



SWOS
Satellite-based Wetland
Observation Service



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 642088

Projet SWOS

Cartographie de l'occupation du sol et du SE de protection contre les crues

Rencontre Gestionnaires ZH Med (France)

Tour du Valat, 22/03/2018

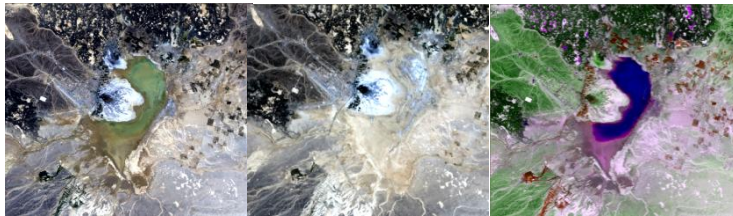
Anis GUELMAMI (Tour du Valat)



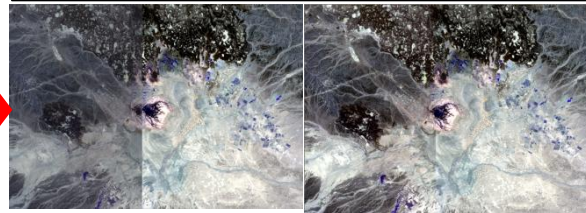
Land Use/Land Cover (LULC)

LULC and habitats dynamics

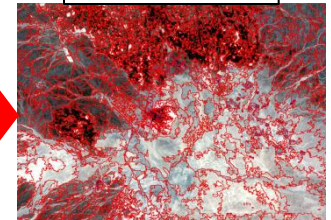
Satellite input images



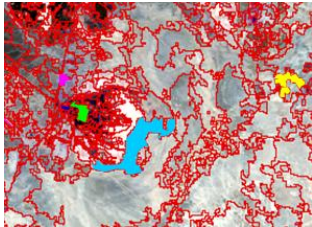
Radiometric and geometric pre-processing



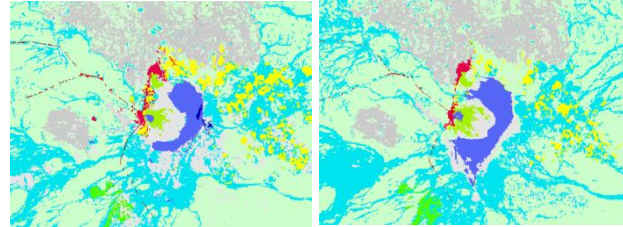
Segmentation



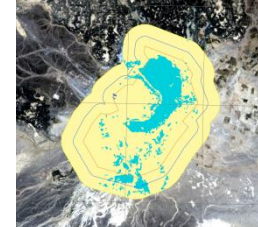
Training for classification



LULC classification result of 2 different years



WCR classification

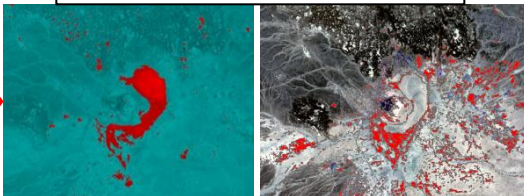


T1 (ex. 1987)

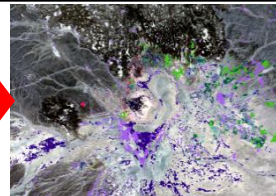
T2 (ex. 2000)

T3 (ex. 2017)

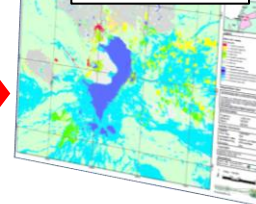
Change / no-change masking



Post classification change



Map layout

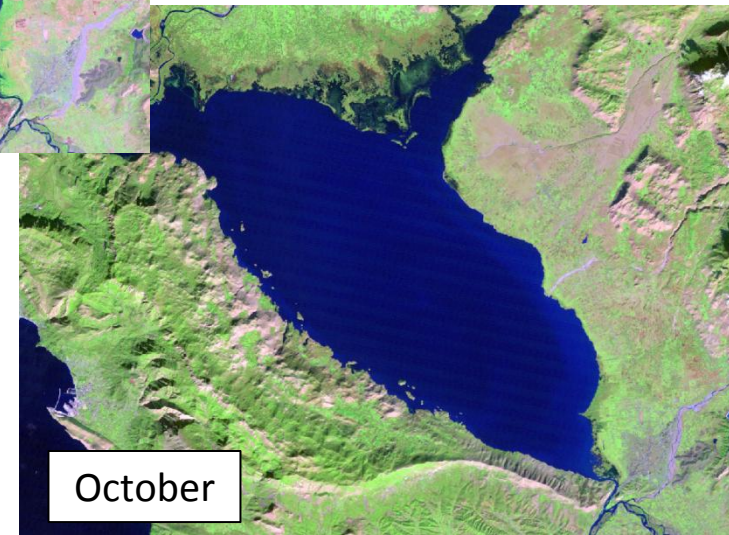
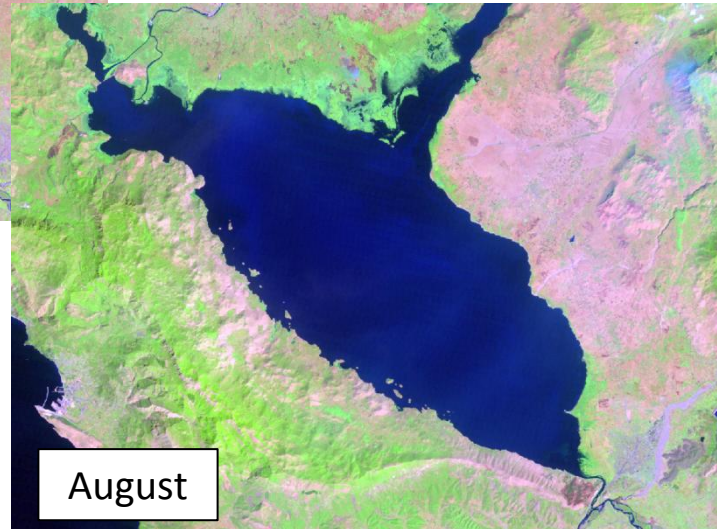
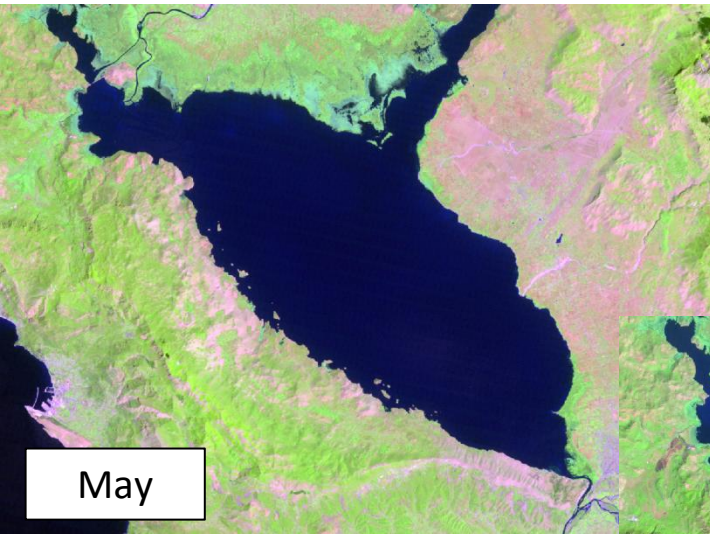


Indicator computation

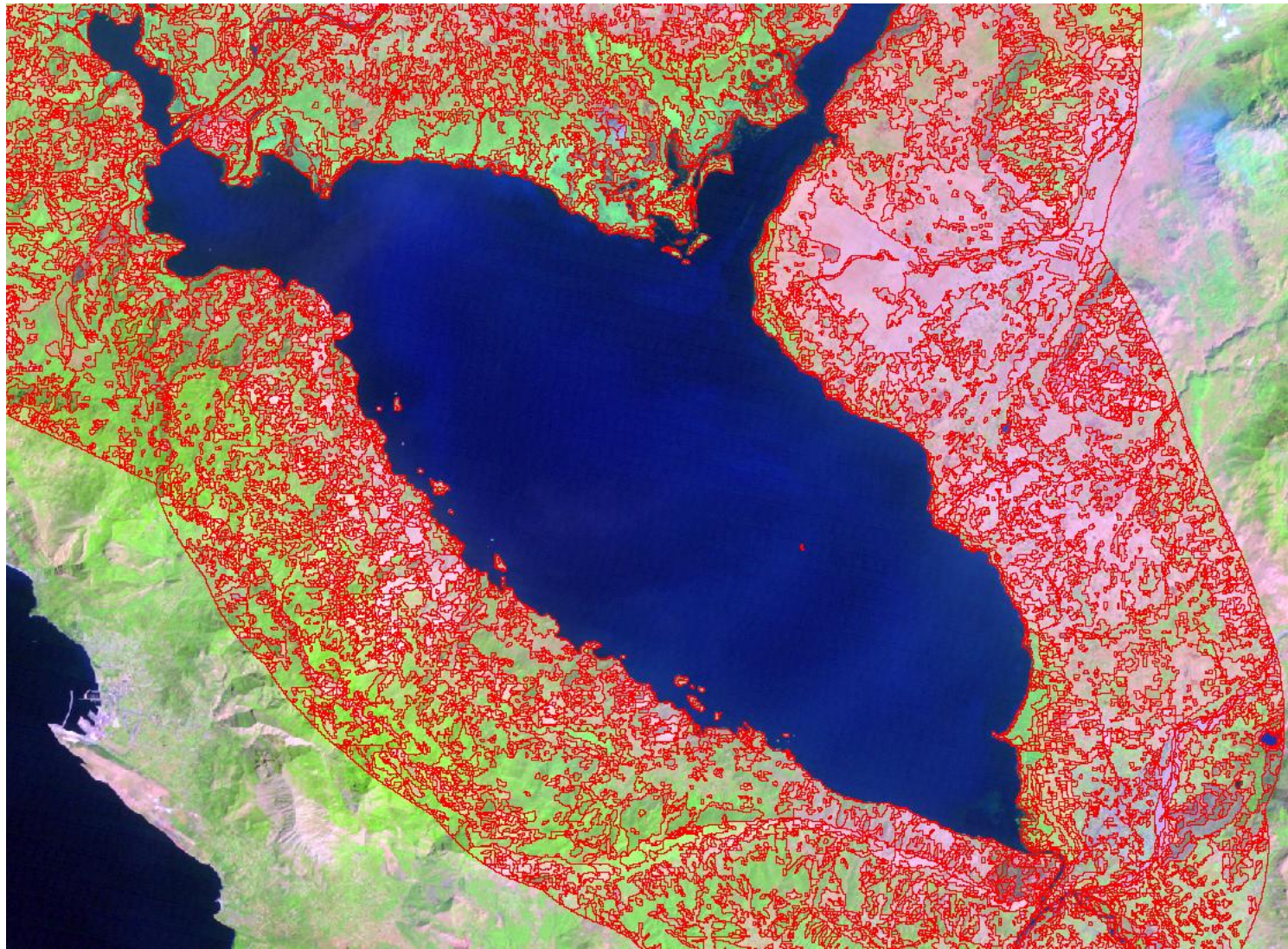
| OID | Level | from Level | IndCAU |
|-----|---------------------|--------------------------------|--------|
| 0 | Agricultural areas | Artificial surfaces | 0.01 |
| 1 | Agricultural areas | Forests and semi-natural areas | 0.31 |
| 2 | Agricultural areas | Water bodies | 0.25 |
| 3 | Agricultural areas | Wetlands | 0.96 |
| 4 | Artificial surfaces | Agricultural areas | 0.21 |
| 5 | Artificial surfaces | Water bodies | |
| 6 | Artificial surfaces | Wetlands | |

LULC mapping

A multi-temporal approach for
the intra-annual mapping

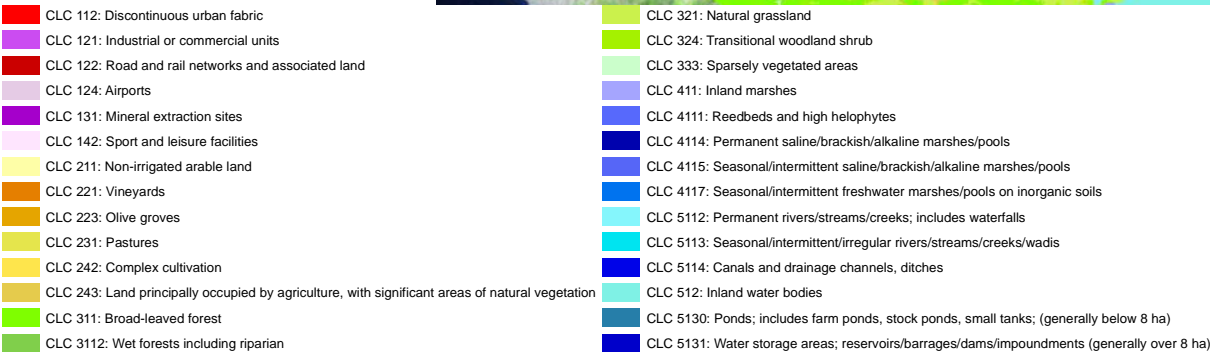
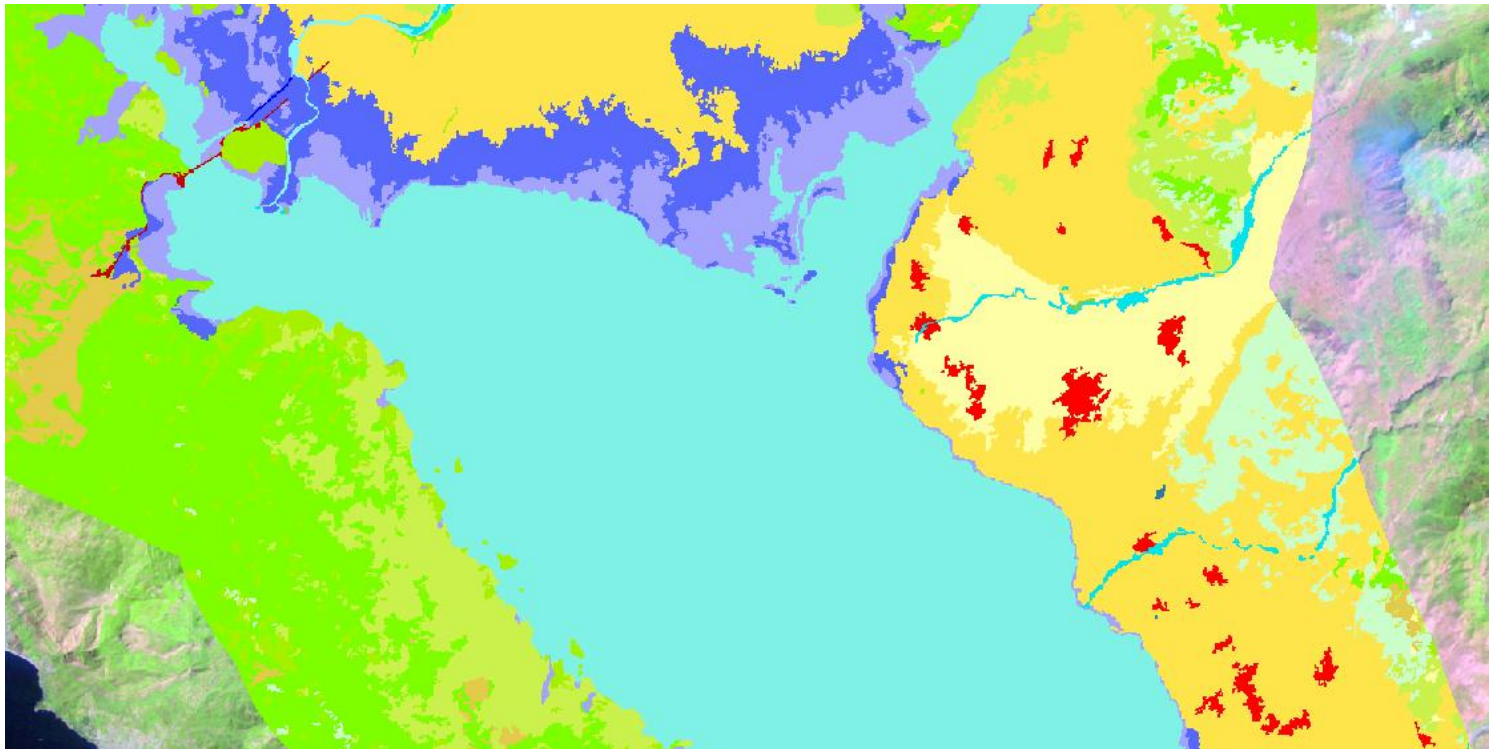


Object-based approach → image segmentation

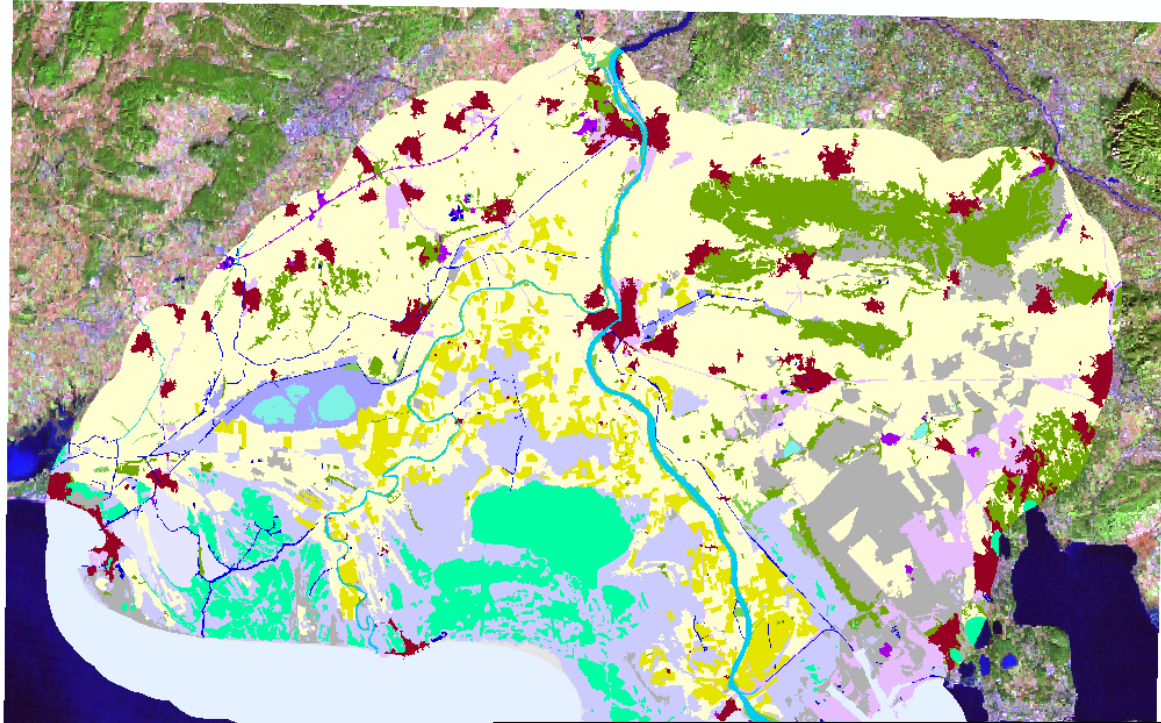


LULC mapping

Object-based approach → image classification



LULC mapping

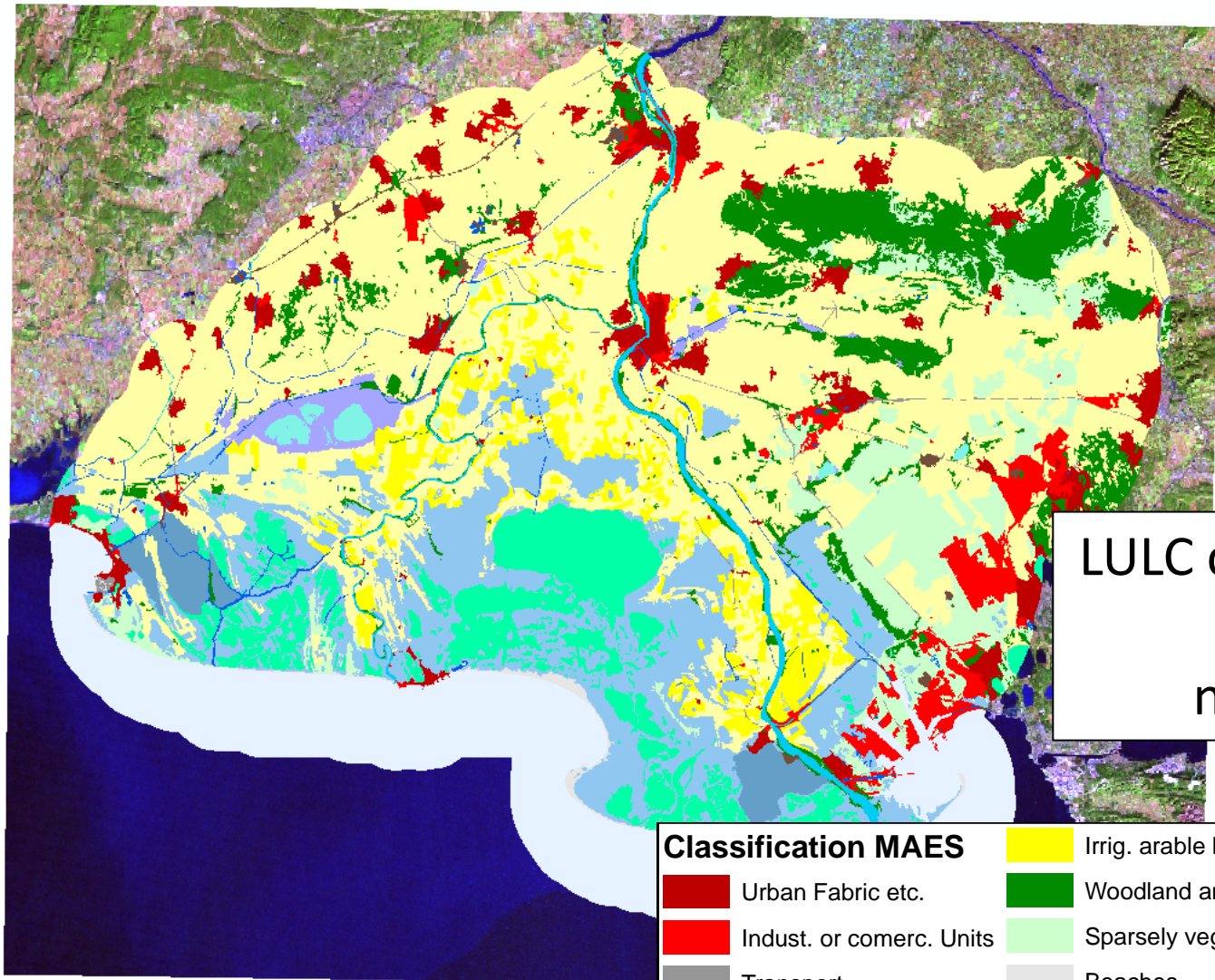


LULC classification 2015
using CLC/Ramsar
nomenclature

Classification GWII

- | | |
|--|--|
| CLC 11: Urban fabric | CLC 411: Inland marshes |
| CLC 12: Industrial, commercial and transport units | CLC 421: Salt marshes |
| CLC 13: Mine, dump and construction sites | CLC 422: Salines |
| CLC 2: Agricultural areas | CLC 511: Inland water courses |
| CLC 213: Rice fields | CLC 5114: Canals and drainage channels, ditches |
| CLC 31: Forests | CLC 512: Inland water bodies |
| CLC 3112: Wet forests including riparian | CLC 5131: Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 ha) |
| CLC 33: Open spaces with little or no vegetation | CLC 521: Coastal lagoons |
| CLC 331: Beaches, dunes, and sand plains | CLC 523: Sea and ocean |

LULC mapping



LULC classification 2015
using MAES
nomenclature

Classification MAES

Urban Fabric etc.

Indust. or comerc. Units

Transport

Mineral extraction etc.

Croplands

Irrig. arable land and rice

Woodland and Forests

Sparsely vegetated areas

Beaches

Inland freshwater marshes

Maritime wetlands

Salines

Coastal lagoons

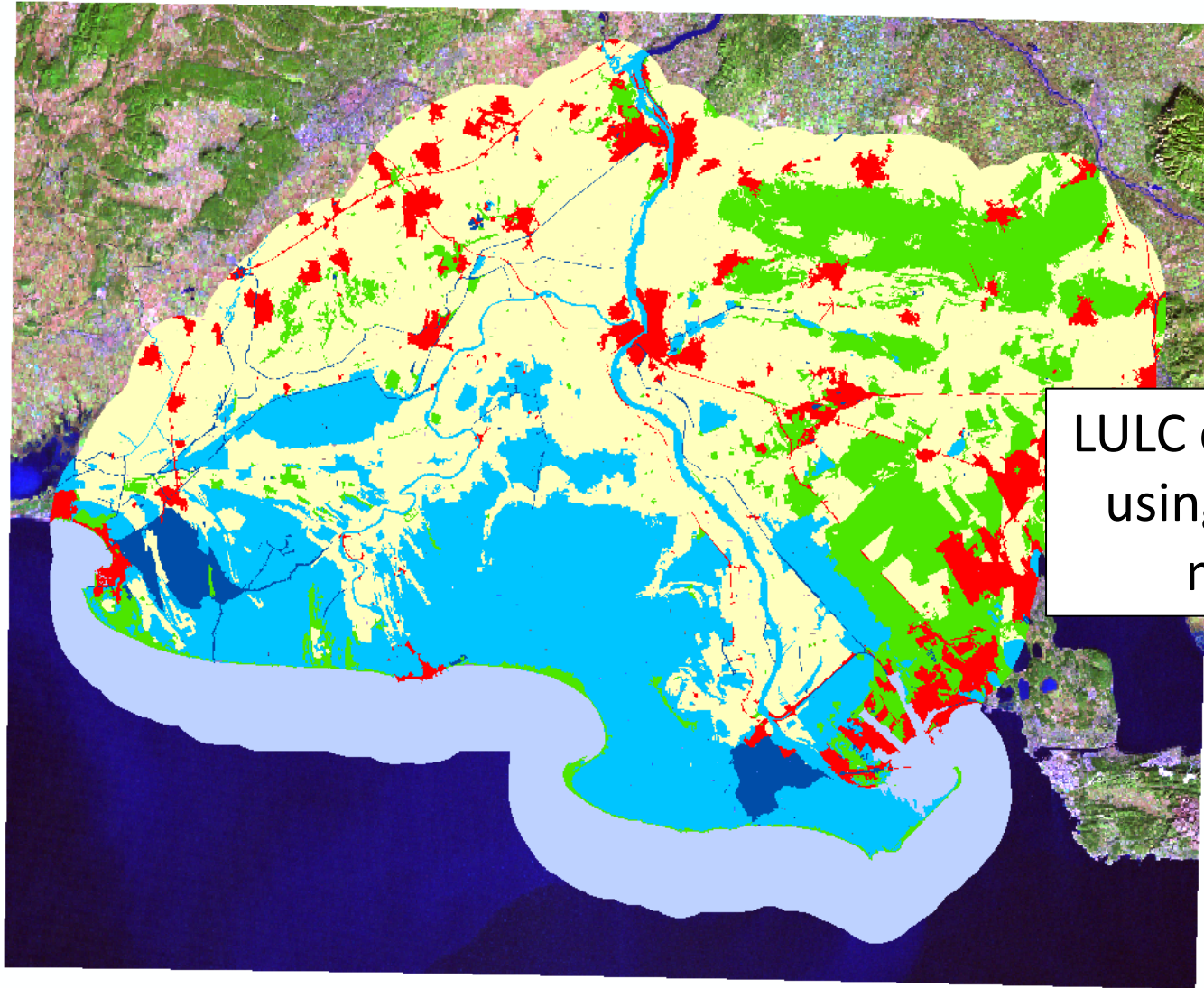
Water courses

Natural water bodies

Artificial water bodies

Marine (other)

LULC mapping



LULC classification 2015
using a « simplified »
nomenclature

MWO Nomenclature

| | |
|---|-------------------------------------|
|  | Built-up areas |
|  | Agricultural lands (including rice) |
|  | Natural terrestrial lands |
|  | Natural wetlands |
|  | Artificial wetlands |
|  | Sea |

Flood regulation mapping

An indicator on flood regulation as an ecosystem service should take into account three key variables:

- **Ecosystem or land use capacity to provide the service**
- **Service demand of the ecosystem or land use**
In the case of flooding, they are mainly those areas where human activities are concentrated: agro-ecosystems, urban areas, roads, etc.
- **Conditions of the environment affecting the generation and distribution of floods and the regulation service** *Precipitation, slopes, land management, soil texture, vegetation density, etc. In summary, anything that could contribute to flood generation and affect or change the way an ecosystem offers its regulation service.*

A very simple way to map flood regulation based on land coverage would be assigning scores to each type of Land Use/Land Cover (LULC)

| | | Ecological Integrity | | | | | | Regulating services | | | | | | Provisioning services | | | | | | Cultural services | | | | | | |
|----------------------------------|-------------------------|----------------------|--------------|-------------------|----------------------|----------------------------|--------------------------|--------------------------|---------------------------|-----------------|----------------------|------------------------|--------------------|-----------------------|--------------------|-------|-----------|--------|-------------------|-------------------|------------|--------|-----------|--------|---------------------------|-----------------------------|
| | CORINE land cover type: | Biotic heterogeneity | Biodiversity | Biotic well-being | Metabolic efficiency | Energy Capture (Radiation) | Storage of Nutrient loss | Local climate regulation | Global climate regulation | Food production | Sourcewater recharge | Air Quality Regulation | Erosion Regulation | Nutrient regulation | Water purification | Crops | Livestock | Fodder | Capture Fisheries | Aquaculture | Wild Foods | Timber | Wood Fuel | Energy | Biochemicals and Medicine | Recreation/Aesthetic Values |
| Continuous urban fabric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Discontinuous urban fabric | | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Industrial or commercial units | | 9 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Road and rail networks | | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Port areas | | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Airports | | 7 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mineral extraction sites | | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dump sites | | 6 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Construction sites | | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green urban areas | | 18 | 3 | 3 | 2 | 1 | 4 | 3 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Sport and leisure facilities | | 16 | 2 | 2 | 2 | 1 | 4 | 3 | 2 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-irrigated arable land | | 22 | 3 | 2 | 3 | 4 | 1 | 4 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 21 | 5 | 5 | 5 | 0 | 0 | 0 | 4 | 1 | 1 |
| Permanently irrigated land | | 21 | 3 | 2 | 5 | 2 | 1 | 3 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 18 | 5 | 5 | 2 | 0 | 0 | 0 | 1 | 1 | 1 |
| Ricefields | | 20 | 3 | 2 | 5 | 1 | 1 | 3 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 1 |
| Vineyards | | 14 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Fruit trees and berries | | 21 | 4 | 3 | 4 | 3 | 2 | 3 | 19 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 6 | 13 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 0 |
| Olive groves | | 17 | 3 | 3 | 2 | 3 | 1 | 3 | 7 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 12 | 4 | 0 | 0 | 0 | 4 | 4 | 1 | 0 |
| Pastures | | 24 | 2 | 2 | 4 | 5 | 5 | 4 | 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 10 | 5 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| Annual and permanent crops | | 18 | 2 | 2 | 3 | 2 | 4 | 2 | 7 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 20 | 5 | 5 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| Complex cultivation patterns | | 19 | 4 | 3 | 3 | 2 | 4 | 1 | 3 | 5 | 2 | 1 | 1 | 0 | 0 | 0 | 9 | 4 | 0 | 3 | 0 | 0 | 0 | 1 | 2 | 2 |
| Agriculture's natural vegetation | | 10 | 3 | 3 | 2 | 3 | 2 | 3 | 13 | 3 | 2 | 1 | 2 | 1 | 3 | 0 | 21 | 3 | 3 | 2 | 0 | 13 | 3 | 3 | 1 | 5 |
| Agro-forestry areas | | 21 | 4 | 4 | 4 | 3 | 4 | 4 | 13 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 3 | 2 | 0 | 0 | 0 | 3 | 3 | 0 | 3 |
| Broad-leaved forest | | 31 | 4 | 5 | 4 | 5 | 5 | 5 | 30 | 5 | 4 | 3 | 0 | 5 | 5 | 5 | 5 | 21 | 0 | 1 | 0 | 6 | 5 | 5 | 1 | 5 |
| Coniferous forest | | 30 | 3 | 4 | 4 | 5 | 5 | 5 | 29 | 5 | 4 | 3 | 2 | 5 | 5 | 5 | 5 | 21 | 0 | 0 | 1 | 5 | 5 | 5 | 1 | 5 |
| Mixed forest | | 32 | 3 | 5 | 4 | 5 | 5 | 5 | 38 | 5 | 4 | 3 | 2 | 5 | 5 | 5 | 5 | 21 | 0 | 1 | 0 | 5 | 5 | 5 | 1 | 5 |
| Natural grassland | | 30 | 5 | 4 | 4 | 4 | 5 | 5 | 22 | 2 | 3 | 1 | 1 | 0 | 5 | 5 | 0 | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 6 |
| Moors and heathland | | 30 | 4 | 4 | 5 | 4 | 5 | 5 | 20 | 4 | 3 | 2 | 2 | 0 | 3 | 4 | 2 | 10 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 3 |
| Sclerophyllous vegetation | | 21 | 3 | 4 | 2 | 3 | 3 | 4 | 7 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 8 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 3 |
| Transitional woodland/shrub | | 21 | 3 | 4 | 2 | 3 | 3 | 4 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 3 |
| Beaches, dunes and sand plains | | 10 | 3 | 3 | 1 | 1 | 1 | 0 | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Bare rock | | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Sparsely vegetated areas | | 9 | 2 | 3 | 1 | 0 | 1 | 1 | 3 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Burnt areas | | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glaciers and perpetual snow | | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 10 | 3 | 3 | 0 | 4 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Inland marshes | | 25 | 3 | 2 | 4 | 4 | 3 | 5 | 14 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 7 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| Peatbogs | | 29 | 3 | 4 | 4 | 4 | 5 | 5 | 24 | 4 | 5 | 3 | 3 | 0 | 0 | 0 | 3 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Salt marshes | | 23 | 3 | 2 | 4 | 3 | 3 | 5 | 8 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Saïnes | | 8 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Intertidal flats | | 13 | 2 | 3 | 0 | 2 | 1 | 4 | 1 | 7 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Water courses | | 16 | 4 | 4 | 0 | 3 | 3 | 3 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 3 | 0 | 4 | 0 | 3 | 5 |
| Water bodies | | 23 | 4 | 4 | 0 | 4 | 4 | 3 | 7 | 2 | 1 | 1 | 3 | 0 | 1 | 0 | 12 | 0 | 0 | 0 | 3 | 0 | 4 | 0 | 0 | 5 |
| Coastal lagoons | | 25 | 4 | 4 | 0 | 5 | 5 | 3 | 5 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 4 | 5 | 4 | 0 | 1 | 0 |
| Estuaries | | 21 | 3 | 3 | 0 | 5 | 5 | 3 | 9 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 5 | 5 | 4 | 0 | 2 | 0 |
| Sea and ocean | | 16 | 2 | 2 | 0 | 3 | 3 | 4 | 1 | 13 | 3 | 5 | 0 | 0 | 0 | 0 | 11 | 0 | 1 | 5 | 0 | 0 | 3 | 0 | 6 | 4 |

| CORINE land cover type: | Regulating services | | | | | | | | Provisioning services | | | | | | | | Cultural services | | | | | | | |
|----------------------------------|--------------------------|---------------------------|------------------|----------------------|------------------------|--------------------|--------------------|-------------|-----------------------|-----------|-------|-------------------|-------------|------------|--------|-----------|-------------------|------------|----------|------------|---------------------------|------------------------|--|--|
| | Local climate regulation | Global climate regulation | Flood protection | Groundwater recharge | Air Quality Regulation | Erosion Regulation | Water purification | Pollination | Crops | Livestock | Woods | Capture Fisheries | Aquaculture | Wild Foods | Timber | Wood fuel | Energy | Recreation | Medicine | Resilience | Increased Aesthetic Value | Increased Biodiversity | | |
| Continuous urban fabric | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | |
| Discontinuous urban fabric | 5 | 5 | 5 | 5 | 5 | 1 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | |
| Industrial or commercial units | 1 | 5 | 4 | 5 | 5 | 1 | 3 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | | | |
| Road and rail networks | 2 | 4 | 4 | 1 | 4 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | | | |
| Port areas | 2 | 2 | 5 | 2 | 2 | 4 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 2 | 2 | 2 | 2 | 2 | 2 | | | |
| Airports | 2 | 5 | 1 | 1 | 5 | 1 | 1 | 2 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | | | |
| Mineral extraction sites | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 0 | | | |
| Dump sites | 2 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | | | |
| Construction sites | 0 | 0 | 2 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | 0 | 2 | 0 | 0 | | | |
| Green urban areas | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | | | |
| Sport and leisure facilities | 2 | 0 | 0 | 2 | 3 | 0 | 0 | 1 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | | | |
| Non-irrigated arable land | 2 | 2 | 2 | 0 | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | | | |
| Permanently irrigated land | 2 | 2 | 2 | 5 | 1 | 2 | 3 | 5 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 5 | 0 | 0 | | | |
| Ricefields | 3 | 4 | 5 | 5 | 1 | 5 | 5 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 5 | 0 | 0 | | | |
| Vineyards | 5 | 2 | 0 | 3 | 1 | 5 | 0 | 4 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 4 | 0 | 0 | | | |
| Fruit trees and berries | 2 | 1 | 0 | 3 | 1 | 1 | 1 | 2 | 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 3 | 0 | 0 | | | |
| Olive groves | 2 | 1 | 0 | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | | | |
| Pastures | 1 | 3 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | | | |
| Annual and permanent crops | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | | | |
| Complex cultivation patterns | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | | | |
| Agriculture & natural vegetation | 1 | 2 | 0 | 1 | 1 | 1 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 0 | | | |
| Agro-forestry areas | 1 | 1 | 0 | 1 | 1 | 0 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | | | |
| Broad-leaved forest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | | |
| Coniferous forest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | | |
| Mixed forest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | | |
| Natural grassland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Moors and heathland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Sclerophyllous vegetation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Transitional woodland shrub | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Beaches, dunes and sand plains | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | | |
| Bare rock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Sparsely vegetated areas | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Burnt areas | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Glaciers and perpetual snow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Inland marshes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Peatbogs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Salt marshes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Solines | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Intertidal flats | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Water courses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Water bodies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Coastal lagoons | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Estuaries | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Sea and ocean | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |

Ecosystem Service **supply** and **demand** for CLC classes

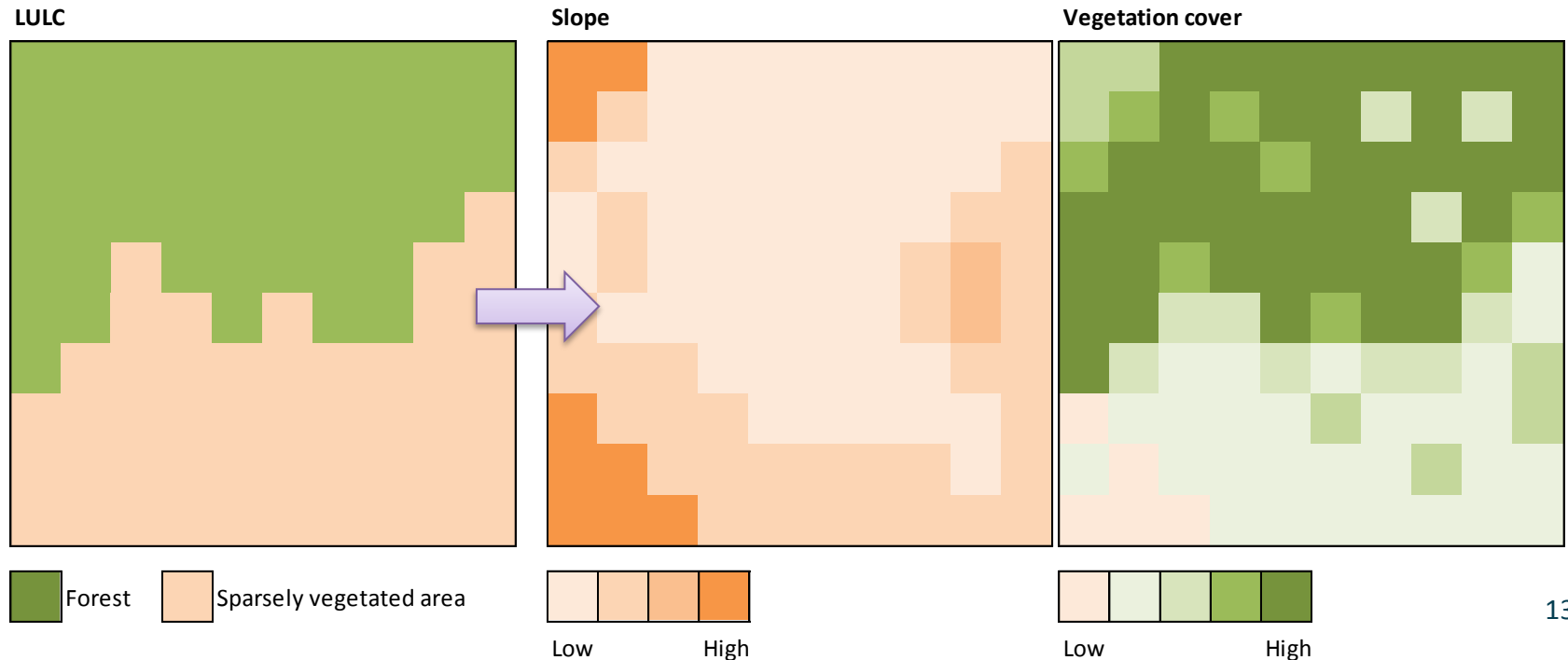
(Burkhard et al., 2012)

Conceptual approach

A very simple way to map flood regulation based on land coverage would be assigning scores to each type of Land Use/Land Cover (LULC)

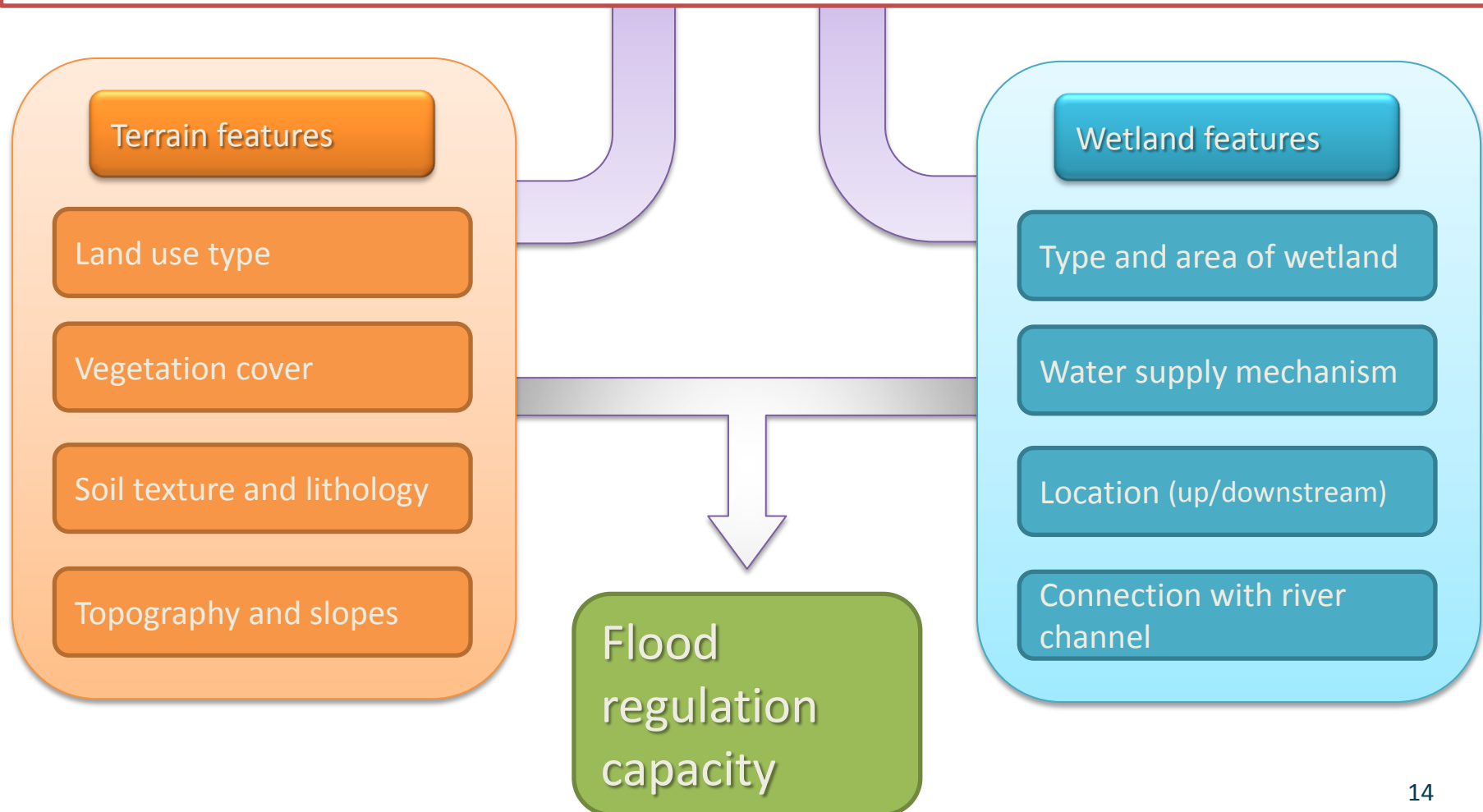
A forest would have a higher score than a sparsely vegetated area

However, these scores do not have a uniform distribution on the territory as properties which regulate water can change within the same type of LULC.



Conceptual approach

SWOS flood regulation indicator considers LULC and the environmental conditions affecting the generation of water run-off to assess the flood regulation capacity.



Example of the Lez river basin (SWOS test site)

The Lez river catchment (in red) and its main water courses in blue (the Lez, the Mosson and the canal from the Rhône to Sète)

Montpellier

The Lez river basin

Example of the Lez river basin (SWOS test site)

LULC map 1986-1987

Using the SWOS toolbox and
the CLC/Ramsar hybrid
nomenclature

- CLC 111: Continuous urban fabrics
- CLC 112: Discontinuous urban fabric
- CLC 121: Industrial or commercial units
- CLC 122: Road and rail networks and associated land
- CLC 123: Port areas
- CLC 124: Airports
- CLC 131: Mineral extraction sites
- CLC 1311: Excavations; gravel/brick/clay pits; borrow pits, mining pools
- CLC 133: Construction sites
- CLC 141: Green urban areas
- CLC 142: Sport and leisure facilities
- CLC 211: Non-irrigated arable land
- CLC 221: Vineyards
- CLC 222: Fruit trees and berry plantations
- CLC 223: Olive groves
- CLC 2313: Wet pastures
- CLC 242: Complex cultivation
- CLC 311: Broad-leaved forest
- CLC 3112: Wet forests including riparian
- CLC 312: Coniferous forest
- CLC 321: Natural grassland
- CLC 323: Sclerophyllous vegetation
- CLC 324: Transitional woodland shrub
- CLC 331: Beaches, dunes, and sand plains
- CLC 333: Sparsely vegetated areas
- CLC 411: Inland marshes
- CLC 421: Salt marshes
- CLC 5112: Permanent rivers/streams/creeks; includes waterfalls
- CLC 5114: Canals and drainage channels, ditches
- CLC 512: Inland water bodies
- CLC 5130: Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha)
- CLC 5131: Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 ha)
- CLC 5132: Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc
- CLC 521: Coastal lagoons
- CLC 523: Sea and ocean

Background Landsat-TM 1986-06-25

Example of the Lez river basin (SWOS test site)

LULC map 2013-2014

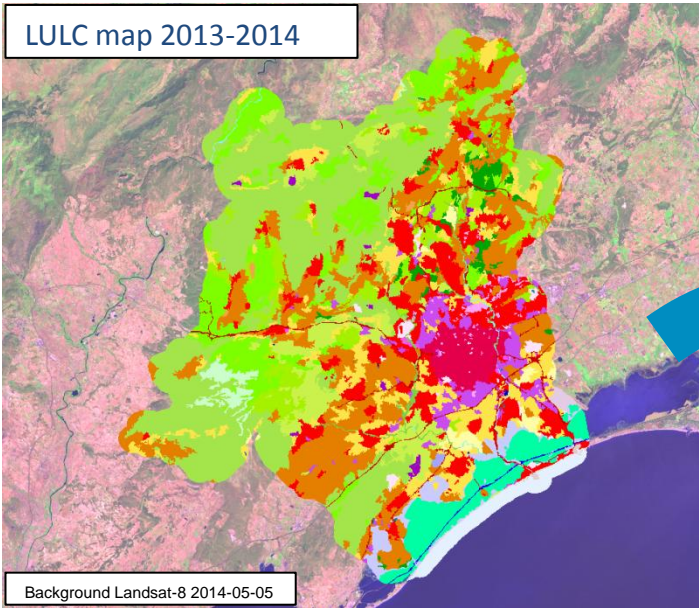
Using the SWOS toolbox and
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Background Landsat-8 2014-05-05

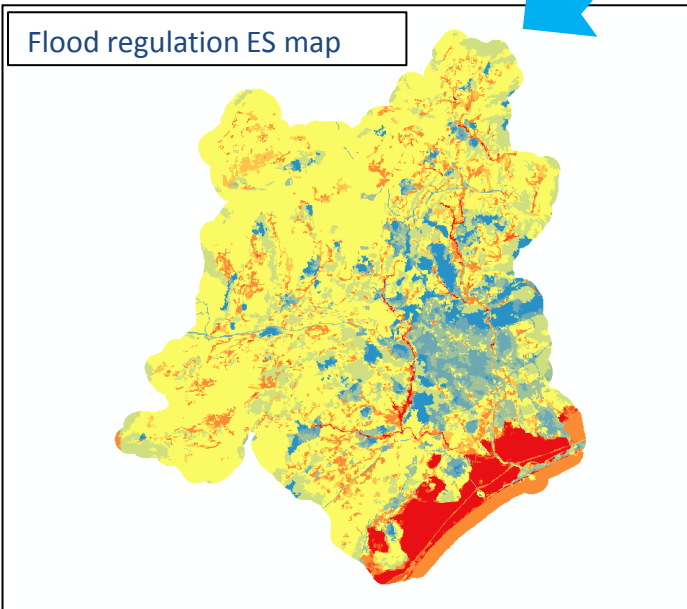
Example of the Lez river basin (France)

LULC map 2013-2014



Background Landsat-8 2014-05-05

Flood regulation ES map

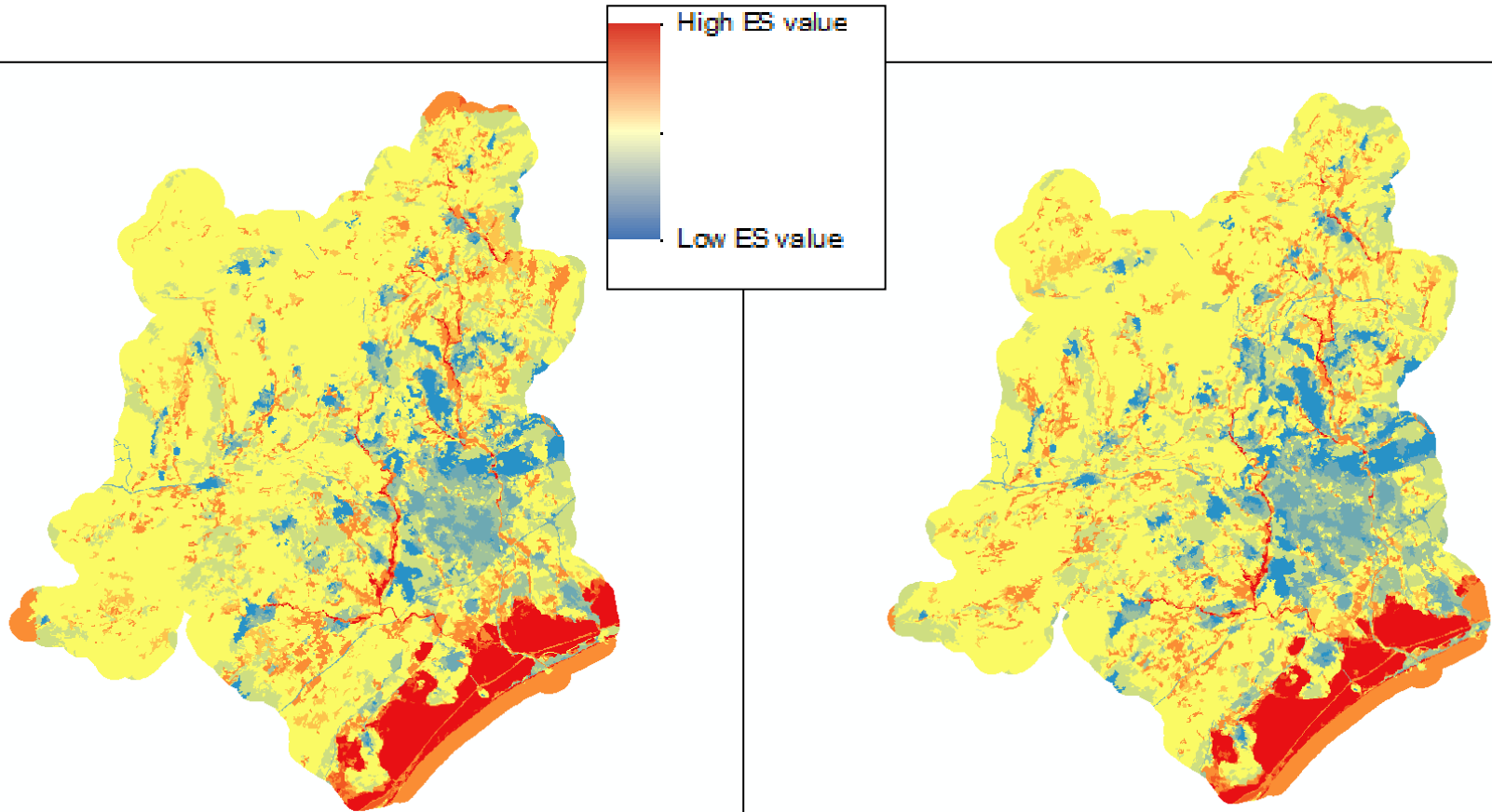


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High ES value

Low ES value

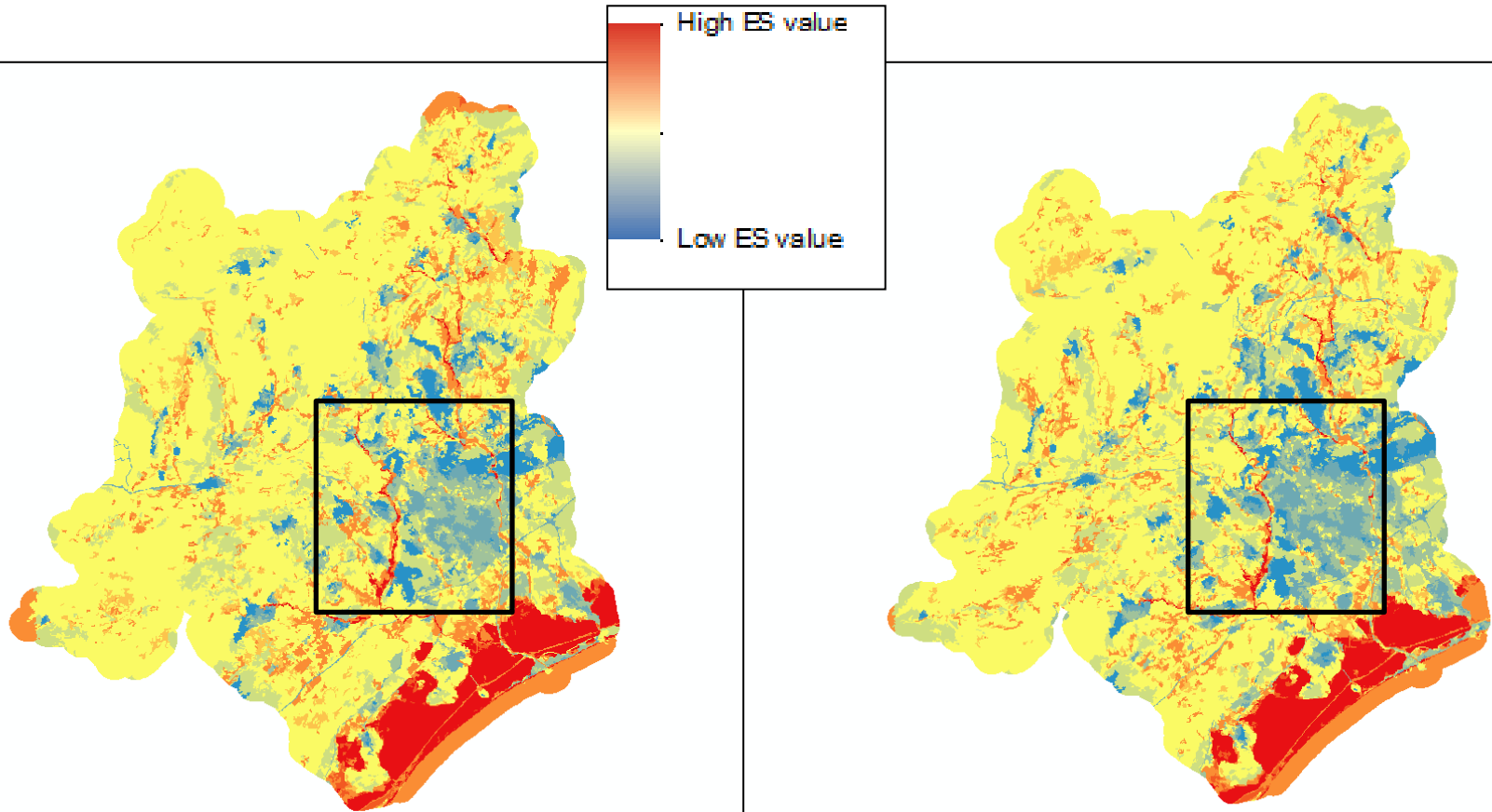
Example of the Lez river basin (SWOS test site)



Flood regulation map 1987

Flood regulation map 2015

Example of the Lez river basin (SWOS test site)

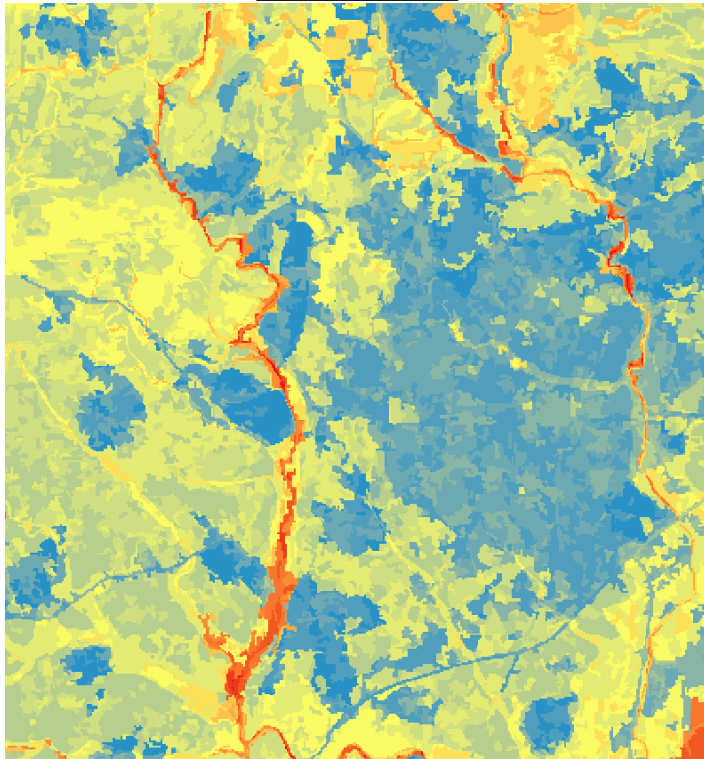
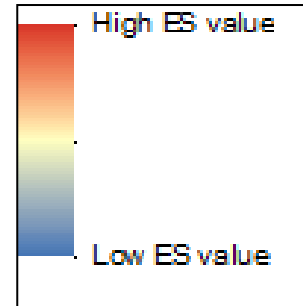


Flood regulation map 1987

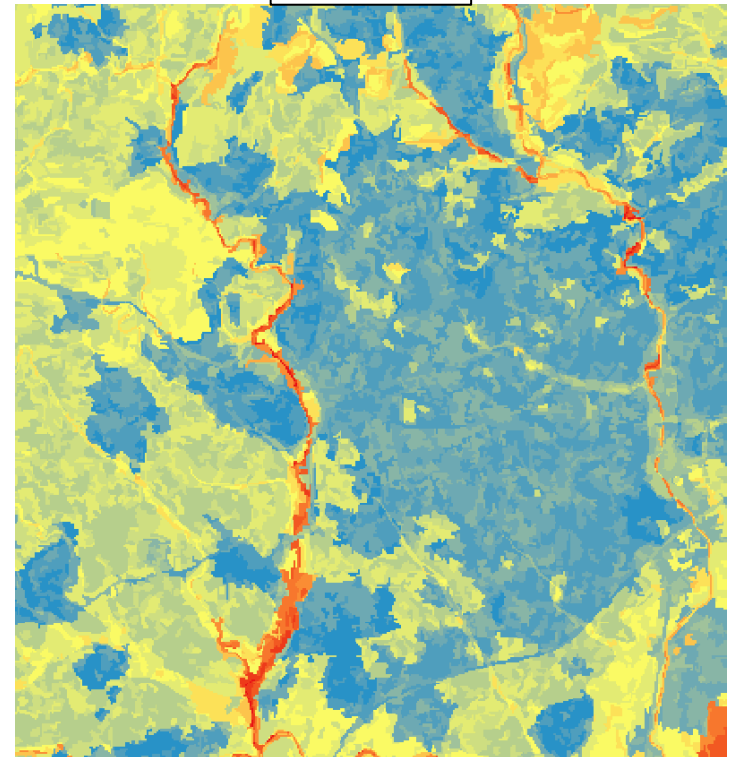
Flood regulation map 2015

Example of the Lez river basin (SWOS test site)

1987



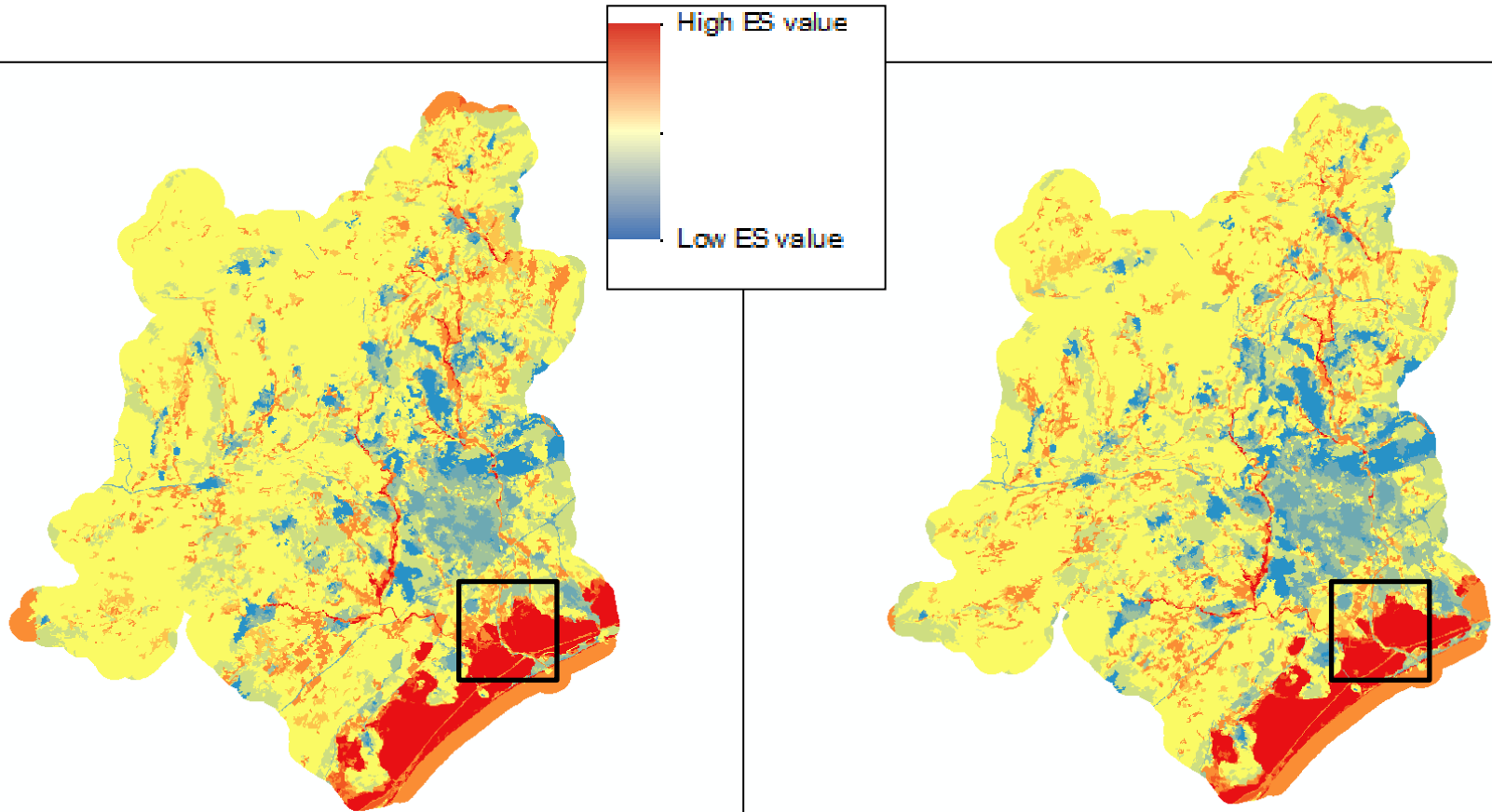
2015



Urban expansion

➔ a loss in the ES value (less flood regulation capacity)

Example of the Lez river basin (SWOS test site)

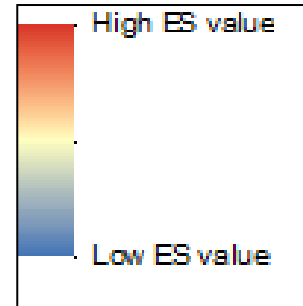
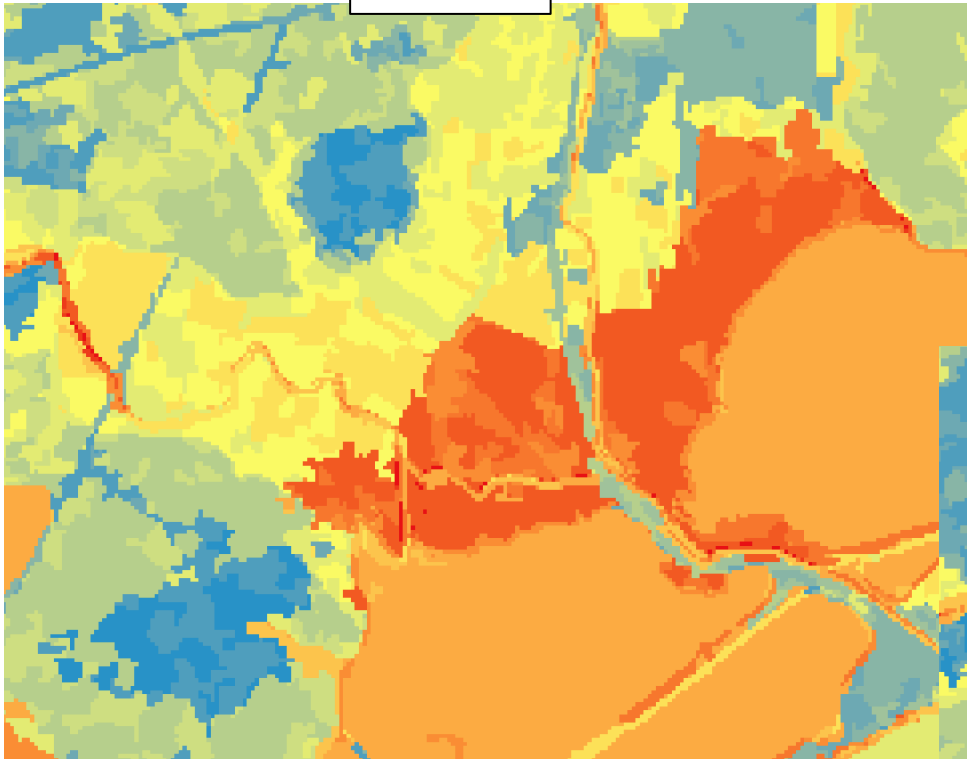


Flood regulation map 1987

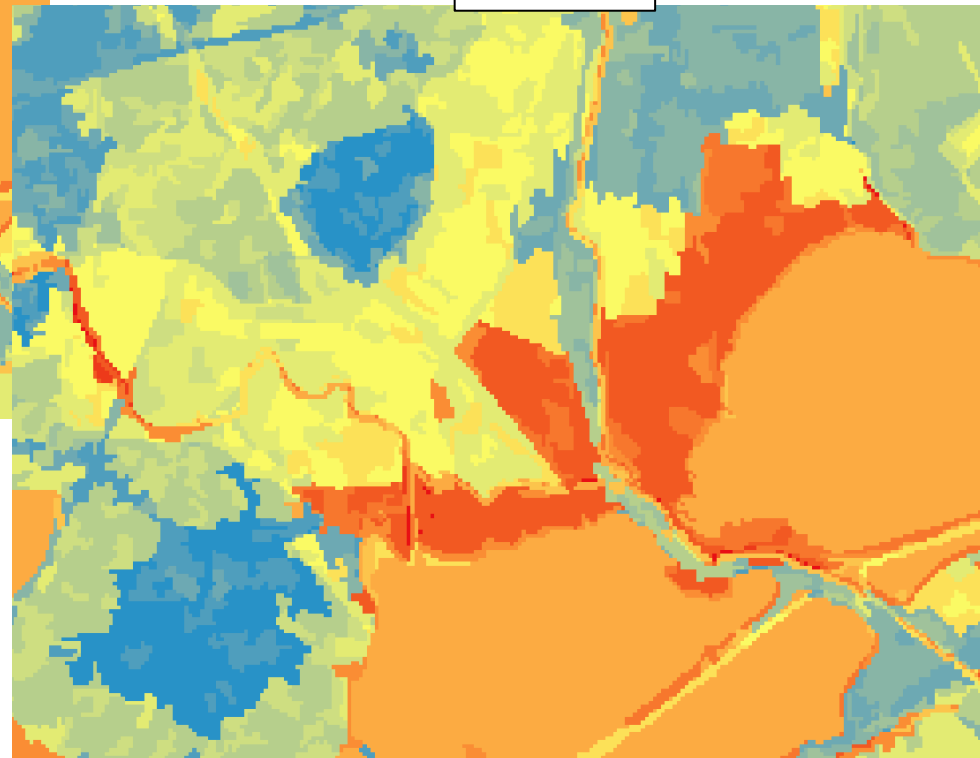
Flood regulation map 2015

Example of the Lez river basin (SWOS test site)

1987



2015

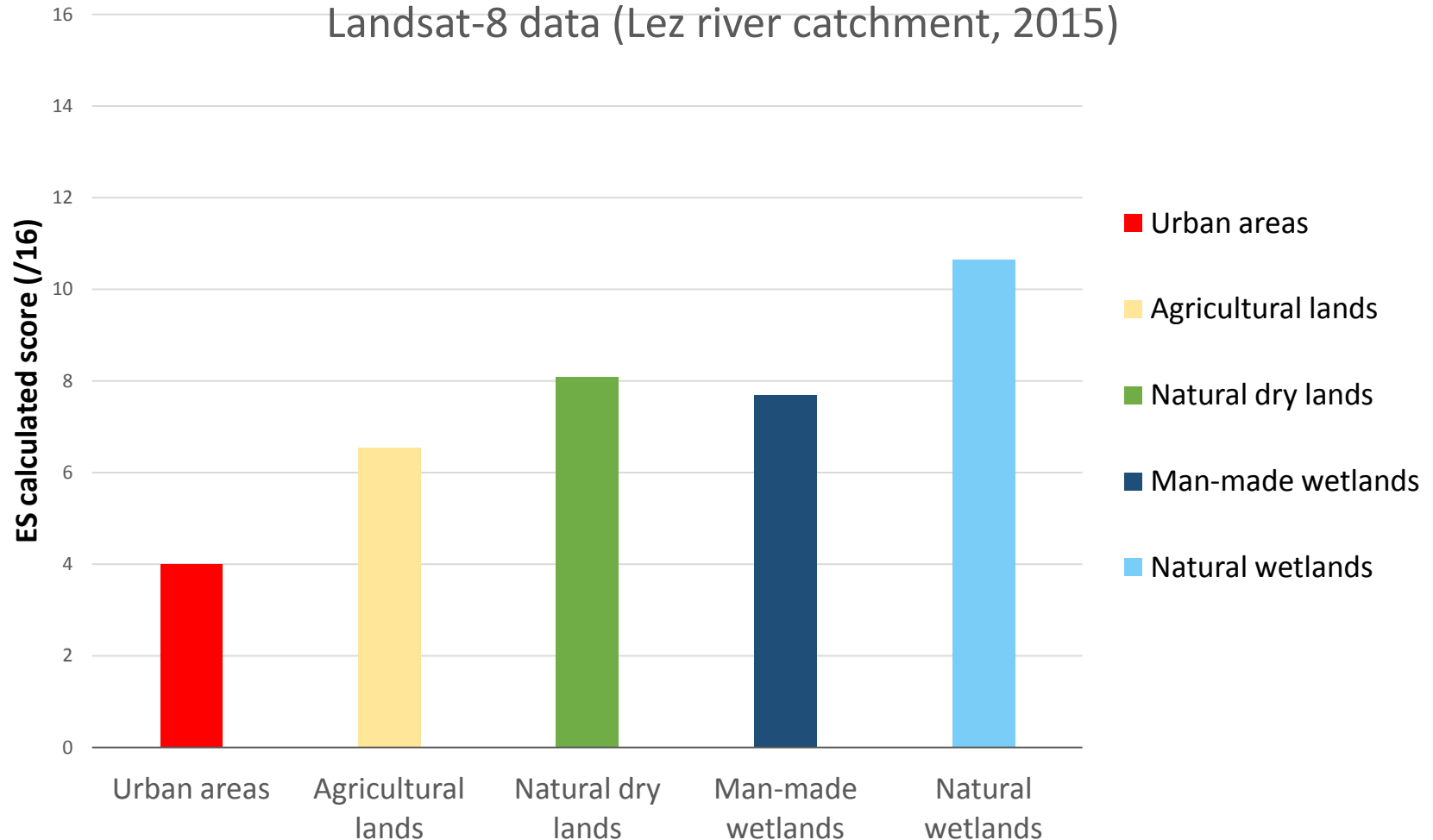


A loss of wetland habitats

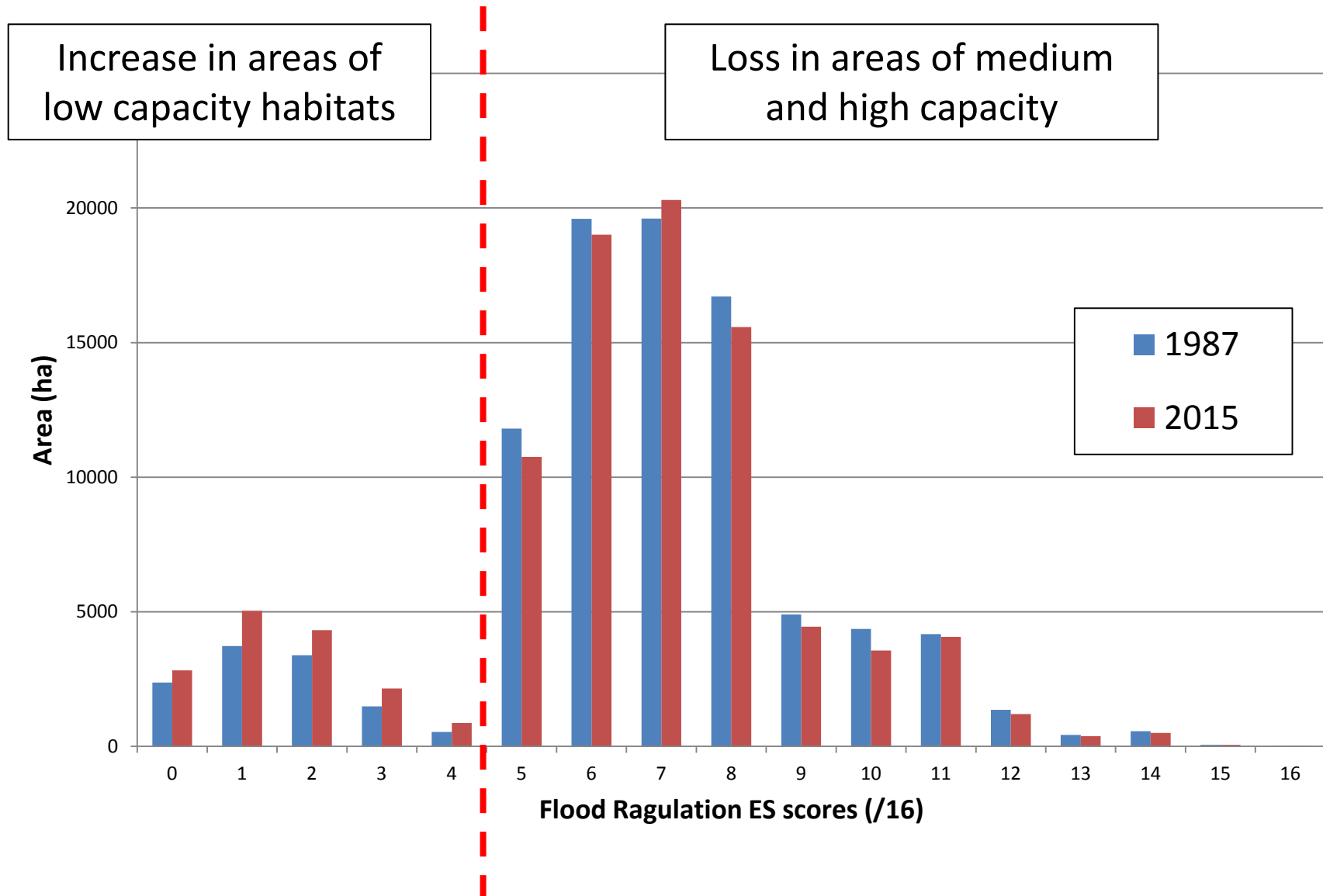
➔ a loss in the ES value (less flood regulation capacity)

Example of the Lez river basin (SWOS test site)

Habitats capacity to provide flood regulation ES derived from Landsat-8 data (Lez river catchment, 2015)



Example of the Lez river basin (SWOS test site)



This approach can help us to:

- Better define the flood regulation ES
- Assess its trends over time
- Create maps with different classes of vulnerability
- Better define priority areas for habitats conservation/restoration regarding their capacity to protect populations against flood hazards
- provide useful spatial information to river basin authorities for territory planning



Thank you

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