



# ALREADY ESTABLISHED OFFICIAL PROCEDURES USING COPERNICUS FOR THE IDENTIFICATION AND MONITORING OF LENITIC ECOSYSTEMS IN SPAIN

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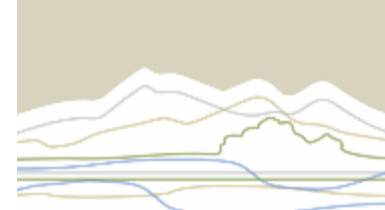
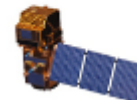
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# LENITIC HABITATS/ECOSYSTEMS CLASSIFICATION /CATALOGUING



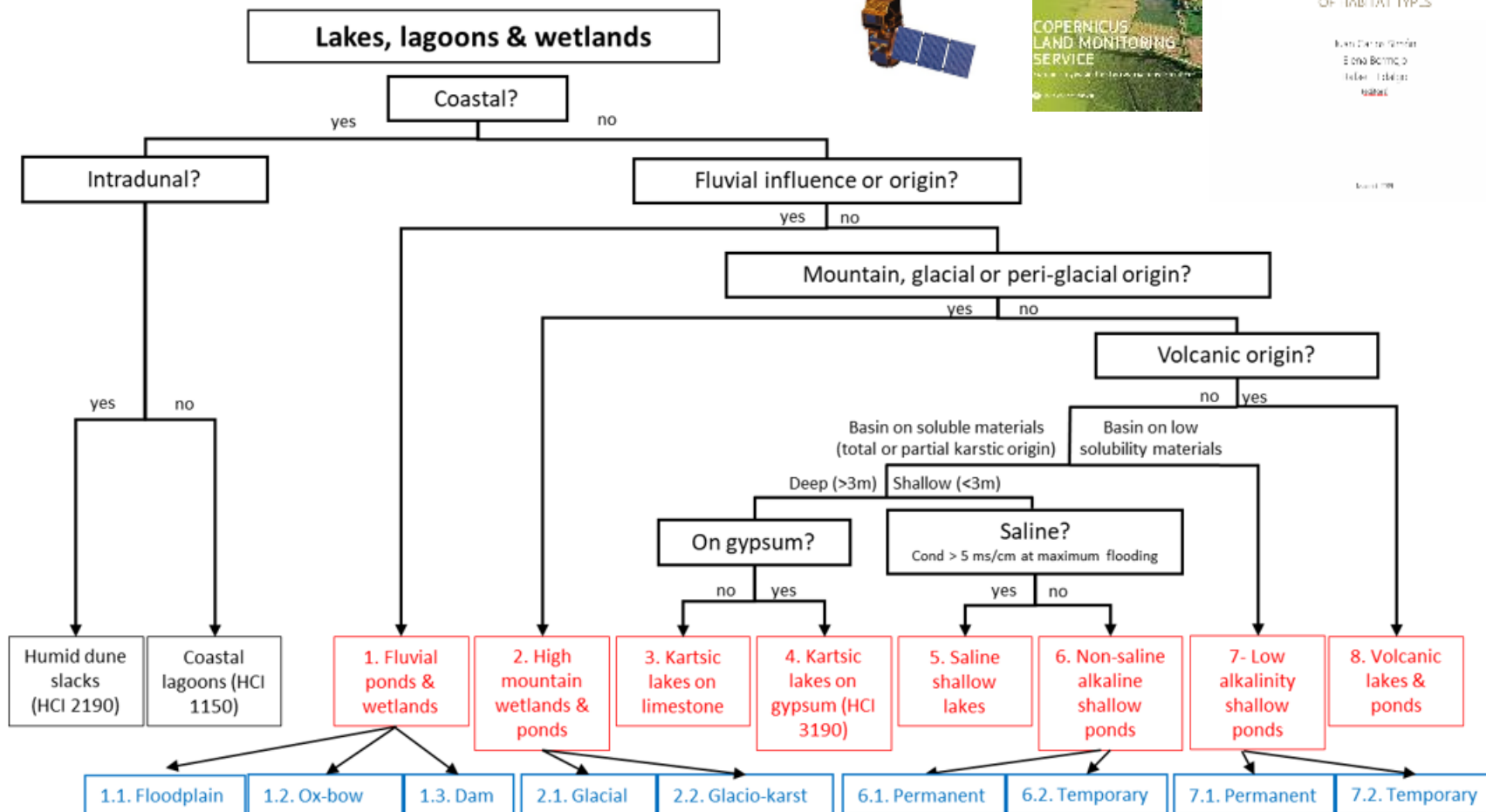
HANDBOOK FOR MONITORING CONSERVATION STATUS OF HABITAT TYPES

Sentinel-2



HANDBOOK FOR MONITORING THE CONSERVATION STATUS OF HABITAT TYPES

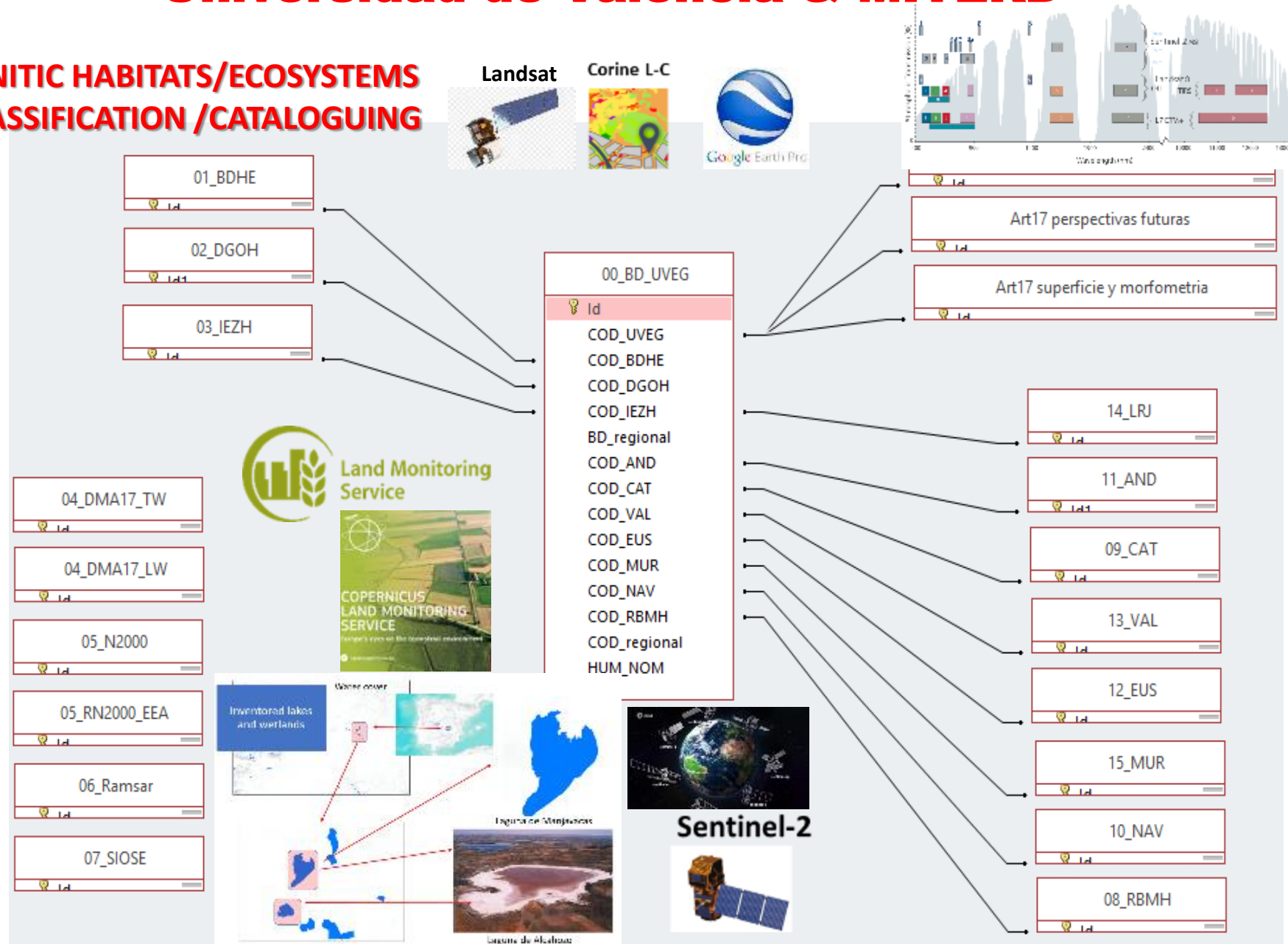
Authors: Carlos García, Elena Gómez, Isabel Galván, María



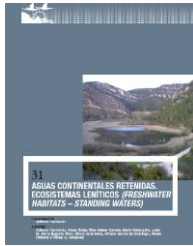
**Figure 31** Dichotomous key for the differentiation between the main ecological types corresponding to group 31 habitat types (inland lenitic ecosystems) present in Spain. In red the main ecological types. In blue, some of the subtypes. Source: prepared by the authors.  
**Note:** for the types (in red) and subtypes (in blue), the digit before the abbreviated name corresponds to the fourth (1.3.2.X) and fifth (1.3.2.X.X) digit of the hierarchical classification of Spanish ecosystems.

# Metadata Base of Spanish lakes and wetlands – Universidad de Valencia & MITERD

## LENITIC HABITATS/ECOSYSTEMS CLASSIFICATION /CATALOGUING



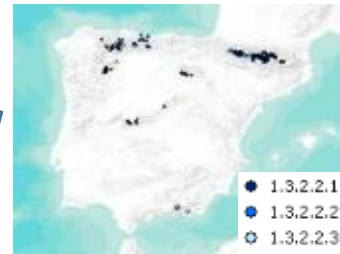
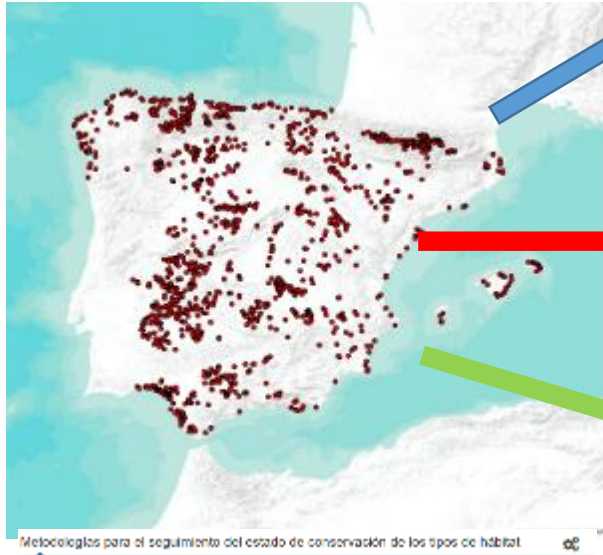
# IDENTIFICATION AND CATALOGUING



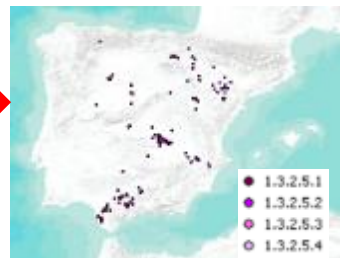
BASES ECOLÓGICAS PRELIMINARES PARA LA CONSERVACIÓN DE LOS TIPOS DE HÁBITAT DE INTERÉS COMUNITARIO EN ESPAÑA



## LENITIC HABITATS/ECOSYSTEMS CLASSIFICATION /CATALOGUING



- 1.3.2.2. – Lagos y humedales de **alta montaña** (morfogénesis glaciar o periglacial)
- 1.3.2.2.1- Lagos y lagunas de alta montaña de origen glaciar, septentrionales y centrales.
  - 1.3.2.2.2- Lagos y lagunas de alta montaña de origen glacio-karstico, septentrionales y centrales.
  - 1.3.2.2.3- Lagos y lagunas de alta montaña meridionales
  - 1.3.2.2.4- Humedales de alta montaña (¿turberas?)



- 1.3.2.5.- Lagunas someras **salinas** (origen kárstico inducido, karst no funcional, u otros orígenes).
- 1.3.2.5.1- Lagunas temporales someras hipomesosalinas
  - 1.3.2.5.2- Lagunas temporales someras hipersalinas
  - 1.3.2.5.3- Lagunas salinas temporales bicarbonatado-sódicas
  - 1.3.2.5.4- Lagunas salinas permanentes



- 1.3.2.7.- Lagunas y humedales **someros no salinos** (origen morfoestructural) de aguas ácidas y/o de baja alcalinidad (**en rañas**)
- 1.3.2.7.1- Lagunas y humedales someros no salinos (origen morfoestructural) de aguas ácidas y/o de baja alcalinidad permanentes
  - 1.3.2.7.2- Lagunas y humedales someros no salinos (origen morfoestructural) de aguas ácidas y/o de baja alcalinidad temporales

Metodologías para el seguimiento del estado de conservación de los tipos de hábitat

- Rocedales, pedregales y glacetas
- Clavadas
- Playas de
- Matorrales y pastizales no inundados
- Bosques y matorrales de ribera
- Hileras
- Pastizales no inundados
- Lagos, lagunas y humedales de interior
- Turberas
- Ecosistemas costeros

Sentinel-2



Sentinel-3



Corine L-C





# Evaluation Matrix for HCIs Conservation Status

Código del tipo de hábitat: .....	Favorable (verde)	Desfavorable – inadecuado (ámbar)	Desfavorable – malo (rojo)	Desconocido (información insuficiente para realizar una evaluación)								
Área de distribución	<div style="background-color: #4a86e8; color: white; padding: 10px; border-radius: 15px; text-align: center; font-weight: bold; font-size: 1.2em;">AMOUNT AND DISTRIBUTION</div>	<ul style="list-style-type: none"> <li>Surface extent</li> <li>Range</li> </ul>	<p>Reducción sustancial: pérdida superior al 5% anual o más de un 5% por debajo del área favorable de referencia</p>	Inexistente o insuficiente información fiable disponible								
Área ocupada por el tipo de hábitat dentro de su área de distribución					<div style="background-color: #4a86e8; color: white; padding: 10px; border-radius: 15px; text-align: center; font-weight: bold; font-size: 1.2em;">QUALITY</div>	<ul style="list-style-type: none"> <li>Composition</li> <li>Structure</li> <li>Function</li> </ul>	<p>Reducción sustancial de la superficie ocupada: equivalente a una disminución superior al 1% anual o cualquier otra con pérdida importante en el patrón de combinación dentro de su área de distribución o más de un 10% por debajo del área favorable de referencia</p>	Inexistente o insuficiente información fiable disponible				
Estructura y funciones específicas									<div style="background-color: #4a86e8; color: white; padding: 10px; border-radius: 15px; text-align: center; font-weight: bold; font-size: 1.2em;">FUTURE PROSPECTS</div>	<ul style="list-style-type: none"> <li>Pressures and threats</li> </ul>	<p>Más de un 15% del área es desfavorable respecto de su estructura y sus funciones específicas, o está bajo la presión de influencias adversas significativas</p>	Inexistente o insuficiente información fiable disponible
Perspectivas de futuro (respecto a población, área de distribución y disponibilidad de hábitat)												
Evaluación global del estado de conservación	<p>Todos verde o tres verde y desconocido</p>	<p>Uno o más ámbar, o desconocido</p>	<p>Uno o más rojo</p>	<p>Dos o más desconocido combinados con verde, o todos desconocido</p>								

+ FRV – Use of Landsat series + Ortophotos

**Table 35** Recommendations for selecting methodologies to determine the delimitation variables of a wetland zone in accordance with the availability of data, difficulty of the method and quality of the results obtained. Source: prepared by the authors.

**Note:** Techniques are ranked in an ordinal manner, with 1 being the most recommended based on the combination of these criteria. Techniques that use satellite images, being the most decisive, are the most complex to use. Therefore, although they are the most recommended for most determinations if facilities are available for their application, the difficulty they entail means that they do not are initially valued as those preferred for all cases. The ratings in brackets for the SWOS GEOportal depend on the final implementation of all the tools currently under development. Techniques that are considered to be unsuitable for use in the specific parameter being assessed are not rated. The detailed methods of determination are shown in Camacho *et al.* (2019a).



	Historical orthophotos	Google Earth Pro®	Satellite images	SWOS Toolbox	SWOS GEOportal	DTM	On-site measurements
<b>Maximum surface area</b>	3	1	5	4	2		6
<b>Current surface area</b>		1	4	3	2		5
<b>Maximum depth</b>						2	1
<b>Hydroperiod</b>		4	3	2	1		
<b>Historical series</b>	3	5	2	1	4		
<b>Vegetation coverage</b>	5	1	4	3	2		6
<b>Surface area of the other zones of the wetland</b>	3	2	5	4	1		6
<b>Surface catchment area</b>						1	
<b>Total basin</b>						1	
<b>Groundwater connection</b>						1*	

\* In order to determine the possible connection to groundwater, it is necessary to overlap the location of the wetland and the groundwater GIS layer.

## Doñana N.P. wetlands 1946 -2016

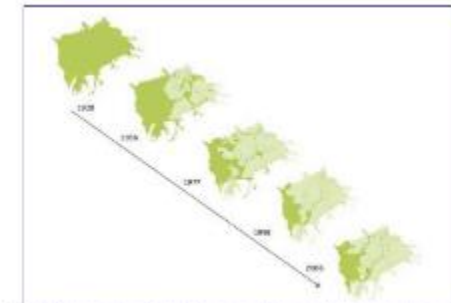


Fig. 2. 1.4.4. Publicación en la revista de la IAGLR, con el título: 'Hacia el estado de conservación de los humedales de Doñana (España)'. (Camacho, 2014)

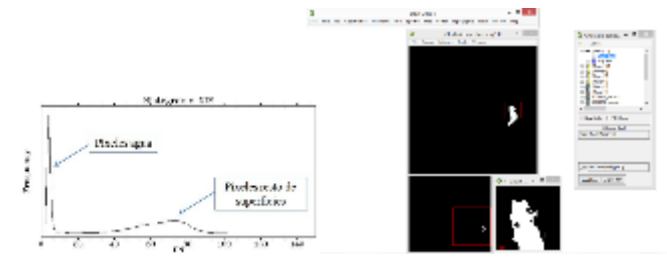
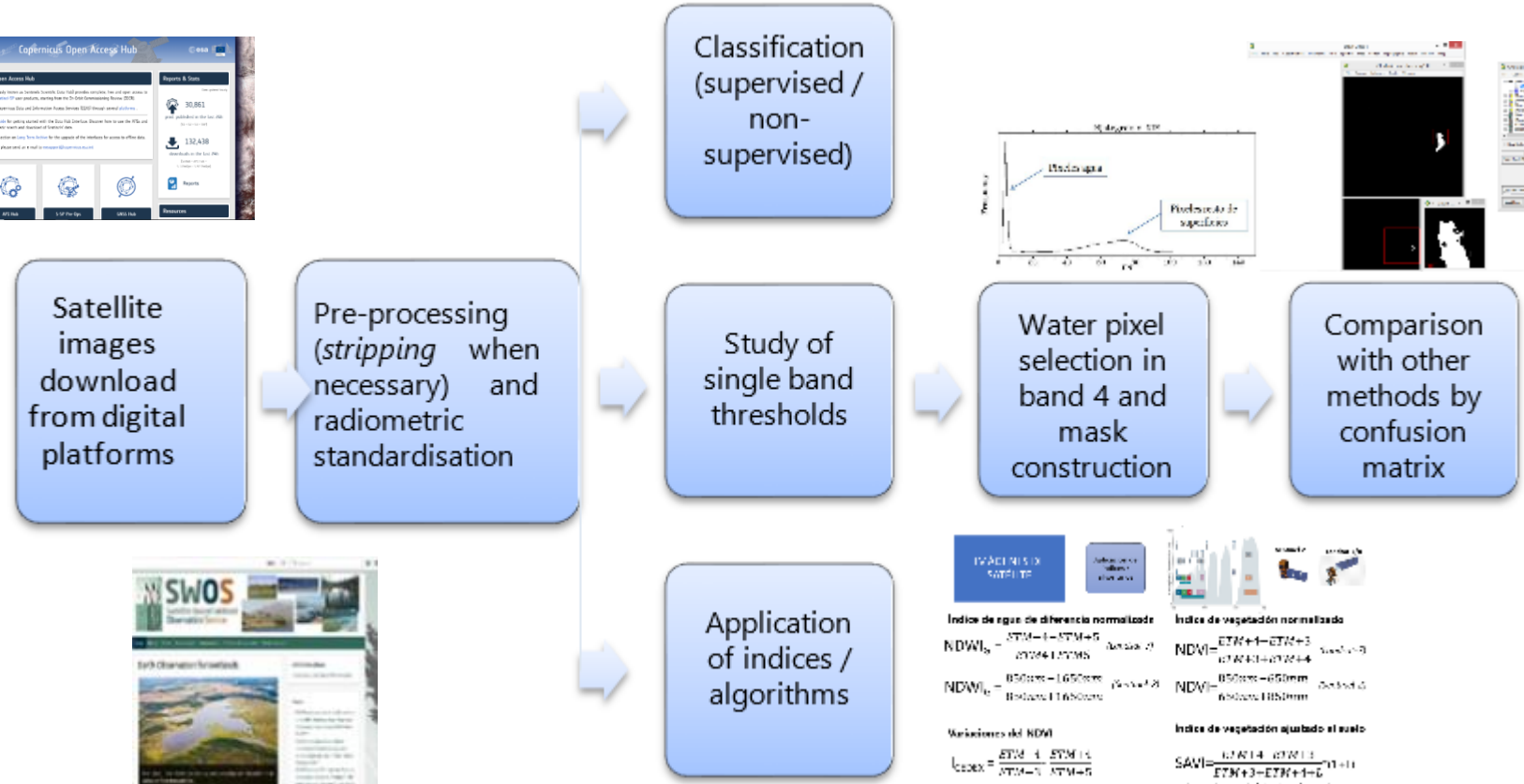
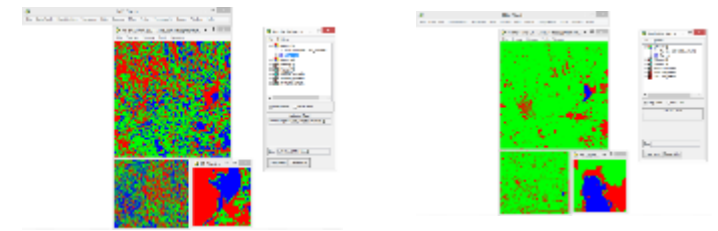


# SATELLITE IMAGERY

## SURFACE and RANGE



Image treatment (ENVIS, SWOS tools,...)  
 Sentinel (since 2014) → COPERNICUS  
 Landsat (since 1982) → USGS



**Índice de agua de diferencia normalizado**

$$NDWI_s = \frac{STM-1 - STM+5}{250nm - 1250nm}$$

$$NDWI_e = \frac{B50nm - I650nm}{B650nm - I650nm}$$

Variaciones del NDWI

$$Index = \frac{ETM-4 - ETM+5}{ETM-7 - ETM+6}$$

**Índice de vegetación normalizado**

$$NDVI = \frac{ETM+4 - ETM+3}{ETM+4 + ETM+3}$$

$$NDVI = \frac{B50nm - B650nm}{B50nm + B650nm}$$

**Índice de vegetación ajustado al agua**

$$SAVI = \frac{ETM+4 - ETM+3}{ETM+3 + ETM+4} \cdot 1.1$$

# SATELLITE IMAGERY

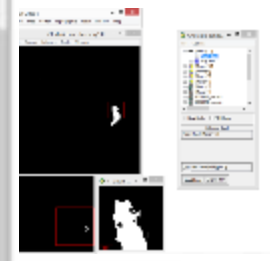
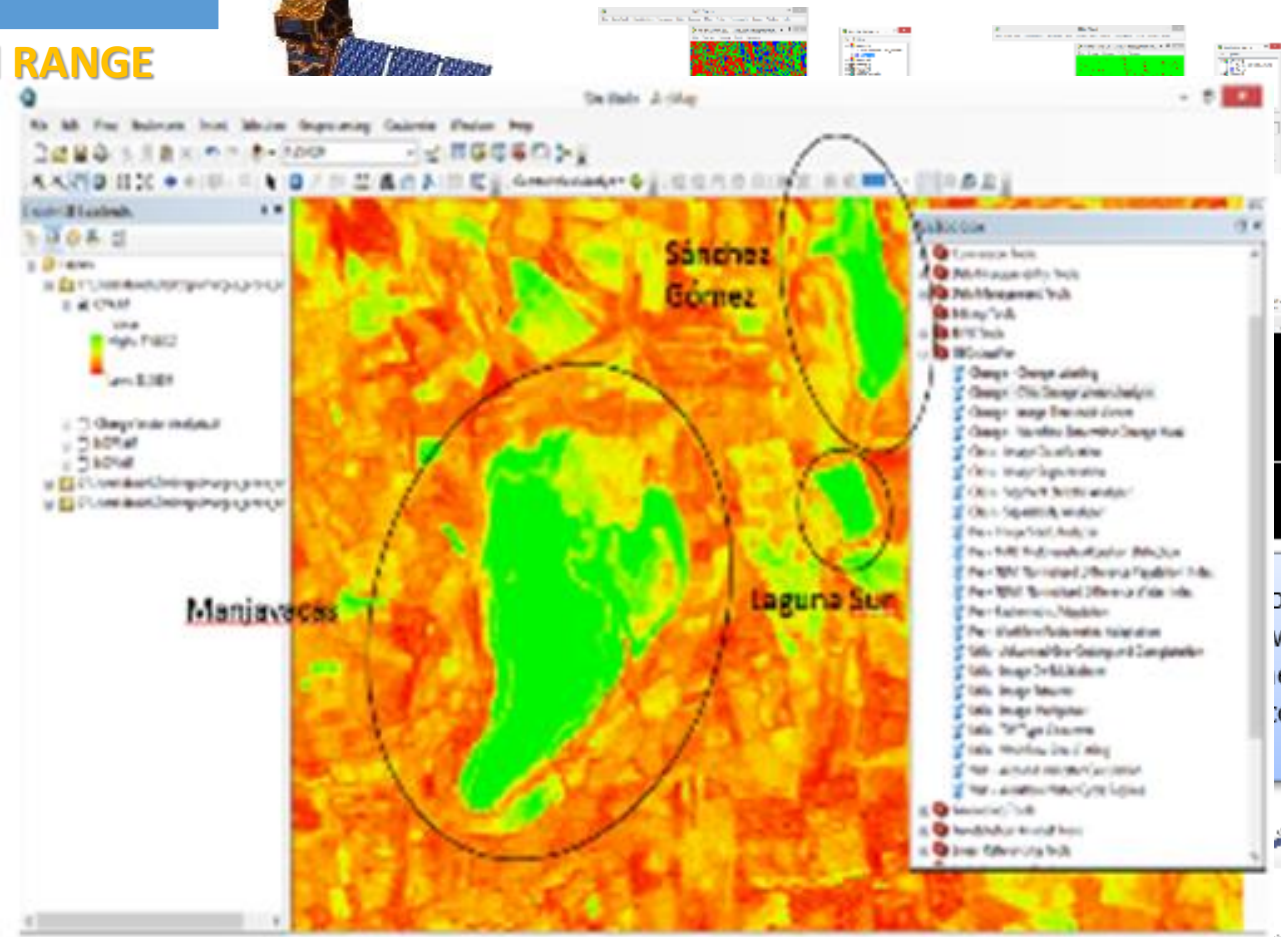


Image treatment (ENVIS, SWOS tools,...)  
 Sentinel (since 2014) → COPERNICUS  
 Landsat (since 1982) → USGS

## SURFACE and RANGE



Satellite images download from digital platform



Comparison with other methods by confusion matrix

of indices / algorithms

$$NDWI = \frac{B5 - B3}{B5 + B3}$$

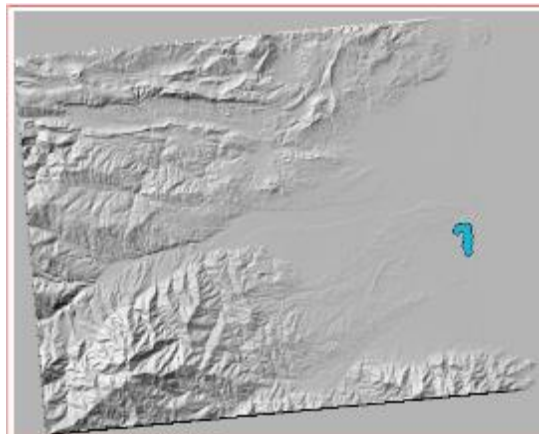
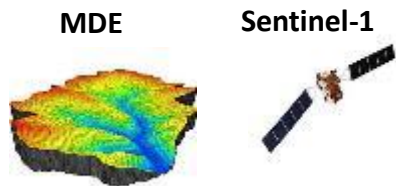
$$SAWI = \frac{B2 + B4 - B3 - B5}{B2 + B4 + B3 + B5}$$



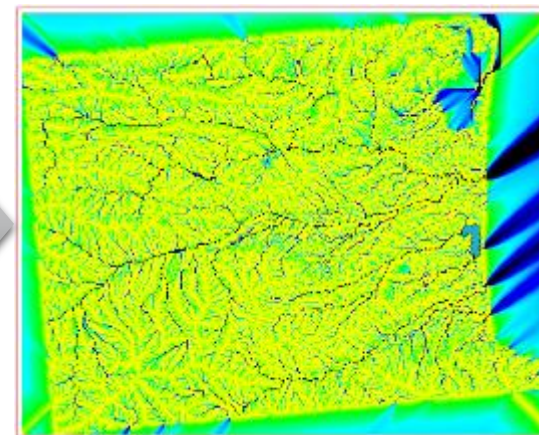


# COPERNICUS PRODUCTS (e.g. DEM FOR CATCHMENT DELINEATION)

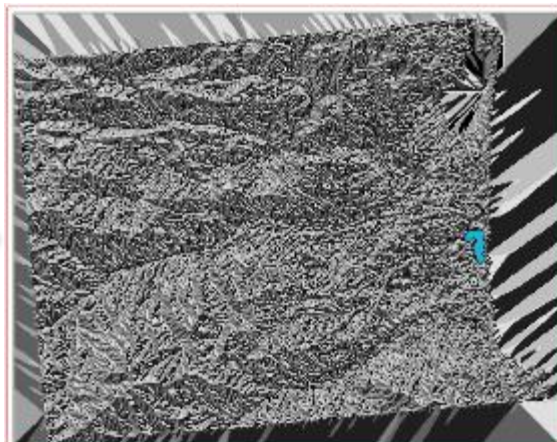
## SURFACE and RANGE



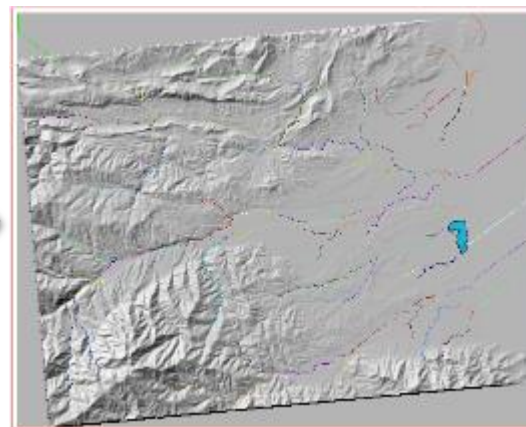
DEM



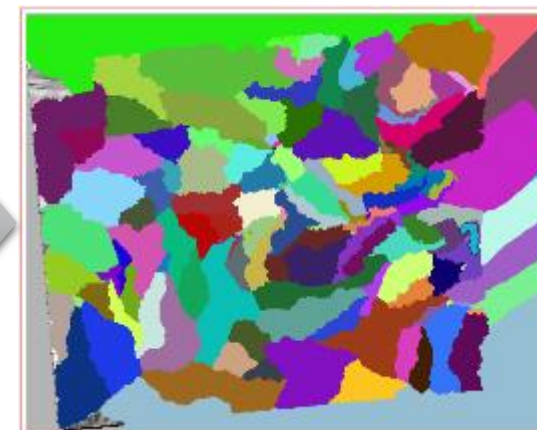
FLOW MAP



DRAINAGE



HIDROLOGICAL NETWORK



CATCHMENT DELINEATION

E ≥ 70 Favourable   
 50 ≤ E < 70 Unfavourable-inadecuate   
 E < 50 Unfavourable-bad

# STRUCTURE

Sentinel-2

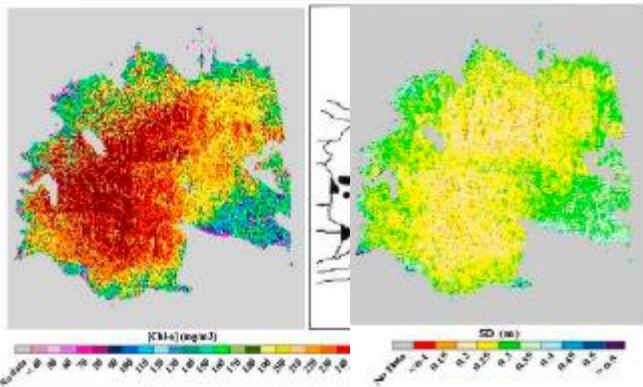


&

Landsat-7/8



# FUNCTION



# ECLECTIC Index for HCIs

BIOLOGICAL FACTORS	Typical vegetation (Block 1)	Coverage of typical hydrophyte's species (submerged or floating plants) Community composition and coverage of helophytes and riparian vegetation Diversity (species richness) of typical or characteristic species representative of submerged, helophytic, and riparian vegetation of the habitat type
	Composition, abundance and biomass of phytoplankton (Block 2)	Phytoplankton biomass (chlorophyll-a concentration) Composition of the phytoplankton community Appearance of a deep chlorophyll maximum and presence of photosynthetic bacteria populations in anoxic layers in summer
	Composition and abundance of invertebrate fauna (Block 2)	Number of branchiopods and copepods taxa Zooplankton/phytoplankton trophic ratio Number of benthic invertebrate taxa in the littoral area
	Composition, abundance and age structure of fish fauna (Block 2)	Proportion of individuals of allochthonous species
	Diversity of amphibians and reptiles (Block 2)	Number of species
	Other aquatic fauna and flora (rare, threatened, protected, exotic species) (Block 2)	Number of taxa from Annexes II and IV of the Habitats Directive, and exotic species, weighted by their indicator value
	Surface area (Block 3)	Habitat type surface area
HYDROGEO-MORPHOLOGICAL FACTORS	Hydrological regime (Block 3)	Filling system Emptying system Hydroperiod
	Geomorphological characteristics (Block 3)	Dynamic status Geomorphological setup Siltation
PHYSICA & CHEMICAL FACTORS	General (Block 4)	Water transparency Daily variation of oxygen saturation (%) Water electrical conductivity range pH Total phosphorus concentration Water colour Salinity of the associated aquifer
	Specific pollutants	This is not considered here as they are accounted as pressures and impacts

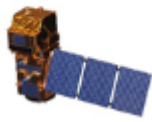
Doña *et al.* 2014 - *IEEE J-STARS* 7: 1632-1641.

Doña *et al.* 2015 - *J. Environ Manag.*151: 416-426.

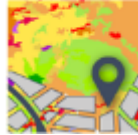
Doña *et al.* 2016 – *Remote Sensing* 8: 618

# FUTURE PROSPECTS

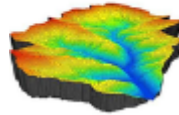
Sentinel-2



Corine L-C

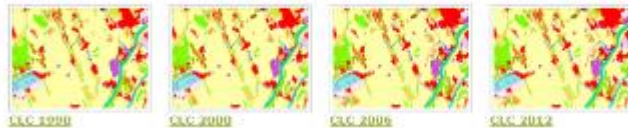


DEM

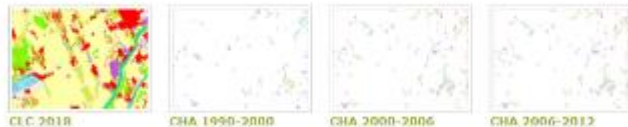


CORINE Land Cover

Print



LAND USES



LAND USES – LAND CHANG

## A- HYDROLOGICAL PRESSURES AND IMPACTS

- A1 - Occurrence of direct water extractions.
- A2 - Alteration of natural flooding regime and water flow patterns (drainage, external flow inputs, variation of flows due to exploitation or by non-natural flow inputs, climate change, etc.).
- A3 - Flow regulation in tributaries.
- A4 - Existence of drainage infrastructures.
- A5 - Extraction of water from the associated aquifer (if applicable).

## GEOMORPHOLOGICAL PRESSURES AND IMPACTS

- B1 - Variation of the morphometry or of the characteristics of the substrate, affecting the structure or function or the wetland occupied surface (grounding, slope, construction of structures, etc.).
- B2 - Extraction of materials.
- B3 - Rubble disposal.

## C – PRESSURES AND IMPACTS ALTERING WATER QUALITY

- C1 - Occurrence of intermittent urban waste water spills.
- C2 - Specific pollutants (priority substances) spills.
- C3 - Existence of diffused pollution sources in the catchment.
- C4 - Inflows with mineralogical characteristics different to those natural.
- C5 - Thermic spills.
- C6 - Alteration of the natural chemical quality of the associated aquifer (if applicable).

## D – PRESSURES AND IMPACTS ON THE STRUCTURE OF THE COMMUNITIES

- D1 - Connectivity with adjacent natural ecosystems.
- D2 - Exploitation or other pressures on the biological community.
- D3 - Uses in aquaculture.

## E – PRESSURES AND IMPACTS DUE TO LAND USES

- E1 - Land uses for road and residential infrastructure.
- E2 - Occurrence of electrical lines.

## F – PRESSURES AND IMPACTS DUE TO SHIFTS OF THE AREA OF THE LENITIC ECOSYSTEM OR HABITAT TYPES

- F1 - Reduction of the area occupied by the habitat type on a local scale.
- F2 - Occupation of the wetland basin or its banks.

## G - PRESSURES AND IMPACTS DUE TO THE PRESENCE OF INVASIVE ALIEN SPECIES

- G1 - Presence of exotic species included in the Spanish catalogue of invasive alien species.
- G2 - Presence of exotic species (alien species of the habitat type) not included in the Spanish catalogue of invasive alien species.

## H - OTHER PRESSURES AND IMPACTS

- H1- Solid wastes.
- H2- Livestock overload.
- H3- Recreational activities.
- H4- Other pressures and impacts (e.g. periodical vegetation burning).

LOW

MEDIUM

HIGH

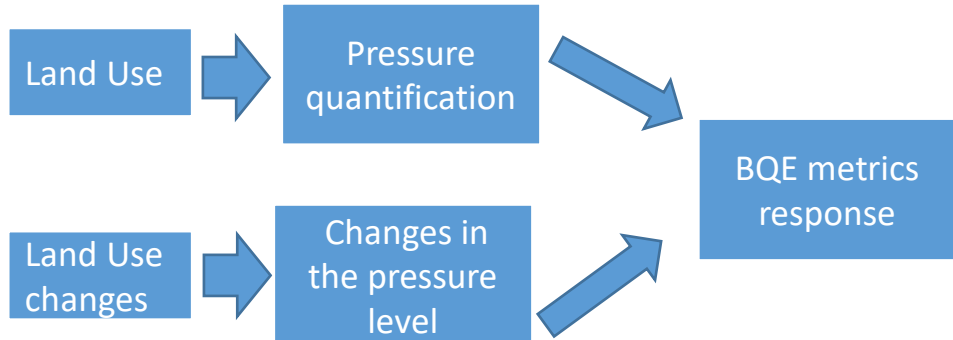
VERY HIGH

# Application to the WFD

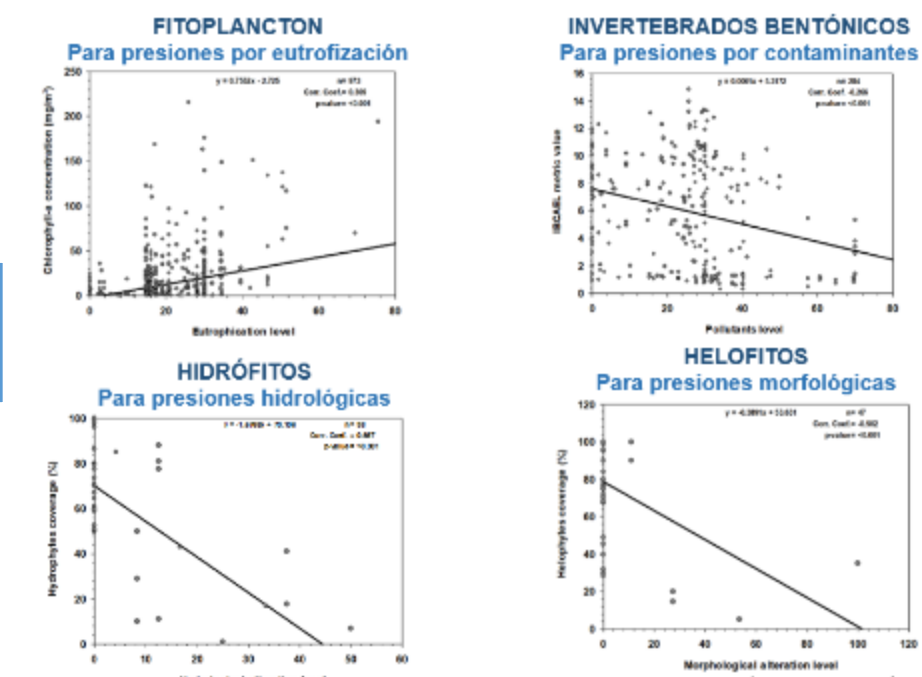
Corine L-C



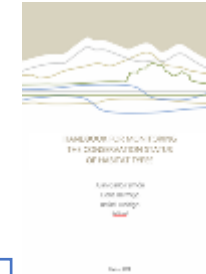
PRESSURE	EUTR.	ORGN.	ACID.	POLL.
Irrigated agriculture	0.8	0.2	0.0	0.7
Rainfed agriculture	0.3	0.1	0.0	0.3
Livestock (pastures)	0.3	0.4	0.3	0.5
Urban uses	0.4	0.6	0.2	0.5
Communication infr.	0.0	0.0	0.2	0.7
Mining	0.0	0.0	0.9	0.9
Dumps	0.7	0.8	0.8	0.8
Contaminated soils	0.0	0.0	0.1	1.0



L-116: Continental, oligosaline, permanent	EUTROPH.	ORGAN.	ACIDID.	POLLUT.	Chl a	S.D.
Bikuña	0.0	0.0	0.0	0.0	4.1	5.6
Laguna Honda	21.2	7.3	0.2	21.3	7.1	
Bassas de Can Jordià	9.8	3.1	0.0	9.5	11.1	10.7
Laguna grande de Maeztu	19.1	6.4	0.0	19.1	15.5	18.7
Estany de Tordera-Estany de Can Torrent	34.1	10.4	0.0	32.6	28.8	20.8
Bassas d'en Broc i Aiguamoixos de la Déu Vella	24.7	8.6	0.7	23.1	43.2	3.7
Laguna de Gulalguemero	29.5	9.8	0.0	29.5	88.1	106.1
Estany de Tordera-Estany de Can Raba	50.7	14.0	0.0	46.2	176.6	55.7



# HCI CONSERVATION STATUS



## RANGE

## SURFACE

## STRUCTURE & FUNCTION

## FUTURE PROSPECTS

**Sentinel-2**



Surfaces

**Sentinel-3**



Only big lakes

**Sentinel-2 Landsat-7/8**



Surface, hidroperiods, vegetation, Chl-a, wáter color, etc

**Sentinel-2 Corine L-C**



LU & LULC

**Corine L-C**



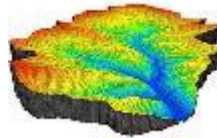
Habitat types

**Sentinel-1**



Morphometry & Catchment delineation

**DEM**



**Corine L-C**



Habitat components

**DEM**



Pressures on Morphometry and catchment

**Sentinel-1**



+

## INVENTORIES

**Landsat-7/8**



**Landsat-7/8**



**Landsat-7/8**



# COPERNICUS PRODUCTS & SERVICES

## SURFACE and RANGE

### Products and Services

The pan-European coverage of the Copernicus Land Monitoring Service offers a range of continually evolving products and services. An overview is listed below, however for a comprehensive list please visit <https://land.copernicus.eu/>

Similar products are produced at a global scale by the JRC. More information can be found at <https://land.copernicus.eu/global/>

Portfolio category	Product name	Individual products
Systematic Biophysical Monitoring	Snow and Ice*	Fractional Snow Cover (FSC)   Permanent Snow Line   River/Lake Ice
	High Resolution Phenology*	Various phenological indicators and seasonal trajectories
Land Cover & Land Use Mapping	Corine Land Cover (CLC)	LCLU status and change
	Corine Land Cover plus (CLC+)*	CLC-backbone   CLC-core   CLC+ instance   CLC – legacy
	High Resolution Layers	Imperviousness   Forest   Grassland   Wetness & Water   Small Woody Features
Thematic Hotspot Mapping	Urban Atlas	LCLU status and change
	Riparian Zones	LCLU status and change
	Natura 2000	LCLU status and change
	Coastal Zones*	LCLU status and change
Reference Data	EU-DEM	EU-DEM   Slope   Aspect   Hillshade
	EU-Hydro	Rivers (centreline and outline)   Inland waters Coastline   Drainage network
	Image Mosaics	Very High Resolution (VHR)   High Resolution (HR)
Ground Motion Service*		

\* = in preparation