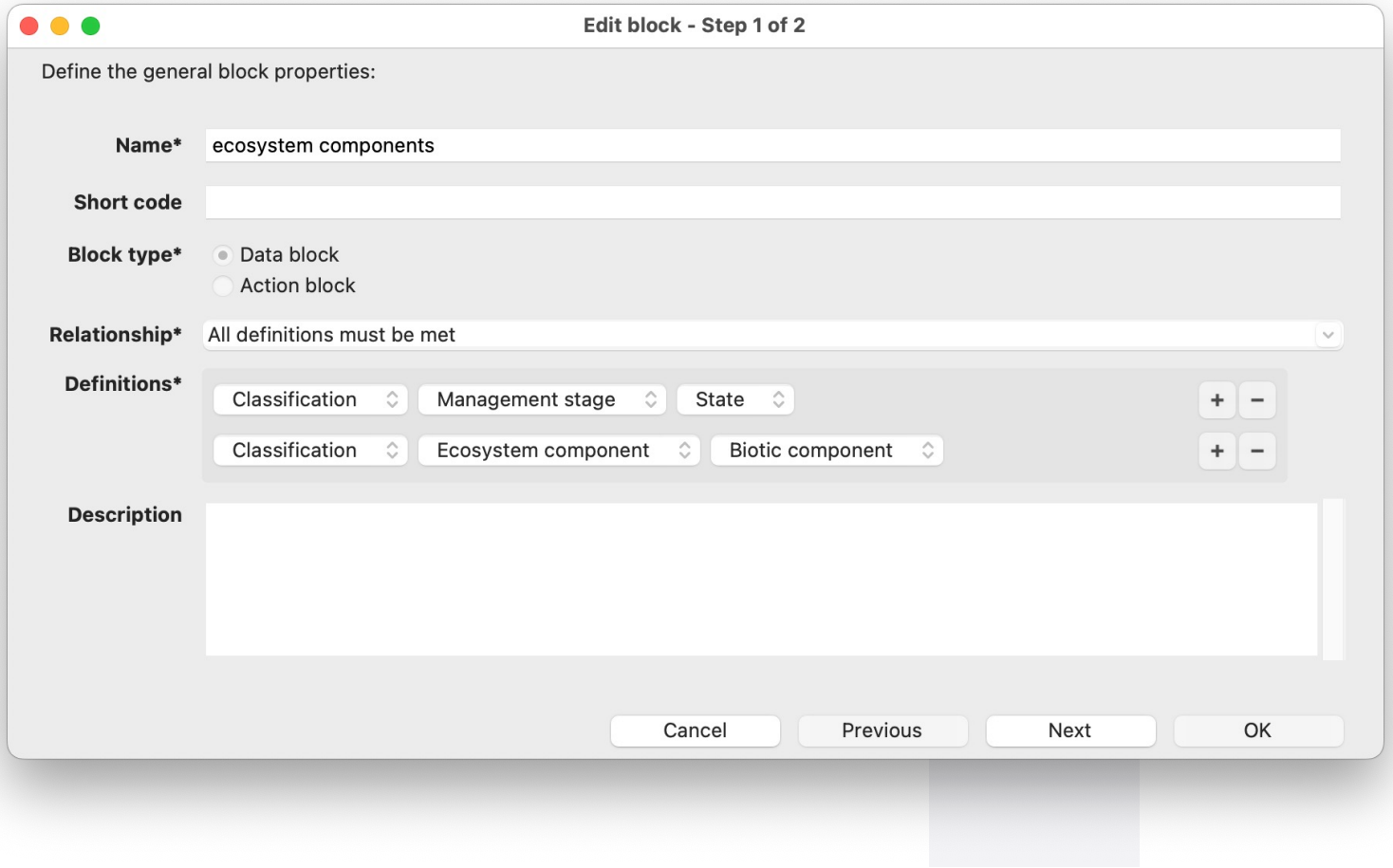


Import & export of spatial and thematic datasets



Flexible custom analysis templates using graphical „modeler“

Toolbox components – “Analysis templates”

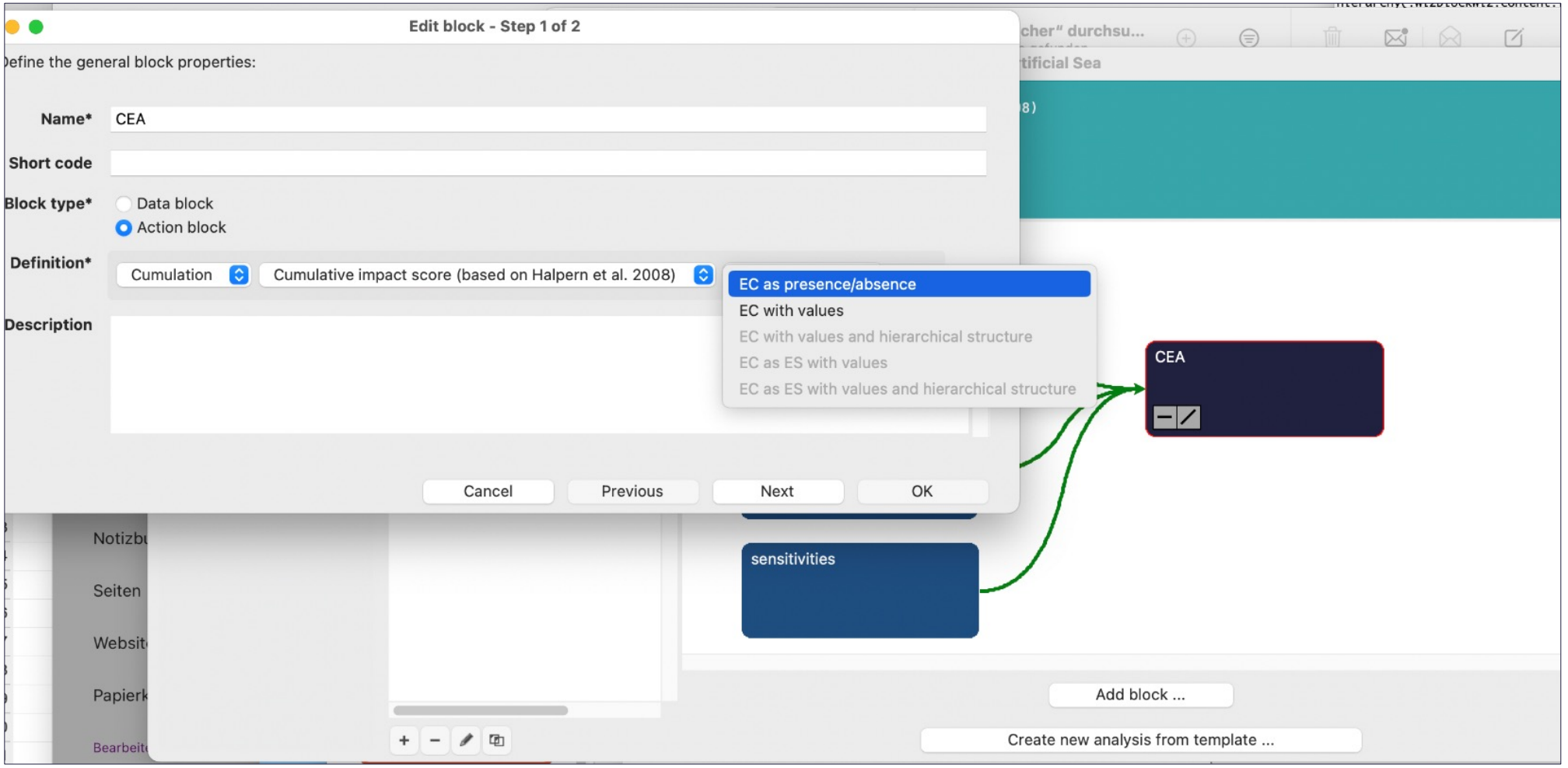


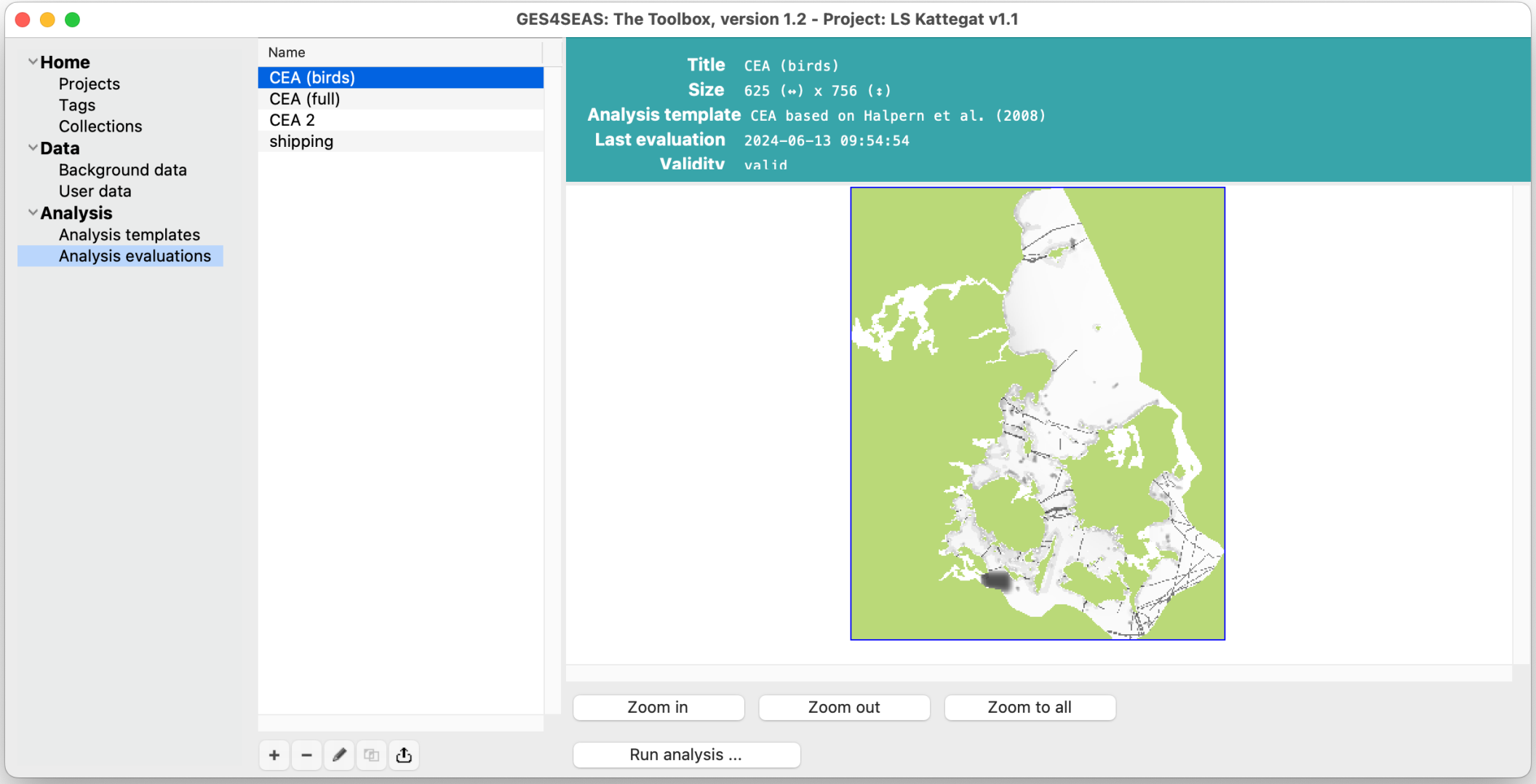
Easy definition of model building blocks – using own GUI package „toolworks“

toolworks package – example

```
twForm::Form blockWiz_p1 -dialog 0 -path $page1.f -ok {} -cancel {}
blockWiz_p1 add entry -label [mc Name]* -value $blockData(modelblock)
blockWiz_p1 add entry -label [mc "Short code"] -value $shortcode
blockWiz_p1 add radiogroup -label [mc "Block type"]* \
    -items [list data [mc "Data block"] action [mc "Action block"]] \
    -checkedValue $blockData(mb_type) -command ::gui::analysisTemplateBlockNewEdit2
blockWiz_p1 add combobox -label [mc Relationship]* -keyed 1 -defaultkey $relDefault -values $relList
blockWiz_p1 add query -label [mc Definitions]* -returnformat {id+ value} \
    -default $blockData(mb_definition,data) -definition {
            choice -label Classification -id 14
            -value {select dataset_id from md_item_dataset where}
            -children {choice -label "Management stage" -id 18 -value {} -children {
                        choice -label Driver -id 19 -value {md_element_id=19}
                        choice -label Activity -id 20 -value {md_element_id=20}
                        choice -label Pressure -id 21 -value {md_element_id=21}
                        …
blockWiz_p1 add text -label [mc Description] -height 10 -value $blockData(mb_comment)
```

Toolbox components – “Analysis templates”

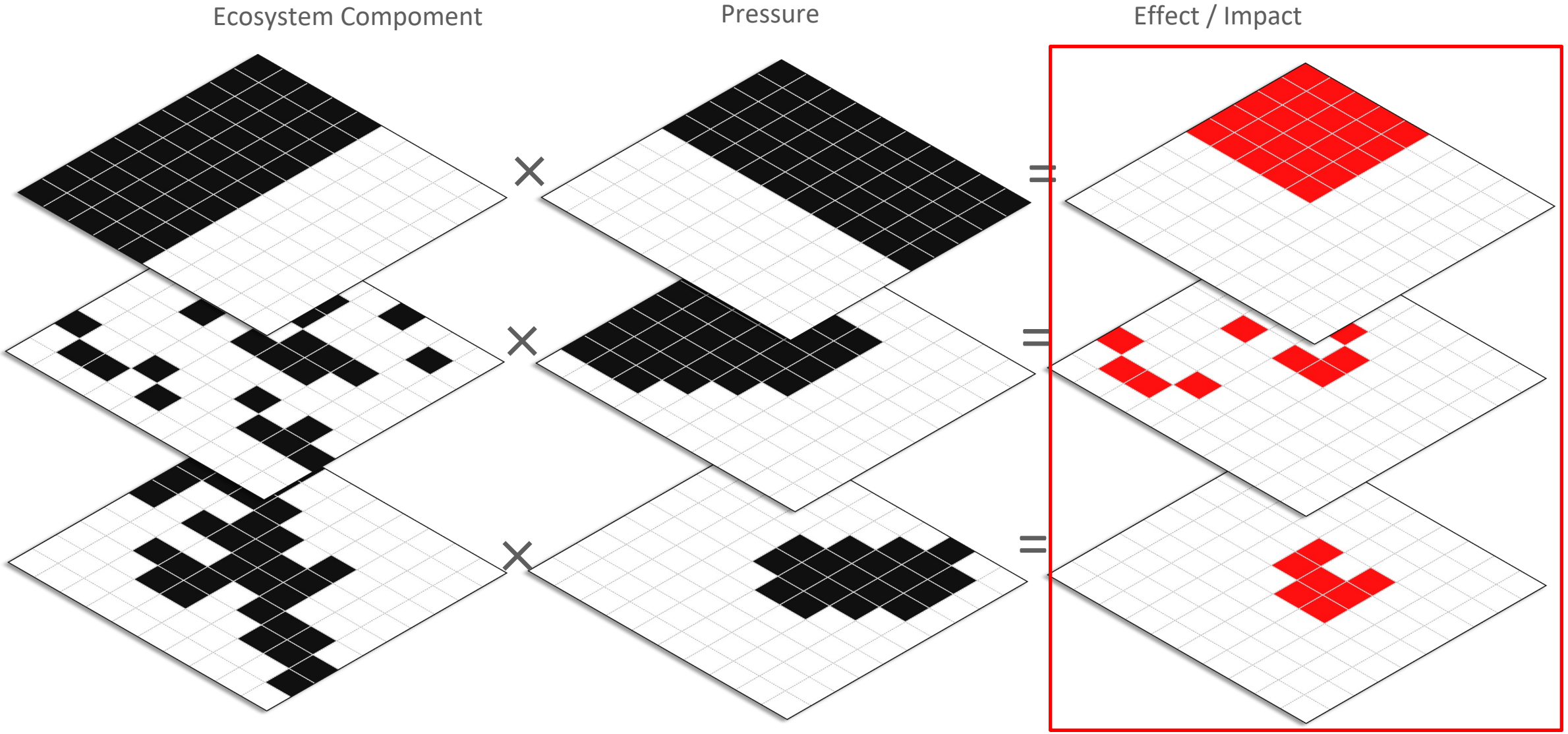




Running analysis & map output

GDAL package – example

```
(GES4SEAS) 5 % gdal info data/sedimenttyp.gpkg infoArray -layer sedimenttyp
(GES4SEAS) 6 % parray infoArray
infoArray(BBox)           = 4288478.4498 3425249.644 4628478.4498 3552749.644
infoArray(bandCount)      = 1
infoArray(dataType,1)     = Float32
infoArray(dataTypeName,1) = Thirty two bit signed integer
infoArray(driver)         = GPKG
infoArray(maxValue,1)     = 254.0
infoArray(minValue,1)     = 12.0
infoArray(nodataValue,1)  = 0.0
infoArray(projection)     = PROJCS["ETRS89-extended / LAEA
Europe",GEOGCS["ETRS89",DATUM["European_Terrestrial_Reference_System_1989",SPHEROID["GRS
1980",6378137,298.257222101,AUTHORITY["EPSG","7019"]],AUTHORITY["EPSG","6258"]],PRIMEM["Greenwich",0,AUTHORI
TY["EPSG","8901"]],UNIT["degree",0.0174532925199433,AUTHORITY["EPSG","9122"]],AUTHORITY["EPSG","4258"]],PROJ
ECTION["Lambert_Azimuthal_Equal_Area"],PARAMETER["latitude_of_center",52],PARAMETER["longitude_of_center",10
],PARAMETER["false_easting",4321000],PARAMETER["false_northing",3210000],UNIT["metre",1,AUTHORITY["EPSG","90
01"]],AXIS["Northing",NORTH],AXIS["Easting",EAST],AUTHORITY["EPSG","3035"]]
----------------
set valueList [gdal read data/sedimenttyp.gpkg infoArray -layer sedimenttyp]
```


Ecosystem Compoment
Pressure
Effect / Impact

Typical calculation case …

- Size: 625 x 756 cells (each cell 500 x 500 m) = 472,500 cells
- Layers: 51 ecosystem components, 41 pressures
- → 51 x 41 = 2,091 combinations of layers per cell
- → 2,091 x 472,500 = 987,997,500 individual calculations

- Calculation time on a recent Mac mini ≈ 2,5 minutes

Future until 2026 …

- many more feature coming on a monthly basis as the project is on-going
- speed up calculations: vecTcl?
- embedding Tcl & R as scripting languages
- release GDAL package as open source (GDAL is a beast with ≈ 12–50 dependencies)
- release toolworks package as open source (mostly custom megawidgets)

… and I can’t wait to bring the toolbox to Tcl 9!

Thank you!

Torsten Berg

berg@marilim.de

www.ges4seas.eu

Grant Agreement
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