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ETC UMA

MAPPING AND ASSESSMENT OF THE STATE OF WETLAND ECOSYSTEMS:
A Mediterranean perspective

In collaboration with: Tour du Valat; MedWet The Mediterranean Wetlands Initiative; The Goulandris Natural History Museum Greek Biotope/Wetland Centre; UN environment programme Mediterranean Action Plan Barcelona Convention; Plan Bleu

MAPPING AND ASSESSMENT OF THE STATE OF WETLAND ECOSYSTEMS:

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Glossary

LEXICON	
Barcelona Convention	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean adopted in 1995. There are currently 22 Contracting Parties comprising 21 Mediterranean states and the EU.
Biodiversity hotspots	Regions that are both rich with life and at high risk of destruction.
Integrated Coastal Zone Management	A multidisciplinary integrated management process to promote sustainable management of coastal zones by balancing environmental, economic, social, cultural and recreational objectives.
Integrated River Basin Management	Multidisciplinary management of water, land and related resources within a river basin, that considers conservation, management and the development of water, land and related resources across sectors, to promote socio-economic benefits arising from water resources while at the same time preserving ecosystem functioning.
Key Biodiversity Areas	Sites contributing significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems (IUCN definition).
Ramsar Convention	The Ramsar Convention on Wetlands of International Importance is an intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.
Specially Protected Areas	A term identified through the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) whereby Contracting Parties to the Barcelona Convention established a List of Specially Protected Areas of Mediterranean Importance (SPAMIs List) in order to promote cooperation in the management and conservation of natural areas, as well as in the protection of threatened species and their habitats[1].
Nature-based Solutions	Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (IUCN definition).
State	The particular condition that someone or something is in at a specific time.

[1] https://www.rac-spa.org/spami

ACRONYMS	
AD	Anno Domini
CLC	CORINE Land Cover
Commission error	In Remote Sensing, it is the classification error which quantifies the number of pixels incorrectly included in the target class being evaluated (Overestimation)
CR	Critically Endangered species
DG EUROSTAT	Statistical office of the European Union
EIONET	European Environment Information and Observation Network
EKBY	Greek Biotope/Wetland Centre
EN	Endangered species
ESRI	Environmental Systems Research Institute
ETC-UMA	European Topic Centre on Spatial Analysis and Synthesis, University of Malaga
EUNIS	European Nature Information System
GEBCO	General Bathymetric Chart of the Oceans
GISCO	Geographical Information System of the Commission
GlobWetland II	Regional pilot project of the Ramsar Convention on Wetlands in the southern Mediterranean basin, ESA project 2010-2014
HydroBASINS	Geospatial product which consists of a series of polygon layers that depict watershed boundaries and sub-basin delineations at a global scale
ICZM	Integrated Coastal Zone Management
IHA	Wetlands Inventory of Andalusia
Interreg	Instrument of the European Union (EU) supporting cooperation across borders through project funding
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Areas
LULC	Land Use / Land Cover
EC MAES WG	The European Commission Working Group on Mapping and Assessment of Ecosystems and their Services
MBPC	Mediterranean Biodiversity Protection Community. Project co-funded by European Regional Development Fund through the Interreg Mediterranean Programme bringing over 300 institutions together to identify the most effective mechanisms to manage and protect Mediterranean biodiversity (2019-2022)
MedIsWet	Project established with the support of the MAVA Foundation with the aim to promote and contribute to the full implementation of Ramsar Resolution XII.14 on "Conservation of Mediterranean Basin Island wetlands" and to the achievement of the Ramsar Convention's and MedWet's objectives
MedWet	Mediterranean Wetlands Initiative
MWO	Mediterranean Wetlands Observatory
Med PATF	Mediterranean Policy and Advocacy Task Force

NUTS	Nomenclature of Territorial Units for Statistics
Omission error	In Remote Sensing, it is the classification error which quantifies the number of pixels left out of the target class being evaluated (Underestimation)
OpenStreetMap (OSM)	Collaborative project to create a free editable geographic database of the world
Plan Bleu	Regional Activity Centre of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP)
PWA	Potential Wetland Areas
SPA	Specially Protected Areas
SPA/BD	Protocol concerning specially protected areas and biological diversity in the Mediterranean (SPA/BD)
SRS	Satellite Remote Sensing
SWOS	Satellite based Wetlands Observation Service, H2020 project 2015-2018
TUNE-UP	Interreg Mediterranean project co-financed by the European Regional Development Fund with the main goal to foster the coordination and enhance the effectiveness of management of Marine Protected Areas in the Mediterranean area, capitalising on the experience of the Interreg Mediterranean WETNET project
UNEP	United Nations Environment Programme
VU	Vulnerable species
Wetland-dependent animal species	Freshwater fishes, molluscs, odonates, decapods, amphibians and mammals that spend all or a critical part of their lifecycle in freshwater, or are confined to brackish water bodies
Wetland-dependent plant species	All the vascular aquatic plants whose photosynthetically active parts are permanently or, at least, for several months each year submerged in water or float on the surface of water
WetMainAreas	Interreg project, entitled "Improving the conservation effectiveness of wetlands", financed by the Transnational Cooperation Programme Balkan-Mediterranean 2014-2020 with the main goal to contribute to the protection, conservation and development of wetlands, as a shared asset of the Balkan-Mediterranean territory
WETNET	Interreg Mediterranean project co-financed by the European Regional Development Fund which had the goal to implement a multilevel governance for Mediterranean wetlands, hence building a common territorial strategy for their integrated management


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Introduction

The Ramsar Strategic Plan (Ramsar Convention Secretariat, 2016) calls for the development of comprehensive national wetland inventories and the improvement of national wetland policies that promote wetland conservation, which often involve lengthy and complex processes. In the framework of the Ramsar Convention, 397 Mediterranean Wetlands of National Importance have been designated (of which 113 sites are mainly coastal and marine), 44% of which have developed a management plan (UNEP/MAP and Plan Bleu, 2020).

The establishment of a Pan-Mediterranean harmonised wetland ecosystem knowledge base and a wetland biodiversity assessment to support regional and national inventories is a crucial step towards building a baseline of understanding on the spatial extent, distribution, and state of wetlands at a regional scale. Such a development is very important in the Mediterranean region where wetlands have been suffering from habitat loss and lack of adequate management resulting in a rapid decline of natural wetlands by 45-51% since 1970 (Mediterranean Wetlands Outlook 2, 2018).

The loss during this period is correlated to the rapid socio-economic and demographic development of Mediterranean countries (especially in the southern and eastern parts of the basin). These trends were observed despite increased commitments of local and national stakeholders in preserving wetlands and developing conservation strategies.
In addition to the loss in extent, Mediterranean wetland habitats are also expected to be severely affected by climate change. A rising sea level in particular, is expected to impact coastal wetlands and estuaries while altered precipitation and droughts cycles will affect the water discharge and sediments flow of Mediterranean rivers and catchments (MedECC, 2020).

Building on its experience in developing the first EU-wide wetland ecosystem condition assessment (Maes et al., 2020), ETC-UMA joined forces with the Mediterranean Policy and Advocacy Task Force (Med PATF) set by MedWet and included regional lead organisations in wetland conservation, namely Tour du Valat, to develop a Mediterranean wide spatial wetland ecosystem mapping and condition assessment. In parallel, ETC-UMA collaborated with a network of institutions and experts to ensure the inclusion of relevant project results, as well as to improve and enrich the knowledge base with validated results at a sub-regional scale. The institutions are acknowledged for the fruitful collaboration and information sharing that was crucial for the development of the final Pan-Mediterranean wetland ecosystem knowledge base.

The collaboration is part of the efforts of the Mediterranean Biodiversity Protection Community (MBPC), led by ETC-UMA and supported by the Regional Activity Centre Plan Bleu, in collaboration with several key Mediterranean institutions, partners and members of the advisory board of the MBPC focusing on wetland ecosystems, and is co-financed by the Interreg Mediterranean programme.

The Pan-Mediterranean wetland ecosystem map fills a major knowledge gap in the region by setting a Mediterranean-wide knowledge base on wetland ecosystems following the Ramsar definition of wetlands. The wetland ecosystem mapping is complemented by the assessment of wetland biodiversity conditions that aims to highlight priority areas for potential conservation and restoration actions in the region, and to support the regional efforts in advocating for effective wetland management and nature-based solutions in the Mediterranean region.

The outputs of this activity include (i) a Pan-Mediterranean wetland ecosystem knowledge base, and (ii) an assessment of their condition that will be used to raise awareness and advocate for a change in wetland management that promotes effective protection, conservation and restoration. The outputs also support regional and national inventories, filling a major regional gap locating Mediterranean wetland habitats, and feed regional and global agendas, namely the EU Biodiversity Strategy to 2030, the Mediterranean Strategy for Sustainable development as well as the Ramsar Convention.

The Pan-Mediterranean knowledge base has strongly benefited from the collaboration with the Tour du Valat and its Mediterranean Wetland Observatory (MWO) in terms of methodological developments and data and knowledge sharing, as well as in the phases of quality control and validation of the final Mediterranean-wide wetland ecosystem map. The Greek Biotope/Wetland Centre (EKBY) is also engaged as the coordinator of the Balkan Mediterranean wetland mapping as well as by participating in the phases of quality control and validation.

This work will further serve as a basis for developing different types of studies/assessments and will feed other processes such as the Ramsar resolutions focusing on Mediterranean wetlands and the next Mediterranean Wetlands Outlook 3 planned for the Ramsar COP15, initially scheduled for 2024.

> "The establishment of a Pan-Mediterranean harmonised wetland ecosystem knowledge base is a crucial step towards building a baseline understanding of this ecosystem at a regional scale


2

Wetland ecosystem mapping

2.1 METHODOLOGICAL APPROACH

The Pan-Mediterranean wetland ecosystem knowledge base has been developed as a common data entry-point where information from different sources, and of different resolution, spatial and temporal accuracy is integrated and meaningfully harmonised to set a Mediterranean-wide geodatabase. The proposed approach relies on a general background geospatial layer of wetland habitats validated for the entire region. The background layer has been developed following a different approach for the northern and southern parts of the basin (see 2.2.1).

Successively, the pre-defined regional spatial data structure of the Pan-Mediterranean knowledge base (see 2.1.3) is enriched with existing data from external providers, developed at various geographical scales (local, regional, or macro-regional) and with the highest possible accuracy and reliability. The output is the Mediterranean wide harmonised wetland ecosystem map. As the baseline year of the background data layer, 2018 is the reference year that is used as the backbone for the northern part of the basin (see 2.2.1.1). For the southern part of the basin, the different datasets used for the mapping refer to a wider temporal range (see Annex II).

2.1.1 DEFINING THE STUDY AREA BOUNDARY

An initial phase within this process was the identification of a meaningful study area boundary for the Mediterranean region. All the 28 MedWet[2] country members are included in the analysis: Albania, Algeria, Andorra, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Egypt, France (overseas territories are not included), Greece, Israel, Italy, Jordan, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Palestinian Authority, Portugal, Serbia, Slovenia, Spain, Syria, North Macedonia, Tunisia and Turkey. In addition to these countries, Mediterranean territories not belonging to MedWet countries are also included (namely the British Oversea Territories of Gibraltar, Akrotiri and Dhekelia).

Following the approach used by MWO, the representation of the Mediterranean countries includes all the contested and disputed borders in a different colour (Figure 1). These boundaries and names are those officially used by the United Nations Organization and the European Union and do not imply official endorsement nor acceptance by either the MWO or ETC-UMA.

Country borders have been defined based on the "Countries 2020" dataset of the DG EUROSTAT "Geographic Information System of the Commission" (GISCO)[3] while the high-resolution coastline layer has been produced by the MWO, based on enhanced OpenStreetMap[4] data through the integration of all coastal lagoons within the mainland to enable their differentiation from marine waters.

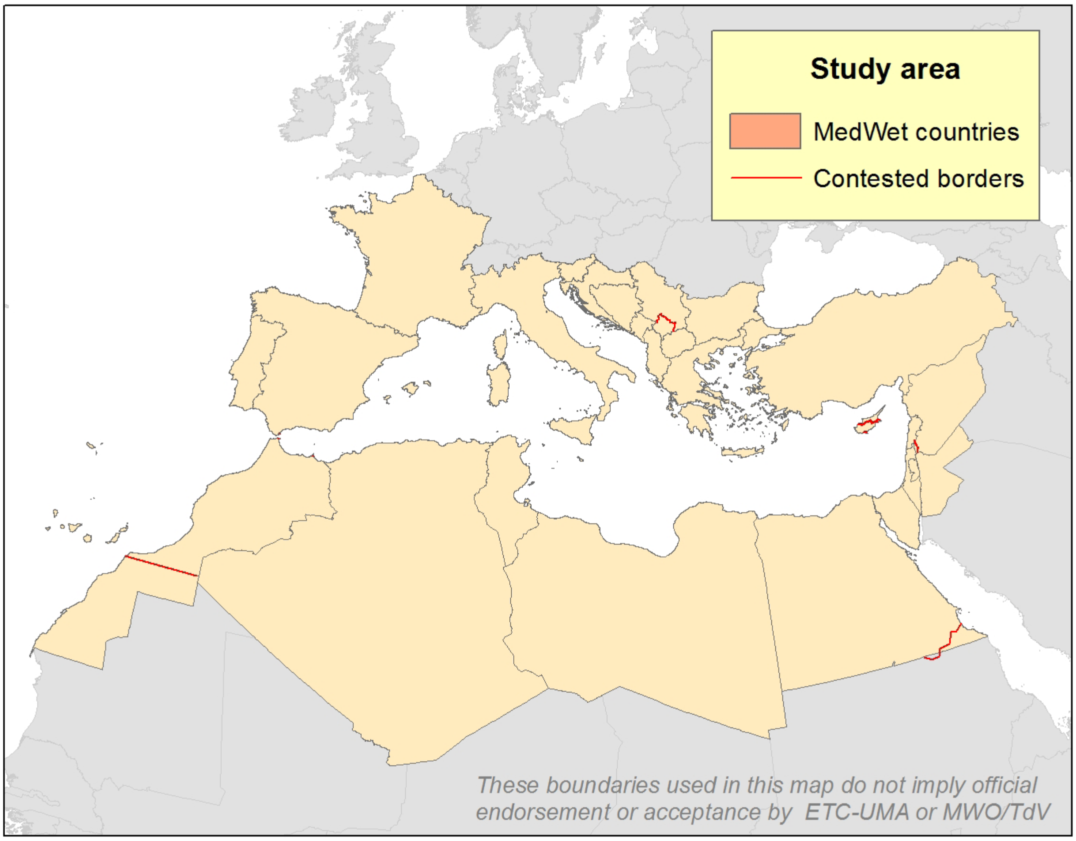

Figure 1. Delimitation of the study area

[2] The Mediterranean Wetlands Initiative (MedWet; https://medwet.org/) is a Ramsar Regional Initiative that brings together 28 Mediterranean and peri-Mediterranean countries and territories that are Parties to the Convention on Wetlands

[3] https://ec.europa.eu/eurostat/web/gisco/geodata

[4] https://evergreen.data.socrata.com/Maps-Statistics/Coastlines-split-4326/rcht-xhew

2.1.2 FROM DIFFERENT NOMENCLATURES TO A COMMON SIMPLE TYPOLOGY

Wetland habitats are very diverse (ranging for instance from inland to coastal and marine wetlands, and from temporarily to permanently flooded ones) making the definition of a wetland ecosystem and its habitats both challenging and controversial, especially in the Mediterranean region (Perennou et al., 2018).

The present work adopts the nomenclature of the Ramsar Convention according to which wetlands include: a wide variety of inland habitats such as marshes, wet grasslands and peatlands, floodplains, rivers and lakes; coastal areas such as saltmarshes, mangroves, intertidal mudflats and seagrass beds; coral reefs and other marine areas no deeper than six meters at low tide; and human-made wetlands such as dams, reservoirs, rice paddies and wastewater treatment ponds (Ramsar Convention Secretariat, 2016). This classification scheme (Ramsar types) uses an ecosystem-based approach that allows the mapping of the "hydro-ecological" boundaries of wetland habitats, including their water regime characteristics (i.e. seasonally or permanently flooded), hence allowing for their inclusive definition, delimitation and delineation.

In many cases, wetland inventories refer to different classification schemes (national classification systems, MAES, EUNIS, CORINE Land Cover), making the conversion to a common one, somewhat uncertain. For this reason, we relied on a crosswalk between widely used nomenclatures of wetland habitats originally developed within the GlobWetland-II (2010-2014) and the SWOS[5] (2015-2018) projects to enable harmonisation at regional scales. This crosswalk table focuses on the harmonisation for Europe using the MAES classification as a basis, and relating its classes with the Ramsar types and with the CORINE Land Cover classes (Fitoka et al., 2017). This table is presented in Annex I.

There are
45-51% FEWER
Mediterranean Wetlands today compared to 1970

The final product, the Pan-Mediterranean wetland ecosystem map, is presented following a common simplified classification (Table 1).
For the northern part of the basin however, and other areas where data are available, the Ramsar-based classification is also provided. A less refined classification scheme was adopted for the southern part of the basin due to data gaps, as the background layer for this region could not be produced with the target thematic accuracy (section 2.2.1.2). Nevertheless, it is likely that the simplified scheme will be refined in the future once more input data are made available for the development of the knowledge base for the southern part of the basin (see section 2.2.1.2).

[5] https://www.swos-service.eu/

Table 1: Typology adopted for the Pan-Mediterranean wide wetland ecosystem map

Class	Name	Description
0	Upland	Absence of wetland classes
1	Other wetlands	All wetland classes which are not classified as "open water"
2	Open Water (seasonal/ temporary/ intermittent)	Water-related classes in non-marine areas. Temporal information is used to mask and classify those pixels that present seasonal/intermittent open water (i.e., seasonal floods)
3	Open Water (permanent)	Water-related classes in non-marine areas. Temporal information is used to mask and classify those pixels that present permanent open water (i.e., permanent ponds and lakes)
4	Marine waters under 6m depth at low tide	See section 2.2.2.4

2.1.3 DATA STRUCTURE OF THE PAN-MEDITERRANEAN WETLAND ECOSYSTEM KNOWLEDGE BASE

The structure of the attribute table of the knowledge base is shown in Table 2. Detailed attribute tables for each of the input datasets are also available with specific information (when provided) and can be linked with the main database table through the "SourceID" field.

"

A less refined classification scheme was adopted for the southern part of the basin due to data gaps, as the background layer for this region could not be produced with the target thematic accuracy

Table 2: Data structure of the Mediterranean wetland ecosystem knowledge base

Label	Explanation
ID	Unique identifier of the wetland site
DB_id	Unique identifier of the source database
SourceID	Identifier of the wetland site in the source database
Ramsar_Typ	Wetland Ramsar type
SourceTyp	Wetland type in the source database
Simpl_Typ	Simplified classification
Name	Name of the wetland site
DB_name	Name of the source database
DB_source	Database source (e.g. website of the data owner)
Reference	Reference of the source database
Related project	Project within which the data was produced
Scale	Geographical scale (e.g. Continental, National, Regional)
Reference year	Year of data update
Type of data	Mapping methodology applied (e.g. Satellite Remote Sensing)
Expected accuracy	High, Medium or Low, depending on the scale and type of data
Notes	Remarks

2.2 INPUT DATA AND CONTRIBUTING DATASETS

Several datasets were used and integrated in different ways to build the first version of this product. The approaches followed to combine the selected datasets to derive a Mediterranean-wide wetland ecosystem map are presented separately for the northern and the southern parts of the basin in section 2.2.1.

Subsequently, in section 2.2.2, the contributing datasets for specific regions provided from collaborating partners are detailed. The list for this specific section is going to be enriched with new datasets as soon as they become available through regular future updates of the Pan-Mediterranean wetlands map presented in this report.

For reading and referencing purposes, the whole list of input datasets is collated in a unique table describing their main features, and is provided in Annex II.

2.2.1 BACKGROUND LAYERS

In the following sections, we introduce the methodology used for developing a background layer for the whole basin and the datasets on which the final product can rely. Due to the difference in terms of the number and accuracy of the available datasets, the process has been developed separately for the northern (2.2.1.1) and southern and eastern (2.2.1.2) parts of the basin. These boundaries are graphically represented in Figure 2.

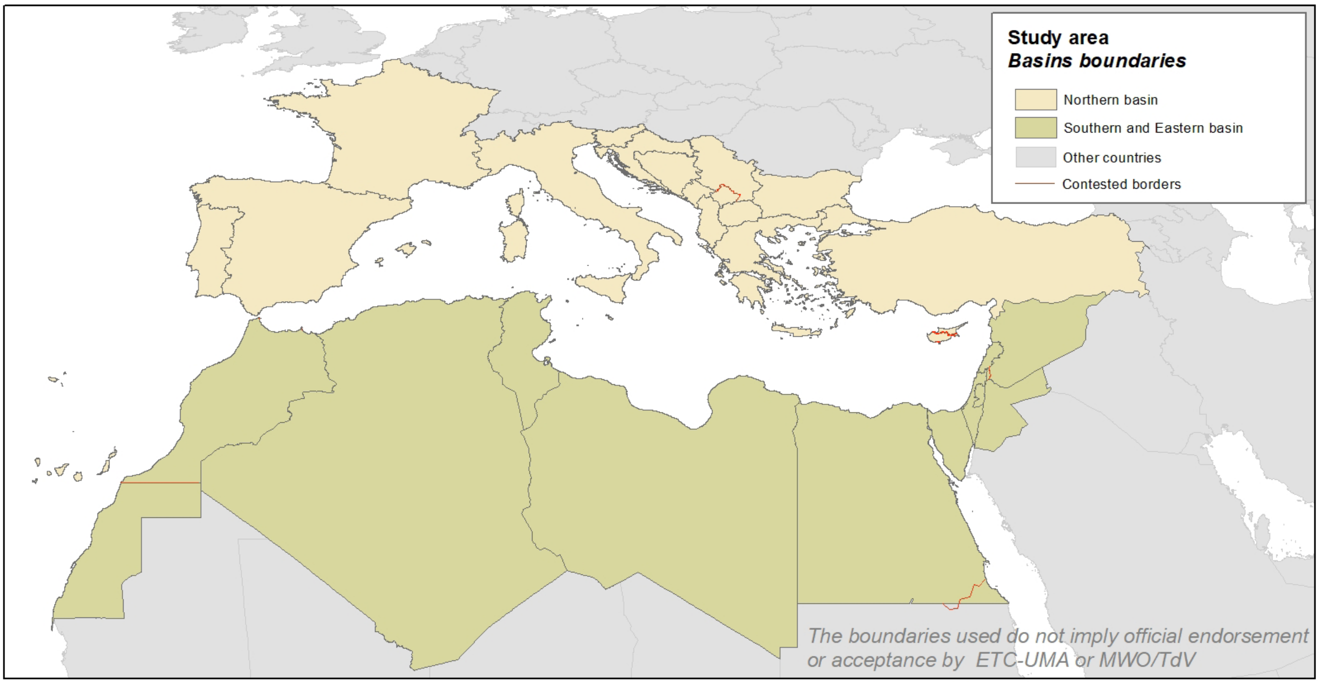

Figure 2. Division of the study area in two main areas (northern and southern-eastern basin) for the development of separated background layers

2.2.1.1 NORTHERN BASIN[6]

The first holistic map of wetland ecosystems at European level (38 EIONET countries plus the UK), was produced and presented within the European Commission Mapping and Assessing Ecosystems and their Services Working Group (EC MAES WG), following an explicit policy request in Europe. For more details, please refer to the Wetland Thematic Assessment chapter[7] (Maes et al., 2020). Wetland habitats are defined based on the revised classification of the MAES nomenclature, and the guidelines set within the Horizon 2020 Satellite-based Wetland Observation Service (SWOS) (see section 2.1.2). Besides the traditional types of inland and coastal wetlands (i.e. marshes, rivers, lakes, lagoons, estuaries), the layer also covers the forest, grassland and agricultural ecosystems which are seasonally or permanently flooded (i.e. riparian forests, wet grasslands, rice fields) and are therefore considered as wetlands according to the Ramsar Convention definition and typology. This wetland reclassification and mapping considers their hydro-ecological characteristics and provides information about the real spatial extent and distribution of varied wetland habitats. This will allow for improved management and governance in terms of the prioritisation of conservation and protection measures.

Wetlands cover approx

~160,000 KM²

of the Mediterranean territory

Specifically, this dataset (namely the "Extended wetland ecosystem layer", 100m * 100m spatial resolution) is a derived product of the CORINE Land Cover (CLC) layer for the years 2012 and 2018 (v20) which has then been reclassified into 20 wetland classes based on ancillary spatial layers ("Water and Wetness 2018" version 2.0; "Delineation of Riparian Zones"; the "Ecosystem types of Europe" v3.1; "The Global Surface Water Explorer"). The raster layer is available for download on the EEA geospatial data catalogue[8].

The version of the extended wetland ecosystem layer which used the northern basin as the background layer has been updated using the latest version of the Water and Wetness product (Annex II), a Copernicus product, which based on satellite remote sensing data shows the occurrence of water and wet surfaces over the period from 2009 to 2018.

2.2.1.2 SOUTHERN AND EASTERN MEDITERRANEAN BASIN[9]

The southern and eastern Mediterranean basin is characterised by a major gap of reliable and harmonised data on wetland habitats. Currently, there is no better accessible source than global Land Cover / Land Use (LULC) datasets to be used for this scope. Global datasets do not specifically aim for wetland mapping but are better suited for threat and pressure assessments. Despite this and although they generally have a lower reliability, for our purposes, at this stage, it is necessary to rely on such global products generated from satellite images and remote sensing techniques to overcome the lack and/or difficulty of access to local datasets.

[6] Albania, Andorra, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, France, Greece, Italy, Malta, Monaco, Montenegro, Portugal, Serbia, Slovenia, Spain, North Macedonia and Turkey.

[7] The EU wide wetland ecosystem condition assessment chapter, led by ETC-UMA, was published in October 2020 as main results on the work developed on wetlands to evaluate the progress done under the Biodiversity Strategy to 2020.

[8] https://sdi.eea.europa.eu/catalogue/eea/eng/catalog.search#/metadata/5fc1b45a-715a-466e-b576-1be0ced40e2a

[9] Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestinian Authority, Syrian Arab Republic and Tunisia.

The development of a background layer to be used as an umbrella coverage for the southern part was carried out following a different methodological approach based on an expert-based aggregation of four LULC products into a unique wetland ecosystem layer (Figure 3). The main wetland classes were derived from the selected LULC products as input data to map the target ecosystems in this region, and temporal information on water presence was used to mask and classify those pixels that present water at certain times of the year to distinguish temporarily and permanently flooded areas. Further details on each of the input datasets for this part of the basin are provided in Annex III.

The resulting background layer was resampled to 100m and projected to WGS 1984 EASE Grid Global, as this is considered a suitable system for gridding and digital mapping for environmental sciences in mid- and low latitudes (Brodzik et al., 2012). The pixel grid was adapted to match the background wetland layer produced for the northern part of the Mediterranean region for compatibility purposes (Section 2.2.1.1).

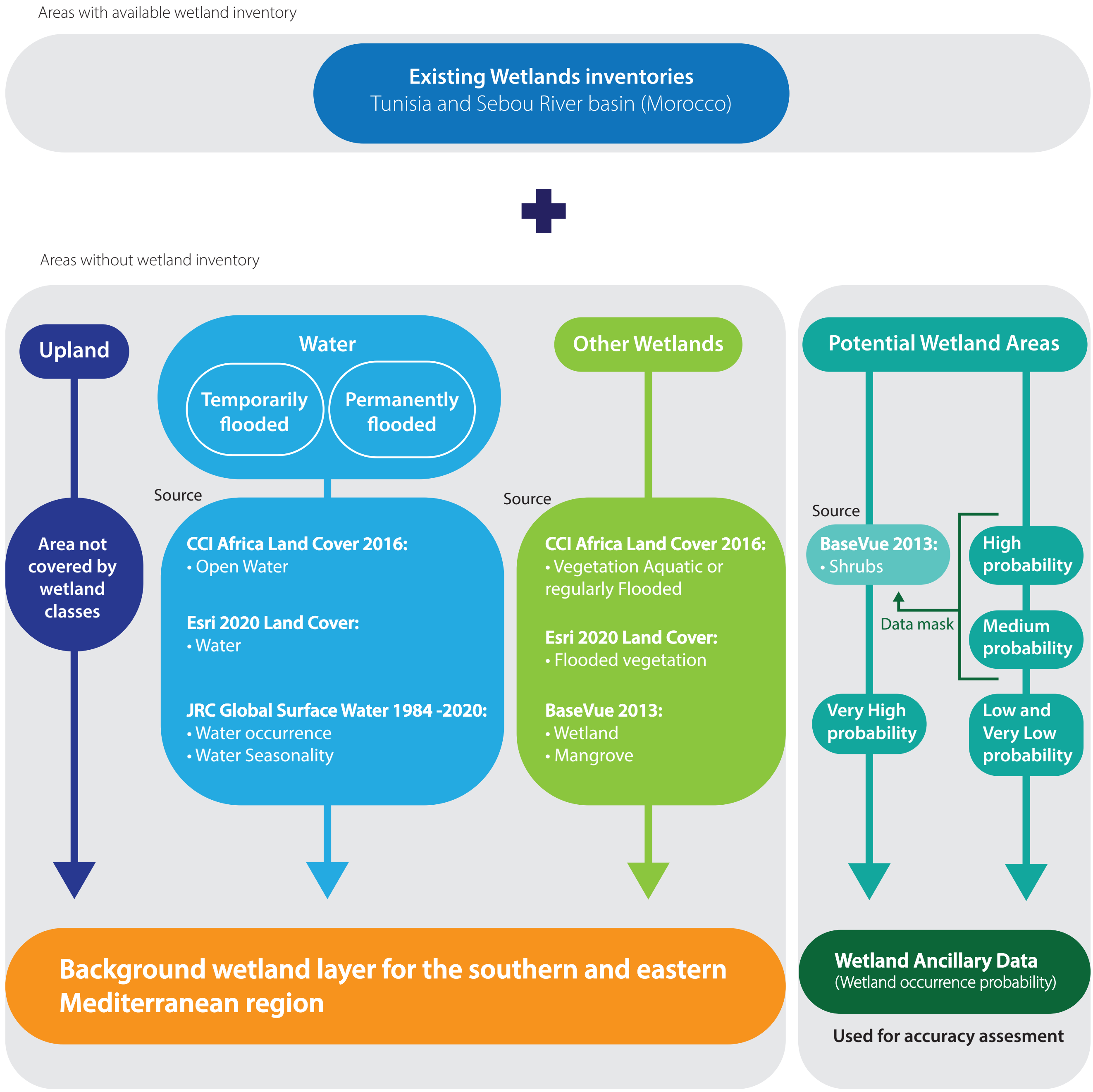

Figure 3: Summary of input data and process to produce the background wetland layer for the southern and eastern Mediterranean regions.

2.2.2 CONTRIBUTING DATASETS

Several available datasets for specific countries/regions were merged into the background layers described above, improving the reliability of the information for these specific areas. When needed, the source vector data were clipped to match the country borders used as a reference layer (section 2.1.1).

The attribute table of the provided spatial datasets was reviewed and harmonised with the structure of the knowledge base (section 2.1.3). When more than one typology is associated with the same wetland site, the one with the biggest extent was then selected and reported in the output table.

2.2.2.1 THE BALKAN MEDITERRANEAN GIS WETLAND LAYERS WetMainAreas PROJECT

Within the scope of the present work, a link was established between the Interreg programmes "Mediterranean" and "Balkan-Mediterranean" in order to find potential synergies and share knowledge, specifically in the context of the MBPC and WetMainAreas projects.

The WetMainAreas project methodology (Fitoka et al., 2020) focuses on the mapping and assessment of the Balkan Mediterranean (BalkanMed) wetland ecosystems as landscape features that play a significant role in the ecological connectivity of Protected Area networks (Natura 2000, Emerald, other national designated areas). Among the main project outputs are the BalkanMed GIS Wetland Layers[10], which were integrated into the Pan-Mediterranean wetland ecosystem map. These layers are the result of harmonised mapping of the wetland ecosystem boundaries carried out by the partners' expert teams under the coordination of the Greek Biotope / Wetland Centre (EKBY). Earth Observation and GIS techniques were applied, including image analysis, photointerpretation of very high-resolution images (Google Earth, World Imagery by ESRI, orthophotos) and integration of various open geospatial datasets (e.g. CORINE Land Cover, Copernicus Hydro Data, OpenStreetMap Data). Existing wetland inventories, scientific papers and expert knowledge were also used.

The mapping covered some 8,500 wetlands sites, natural and artificial of different sizes with the minimum wetland size of around 0.05 ha. Each wetland site owns a code, a name and is classified according to the Ramsar typology. The spatial data for rivers is provided separately as line vectors. For the sake of integration in the Pan-Mediterranean common knowledge base (polygon vectors), the river lines have been converted to polygons by drawing a buffer area of 5m width on both sides of the line.

2.2.2.2 MedIsWet PROJECT

The project MedIsWet[11] is documenting Mediterranean island wetlands through national inventories following a common methodology.

Currently, the implementation stage of the mapping task varies between the involved countries. So far, data integrated in the knowledge base cover the Greek, Balearic and 24 of the Turkish islands; Cyprus, Malta, Corsica; and other small French Mediterranean islands. The data for Croatia and Italy (Sardinia and Sicily) is currently being updated.

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[10] Available via the Balkan-Mediterranean Wetland Geoportal (https://wetmainareas.com/ or directly via http://185.17.146.157) which provides free access to 97 geospatial layers (i.e. polygons of wetland sites, protected areas, Natura 2000 sites, Emerald sites, connected areas favourable for biodiversity and others)

[11] https://sites.google.com/view/mediswet/home

2.2.2.3 POTENTIAL WETLAND AREAS (PWA)

The PWA layer is a comprehensive Pan-Mediterranean map developed by the MWO, which represents areas where wetland habitats could potentially occur. It is based on the surface hydro-ecological characteristics of wetlands (including topographic and hydrological parameters), combined with climatic variables (mean precipitation values, Global Potential Evapo-Transpiration and Aridity Index datasets), surface water data (derived from the Global Surface Water Explorer) and a mask of built-up areas (derived from the Global Urban Footprint dataset). According to these criteria, this layer could help to locate and delineate former wetlands that have been degraded by human activities through draining and/or land conversion into other land cover classes (e.g. agriculture), and could further help prioritise areas for future wetland restoration actions. In the frame of the work presented in this report, this layer was used for the accuracy assessment of the final map (Annex IV).

2.2.2.4 MARINE WATERS UNDER 6 METRES DEPTH AT LOW TIDE

According to the Ramsar definition, wetland ecosystems also include coastal and marine habitats covering marine waters up to 6m depth at low tide. A Pan-Mediterranean layer delineating these habitats, based on the GEBCO grid, was developed and provided by the MWO. This layer includes those seashores that do not drain into the Mediterranean Sea (Atlantic, the Red Sea and the Black Sea sides of MedWet countries).

2.2.2.5 UPDATED EO-BASED LOCAL/NATIONAL WETLAND INVENTORIES (TUNISIA AND THE SEBOU RIVER BASIN)

Detailed and updated wetland inventories for Tunisia (national) and the Sebou river basin in Morocco have been provided by the MWO. These datasets are based on EO tools and satellite time series covering the annual time-period of 2020.

The used nomenclature for maps production is CORINE Land Cover combined with Ramsar definitions for wetland classes. The overall accuracy is 91% (95%-88% depending on the classes) and the Minimum Mapping Unit for the produced maps is 0.1ha (even small wetlands like artificial ponds for agriculture are identified).

[12] https://www.gebco.net/

2.3 RESULTS

2.3.1 ACCURACY ASSESSMENT

Given the heterogeneity of the data sources contributing to this knowledge base, the accuracy and reliability of the Pan-Mediterranean wetland ecosystem map is diverse across the study area. Accuracy and reliability depend on the features of the input source data and are assessed separately for their two component parts.

The details on this part of the assessment are given in Annex IV, separately for the northern and the south-eastern basins. The information is combined and represented as overall accuracy for the whole study area in the next section (2.3.2).

2.3.2 OVERALL RESULTS

The final Pan-Mediterranean wetland ecosystem map currently combines data from 23 input datasets and is distributed in a vector format made of about 11,500 features.

The wetland ecosystem spatial extent in the Mediterranean territory (as defined in section 2.1.1) reaches almost 160,000 km^2 (Table 3). The spatial extent of the non-marine water-related classes is the same in both sides of the basin while the extent of other wetland classes in the northern part is 50% larger than in the southern one.

As introduced in section 2.3.1, based on the availability of input data it is possible to assess the expected accuracy of the resulting product (Figure 4). As expected, beside isolated areas, the major data gap is in the southern and the eastern parts of the basin. Due to the lack of reliable baseline datasets the final map for this region does not include water courses, which constitute a large part of the wetland ecosystem.

Datasets with high accuracy produced at local and regional scale are also mostly missing in the northern region (except for the Balkan-Mediterranean territory).

Table 3: Surface extent in km^2 of the Mediterranean wetland ecosystem

Wetland ecosystem extent [km^2]	Water-related classes in non-marine areas	Other wetlands	Marine areas	Sub-total	Total
Northern basin	36,114	28,686	23,794	88,594	159,800
Southern-eastern basin	36,082	19,764	15,360	71,206	

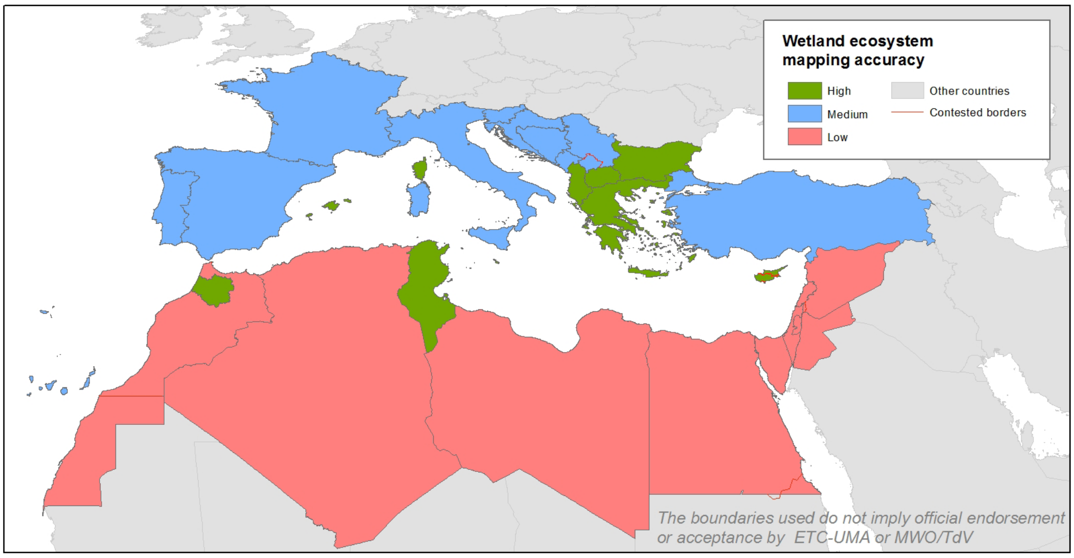


Figure 4. Spatial distribution of the expected mapping accuracy of the final product based on the features of the contributing input datasets

In terms of spatial distribution, when considering the spatial extent per watershed (as defined by the HydroSHEDS dataset), wetland sites are relatively homogeneously distributed over the whole basin (Figure 5).

As expected, in the southern part the mapped wetlands are mostly located along the coastal and near-coastal zones while, in the northern part, the distribution of wetlands extends to the inland watersheds too. In terms of habitat distribution (Figure 6), due to the previously mentioned mapping limitations (2.2), it is possible to distinguish only between water-related classes and other wetlands for the southern part of the basin. In this part of the basin almost two thirds of the spatial extent of wetland ecosystems are covered by permanently or temporarily flooded habitats.

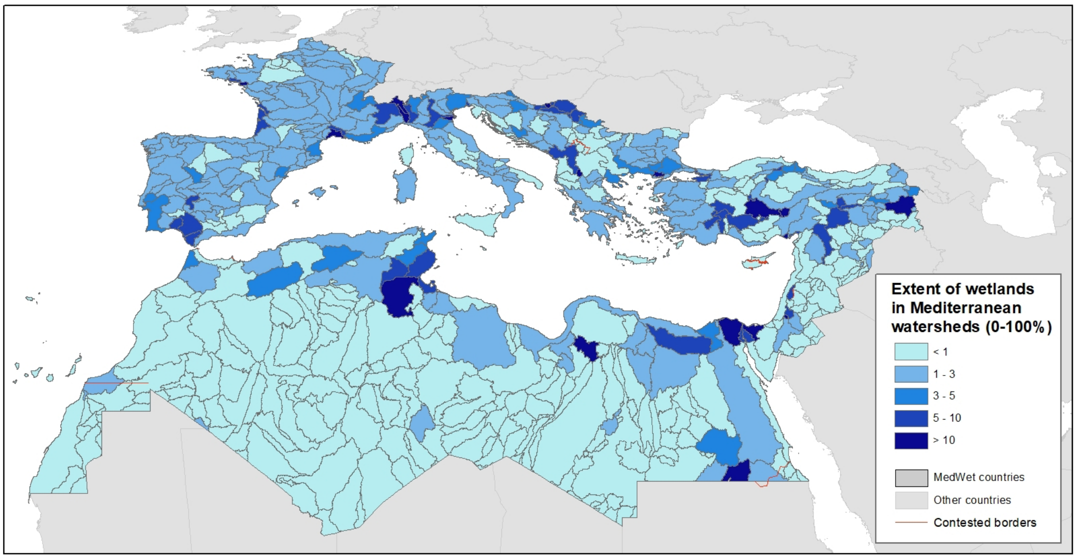
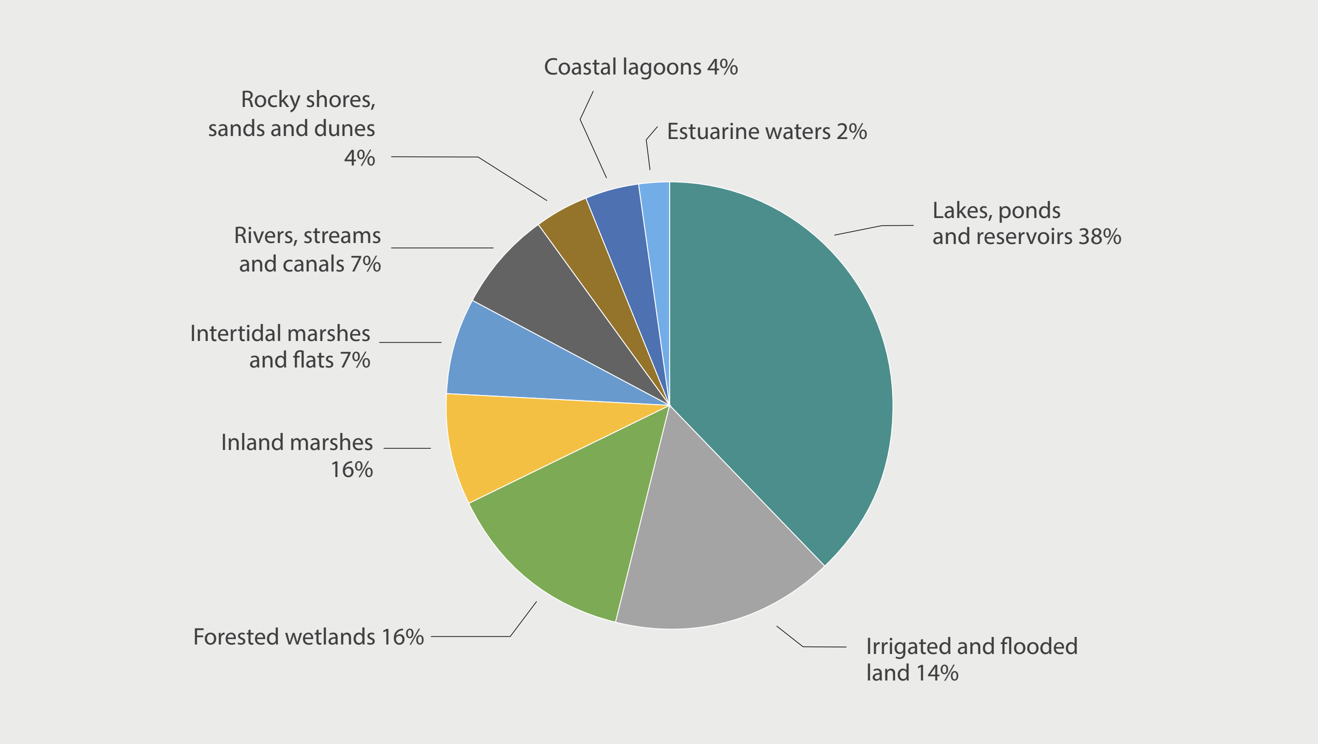


Figure 5. Extent of wetlands in Mediterranean watersheds [%] (non-marine habitats)

[12] https://www.hydrosheds.org

This pattern is similar in the northern part of the basin where water related habitats, such as lakes, ponds and reservoirs; irrigated and flooded land; rivers, streams and canals; and coastal lagoons, cover 63% of the surface extent of the ecosystem. Thanks to the availability of mapping products with higher thematic resolution, it is possible to estimate the extent of other wetland habitats with high ecological significance but a limited surface extent (e.g. estuarine waters or rocky shores, sands and dunes habitats) for this part of the study area. Here, it is necessary to highlight the importance of forested wetland habitats, which in terms of spatial extent, constitute a large share of the total wetland ecosystem area (16%).

> "In the southern part the mapped wetlands are mostly located along the coastal and near-coastal zones while, in the northern part, the distribution of wetlands extends to the inland watersheds



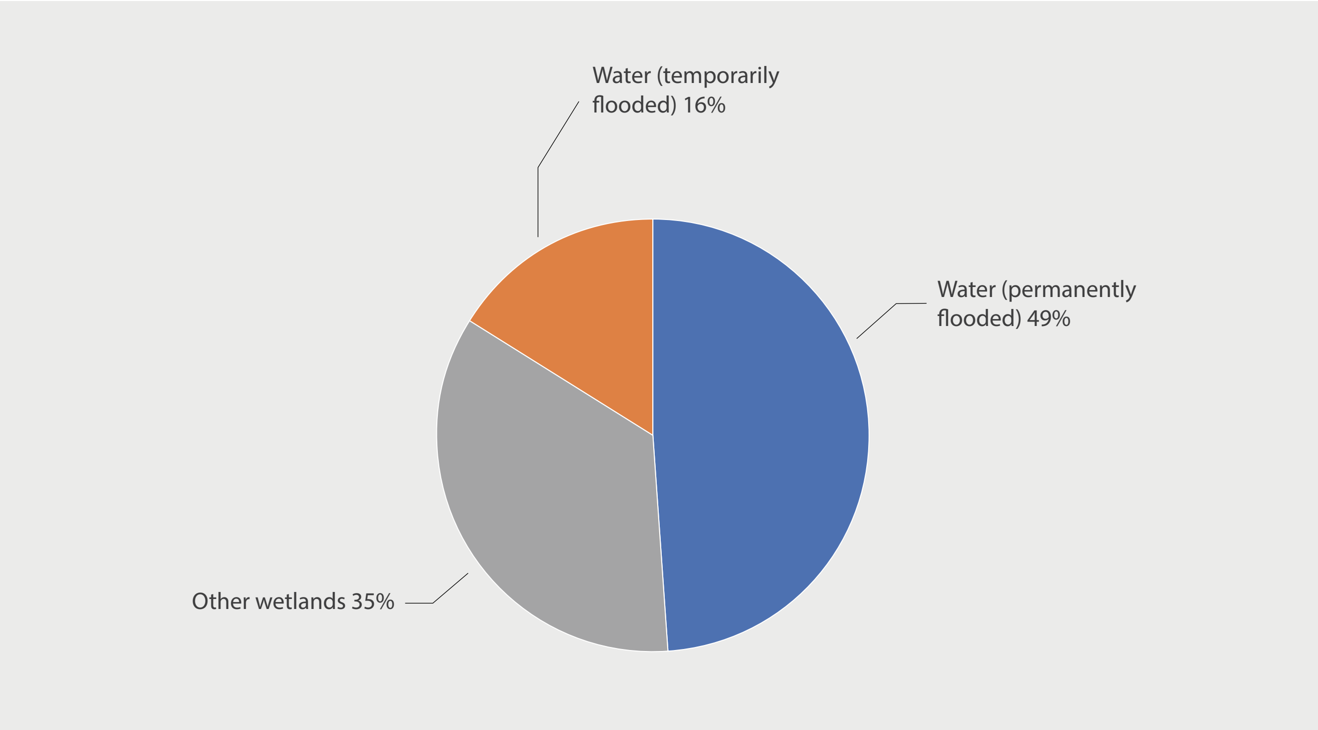


Figure 6. Mediterranean wetland ecosystem: share of wetland types in the northern (top) and southern (bottom) parts of the basin.

2.4 LIMITATIONS AND POSSIBLE IMPROVEMENTS

The Pan-Mediterranean wetland ecosystem map presented in this report constitutes the first step in building and making available a harmonised knowledge base across the whole region on the spatial extent, distribution and types of wetlands in the Mediterranean region.

Despite the amount of data ingested and the variety of contributors, large areas of the whole basin (also in the north) still lack detailed and reliable regional data, which makes the final Pan-Mediterranean wetlands map worth improving as data and knowledge become more available and accessible over time. Further efforts are needed to identify already available higher resolution data for specific areas.

The Potential Wetland Areas (PWA) product definitely constitutes a layer with the capacity to support the identification of wetland areas in the background layers. The PWA probability classes could be masked based on proximity to water bodies. Using a buffer or the differences in topography can help define a catch area to rule out commission errors. More broadly, this layer could also be used as a baseline to assess the conservation status of the effective wetlands, their threats and pressures and to identify potential areas for restoration actions (e.g. highly degraded and/or lost wetlands).

Linear and small features, mainly watercourses, which constitute a large part of the wetland ecosystem are not mapped by the input global LULC data. Vegetation and soils associated with these wetlands are classified as not-wetland related classes since they use very general nomenclatures. Classification of high-resolution imagery with specific methods for wetlands (wetness and vegetation indices) as well as the use of the PWA probability classes will be needed to overcome this limitation.

As a consequence of the mapping limitations in the southern part of the basin, the nomenclature of the wetland typology had to be simplified: input data are not detailed enough to better identify wetland habitats.

This Pan-Mediterranean map is nevertheless a product that fills a regional gap and was made possible through a collaborative effort among reference institutions in the Mediterranean region. Collaboration to improve and update this product in a timely manner is a worthy investment to maintain this knowledge base and improve it so that it becomes a reference for action and decisions in the region.

3

Mediterranean wetlands biodiversity assessment based on the IUCN Red List of threatened species™

Beside the first necessary step of developing comprehensive mapping for the Mediterranean wetland ecosystem (Section 2), the Ramsar Strategic Plan also calls for the restoration of degraded wetlands. In addition, the SPA/BD (concerning specially protected areas and biological diversity in the Mediterranean) and the ICZM (Integrated Coastal Zone Management) protocols of the Barcelona Convention aim to ensure respectively, the safeguarding of biological diversity and better management of the coastal zones of the basin.

With the aim to support these policy frameworks, ETC-UMA produced an assessment that targets the distribution, state and trends of pressures and impacts on key animal and plant biodiversity hosted by wetland habitats in the region. The results of the assessment will help focus conservation and restoration efforts to improve the ecosystem health by identifying priorities to be raised with practitioners, decision makers and funding institutions, urging them for evidence-based restoration action.

The Mediterranean region is home to a remarkable biodiversity: one-third of the animal species are endemic - unique to the Mediterranean and found nowhere else in the world - including 60% of the freshwater molluscs, almost half of amphibians and freshwater fishes, 41% of reptiles, 21% of butterflies, 13% of dragonflies, 12% of mammals and 2% of birds (Critical Ecosystem Partnership Fund, 2017).

Also, underwater, the Mediterranean Sea´s biodiversity is exceptionally rich, with 14% of the marine fish being endemic (Cavanagh and Gibson, 2007, Abdul Malak et al., 2011) and up to 18% of the world's macroscopic marine species being found there, of which 25 to 30% are endemic (Bianchi and Morri, 2000). Its wildlife richness extends to millions of migratory birds from the far reaches of Europe and Africa which use Mediterranean wetlands and other habitats as stopover, wintering or breeding sites (Cuttelod et al., 2008, García et al., 2018).

An exhaustive overview on the status of biodiversity in the Mediterranean region has been provided by the Mediterranean Wetlands Outlook 2 (MWO2), 2018 and, very recently by the Living Mediterranean Report (Galewski et al., 2021). The MWO2 is a regional indicator-based assessment of the state of wetlands and the issues they face; it includes 16 indicator factsheets, among which two are specifically related to biodiversity ("species abundance" and "extinction risk of species").

In the Mediterranean areas studied (302 wetlands), many of the plants and animals that depend upon them are also in decline and are increasingly threatened with extinction. The abundance of wetland-dependent vertebrates has declined by 15% since 1990, with fish declining by 34%, and amphibians, reptiles and mammals by 35%. However, increased protection has led to increases in waterbird populations since the mid-2000s. The abundance of globally-threatened, wetland-dependent species in the Mediterranean Basin has declined even more, by 46% in 2013 since 1990.
With 36% of wetland-dependent species now threatened with extinction, the Mediterranean basin has amongst the highest extinction threat levels of any part of the world, with the most threatened groups being freshwater molluscs (53% globally threatened) and freshwater fish (40%), but only 11% of the dragonflies and damselflies, and 7% of the birds.

The Living Mediterranean Report (Galewski et al., 2021) gathered abundance records for more than 80,000 animal populations, belonging to all biomes (terrestrial, freshwater and marine), and based on which they calculated an average abundance change index (the so-called Living Planet Index), representative of the region's biodiversity.
Across all biomes, marine and freshwater species are the most heavily impacted taxa. The index shows a 28% average drop in the population abundance of vertebrate species living in freshwater ecosystems monitored in the region between 1993 and 2016, with all the different taxonomic groups showing sharp declines in their population, except water birds.

The work presented in this section aims to complement existing knowledge and address the lack of readily available spatially-explicit information on the areas where biodiversity unique to the Mediterranean occurs, and where endemic biodiversity is most threatened, using data from The Red List of Threatened Species™ of the International Union for Conservation of Nature (IUCN). The IUCN Red List is the most comprehensive inventory of the global conservation status of animal, plant and fungi species. With its strong scientific base, the IUCN Red List is recognised as the most authoritative guide to the status of biological diversity (IUCN 2021).

Overall, the main objective of this assessment is to present biodiversity information in a suitable format for stakeholders and decision makers for subsequent integration within the development/conservation planning process.

The region is home to a large number of freshwater species, with around 3,200 species estimated to belong to the selected taxa

3.1 METHODOLOGICAL APPROACH

The assessment covers the same area of interest described in the previous section (2.1.1), including the national waters of the considered countries.

3.1.1 SELECTION OF PRIORITY TAXA

Priority taxa were selected to represent a range of trophic levels within the food webs that underlie and support wetland ecosystems, all of which play diverse ecological roles and therefore are thought to provide a useful indication on the overall status of the associated wetland ecosystems (Smith et al., 2014).

Together, the seven selected taxa represent indicators of the overall conservation status of wetland ecosystems: fish, molluscs, odonates (dragonflies and damselflies), decapods (crabs, crayfish, and shrimps), amphibians, mammals and plants. These groups were chosen as good representatives of the freshwater biome.

Most bird species have distribution ranges which exceed the Mediterranean region. For this reason, no bird species have been included in the analysis that focused specifically on endemic or near endemic taxa with at least 80% of their distribution range occurring within the region.

All key wetland-dependent species occurring within the region´s boundaries are identified based on their taxonomy and habitat preferences, and their distribution maps and associated information from the IUCN Red List of Threatened Species™ (Version 2021-2) publicly available online database (www.iucnredlist.org).

For wetland-dependent plant species, we considered all vascular aquatic plants: "all Pteridophytina and Spermatophytina whose photosynthetically active parts are permanently or, at least for several months each year, submerged in water or floating on the surface of water" (Cook, 1996).

For wetland-dependent animal species, the freshwater fishes, molluscs, odonates, decapods, amphibians and mammals included in the analysis are those that spend all, or a critical part, of their lifecycle in freshwaters or are confined to brackish water bodies.

Some marine species occasionally enter freshwater bodies in the region, but freshwater habitats are not an essential element of the life cycle of these species and they are thus excluded from the analysis.

The region is home to a large number of freshwater species, with around 3,200 species estimated to belong to the selected taxa. For this study, a key subset of endemic species (unique to the region) and near endemic (less than 20% of their distribution is outside the region), were selected. As a result, this assessment evaluated a total of 1,572 endemic species related to Mediterranean wetlands.

For the threatened species analysis, only species categorised in the IUCN Red List as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) were considered. The categories of threat reflect the risk that a species will go extinct within a specified period of time. A species assessed as "Critically Endangered", "Endangered" or "Vulnerable" is considered to be facing an extremely high, very high or high risk of extinction in the wild (Smith et al., 2014).

Exotic species that settled or were introduced to the Mediterranean after 1500 AD were not considered for this assessment. In addition, species that are not strictly dependent upon freshwater ecosystems, or if their presence in the region is unclear or are vagrants, were also excluded.

3.1.2 DATA COLLATION AND QUALITY CONTROL

The first step of the process was a desktop analysis of data collated from the Red List database and from a series of published reports of IUCN Red List assessments for the region. These data sets included digital shape file distributions. The main information sources are listed in Annex V.

3.1.3 SPATIAL ANALYSIS

In the IUCN Red List, the present distribution of freshwater fish, freshwater molluscs, odonates, some decapods and aquatic plants is mapped at the sub-basin level of the water body[14]. Although species' ranges may not always extend throughout a river sub-basin, it is generally accepted that this is the most appropriate management unit for inland waters (Darwall et al., 2011).

The present delineation of the global distributions of mammals, amphibians, and some decapods, is available on the IUCN Red List. These are mapped as polygons representing the species range extent, which has then been translated to the sub-basin base layer. For a few species, only point locations were available on the IUCN Red List. These were used to identify which sub-basins are known to currently host each species.

However, not all species have mapped distribution ranges available on the IUCN Red List. This is due to various reasons, for example, the taxon distribution is not known and the map is therefore impossible to create, or it may be because the map has been withheld for a specific reason such as lack of permission to be publicly available or, in very few specific cases, due to the sensitive nature of the data. In total, spatially explicit information on the distribution was available for 1,154 species (out of the 1,572 selected species, see section 3.1.1) which were then used for the spatial analysis.

Instead, statistical analysis of the Red List status was carried out for the total of 1,572 freshwater species identified as endemic in the region.

> Almost half of the 1,572 freshwater endemic species to the region used in this study are threatened with extinction

[14] www.hydrosheds.org/page/hydrobasins

3.2 RESULTS AND DISCUSSION

3.2.1 RED LIST STATUS

Almost half (49%; 777 species) of the 1,572 freshwater endemic species to the region used in this study are threatened with extinction. In addition, 10% are Near Threatened, and 17% Data Deficient (Figure 7). Data Deficient species are those for which information is inadequate to achieve an informed conservation assessment at present but could be potentially threatened if future updated data changes our current knowledge about their conservation status. Regional efforts and appropriate funding need to be ensured to assess the species which are Data Deficient to increase the knowledge about their status and trends in the region. This will help address prioritisation decisions for management.

Only 22% of the studied species are considered to be of Least Concern status, meaning that their specific conservation is not a priority in the region due to factors such as their abundance, wide distribution and/or the lack of major threats impacting their global population.

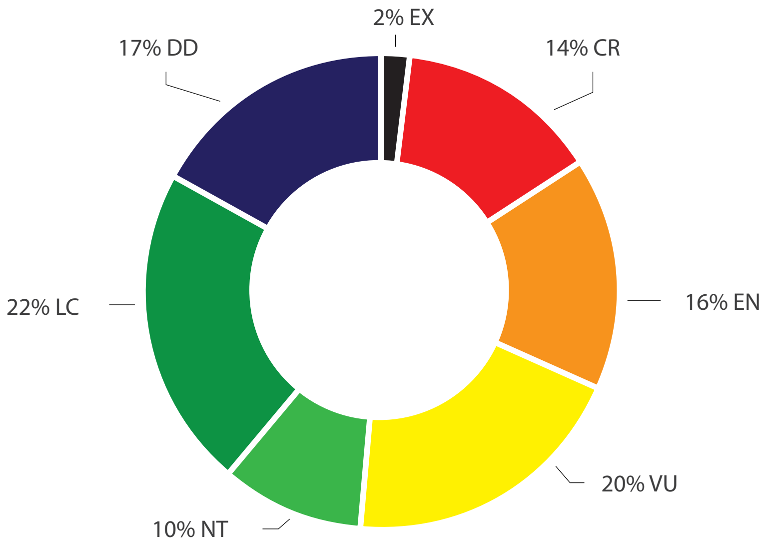


Figure 7. IUCN Red List status of endemic wetland-dependent species in the region[15]

Of the different taxa considered, all endemic mammals, 53% of the freshwater fish and 52% of the molluscs are at risk of extinction (Table 4). A significant number (31 species; 2% of the endemics) of taxa have disappeared from the region and these are therefore listed in the Extinct category, including eleven freshwater fish and twenty freshwater molluscs.

More than half (52%) of these extinct species were originally restricted to North African countries: Morocco (*Salmo pallaryi and Hydrobia gracilis*), Tunisia (*Bythinella limnopsis, Bythinella mauritanica, Bythinella microcochlia, Bythinella punica, Pseudamnicola barratei, Pseudamnicola doumeti, Pseudamnicola globulina, Pseudamnicola latasteana, Pseudamnicola oudrefica, Pseudamnicola ragia and Pseudamnicola singularis*), Algeria (*Mercuria letourneuxiana and Pseudamnicola desertorum*) and Egypt (*Chambardia letourneuxi*).

[15] IUCN Red List Categories: EX – Extinct, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient

Table 4: Summary of Red List Category classifications for all endemic wetland-dependent species in the region by taxonomic groups

Taxon	EX	CR	EN	VU	NT	LC	DD	Total Species (%)	Number of threatened species (%)
Fish	11	69	99	80	33	131	43	466 (30%)	248 (53%)
Molluscs	20	121	107	175	62	94	201	780 (50%)	403 (52%)
Odonates	0	1	9	5	5	18	1	39 (2%)	15 (38%)
Decapods	0	1	3	8	9	7	4	32 (2%)	12 (37%)
Aquatic Plants	0	23	25	25	37	68	18	196 (12%)	73 (37%)
Mammals	0	1	0	2	0	0	0	3 (0,2%)	3 (100%)
Amphibians	0	4	7	12	8	25	0	56 (4%)	23 (41%)
Total species	31	220	250	307	154	343	267	1572 (100%)	777 (49%)

These findings are directly related to the high concentration of human activities in the area and to the lack of adequate management, as well as to the limited dispersal capacity of some freshwater groups such as the molluscs, which are often restricted to a single catchment or lake (García et al., 2010).

For instance, the infrastructure development of the Aswan Dam in the Egyptian Nile River acts as a barrier to the water flow which impedes the reproductive cycles and migratory routes of fish species. This dam, due to the trapping of nutrients, is expected to be the cause of extinction at regional level of several taxa with a restricted range (García et al., 2010).

In Maghrebian Africa, the number of species with restricted ranges in surface waters, i.e., confined to one river system or, in some cases, to two adjacent systems, is the highest in the Moroccan rivers running towards the Atlantic (Van Damme et al., 2010).
For example, the endemic salmonid *Salmo pallaryi* once native to the Atlas Mountains in northern Morocco, is thought to have disappeared as a result of the introduction of the common carp, *Cyprinus carpio* (Azeroual, 2003, Kottelat, 1997, García et al., 2010).

3.2.2 SPATIAL PATTERNS OF SPECIES DISTRIBUTION AND RICHNESS

3.2.2.1 ENDEMIC SPECIES

Species richness patterns were identified by combining the number of species contained in sub-basins for each focal taxonomic group (freshwater fishes, molluscs, decapods, odonates, amphibians, mammals and wetland-dependent plants).

The highest concentrations of endemic species (Figure 8) was found in the Balkan region, particularly in the southern regions of Croatia, Bosnia & Herzegovina, and Montenegro, including the areas of South Travunija, Cetina Canyon and River, Bacina Lakes, Neretva Delta and Surrounding Area, Vrgorac and Polje Lake, Orjen i Bijela gora (up to 367 species per sub-basin); on the border between Albania, Macedonia and Kosovo (areas of Lake Ohrid and surrounding area, Lura, Korab-Koritnik mountain range, River Radika catchment, Jablanica, Ilinska Planina Mountain; up to 290 species); in Bosnia & Herzegovina (Trebinjsko Jezero, Orijen i Bijela gora and North Travunija; up to 217 species); and on the border between Albania, North Macedonia and Greece (Lake Megali Prespa, Prespa National Park and Varnountas mountains and Galicica Mountain; 209 species).

The Sahara Desert covers most of the northern Africa region, which is particularly poor in terms of permanently flowing waters. With the exception of the Nile River, permanent rivers are only found in the northern part of Morocco, Algeria and Tunisia - the region that is fed by the rain and snow melt in the Atlas Mountains range (García et al., 2010). This water scarcity is reflected in the low number of reported endemic species for this area in comparison with other Mediterranean regions. Here, the most important areas that can be highlighted as having the highest numbers of endemic freshwater species are located in the Kabylias–Numidia–Kroumiria region on the border between Algeria and Tunisia (up to 115 species per sub-basin), the Middle Atlas on the border between Algeria and Morocco (up to 113 species per sub-basin) and the High Atlas in Morocco (up to 84 species per sub-basin).

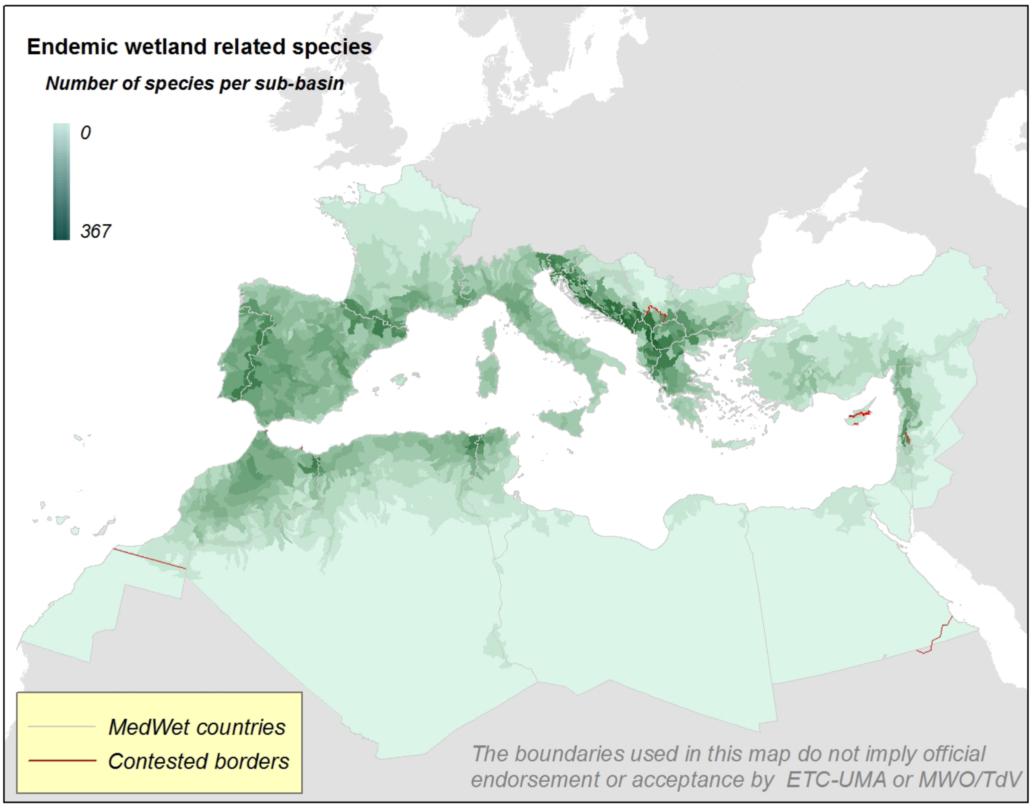


Figure 8. Endemic Mediterranean Wetland Species Richness (Number of species per sub-basin)

3.2.2.2 THREATENED ENDEMIC SPECIES

The areas with the highest concentration of threatened-endemic freshwater species in the region (Figure 9) are also in the Balkan sub-region, including southern parts of Croatia, Bosnia & Herzegovina, and Montenegro (up to 163 threatened species), as well as the border between Albania, North Macedonia and Kosovo (areas of Lake Ohrid and surrounding area, Lura, Korab-Koritnik mountain range, River Radika catchment, Jablanica, Ilinska Planina Mountain; up to 128 threatened species).

In the north-western Mediterranean region, a centre for threatened-endemic species richness is the area of Carso in Italy, the Karst in Slovenia (up to 53 threatened species in each), and the transboundary catchments of the Iberian Peninsula such as the Guadiana (up to 49 threatened species), Tajo (up to 44 threatened species) and Duero (38 threatened species) on the border between Portugal and Spain. Furthermore, other areas such as Mount Voras (Kaïmaktsalan) in Greece also host an elevated number of threatened endemic species (up to 32 species).

It is also relevant to highlight the Golan Heights and Mount Hermon in Syria; Sarada, Rihane - Chouf - Ammiq - Sannine and Mount Hermon in Lebanon (each of them with up to 53 threatened species); and the Upper Litani River in Lebanon (up to 37 species) and the areas of Hula Valley and Lake Kinneret and Kinerot in Israel.

In the northern Africa region, the highest numbers of threatened endemic species are found in the Kabylias–Numidia–Kroumiria region, including the areas of El Kala and Tarf and Ouenza Nord (up to 30 species), the Middle Atlas in the border between Morocco and Algeria (up to 21 species), and the High Atlas in Morocco (up to 20 species).

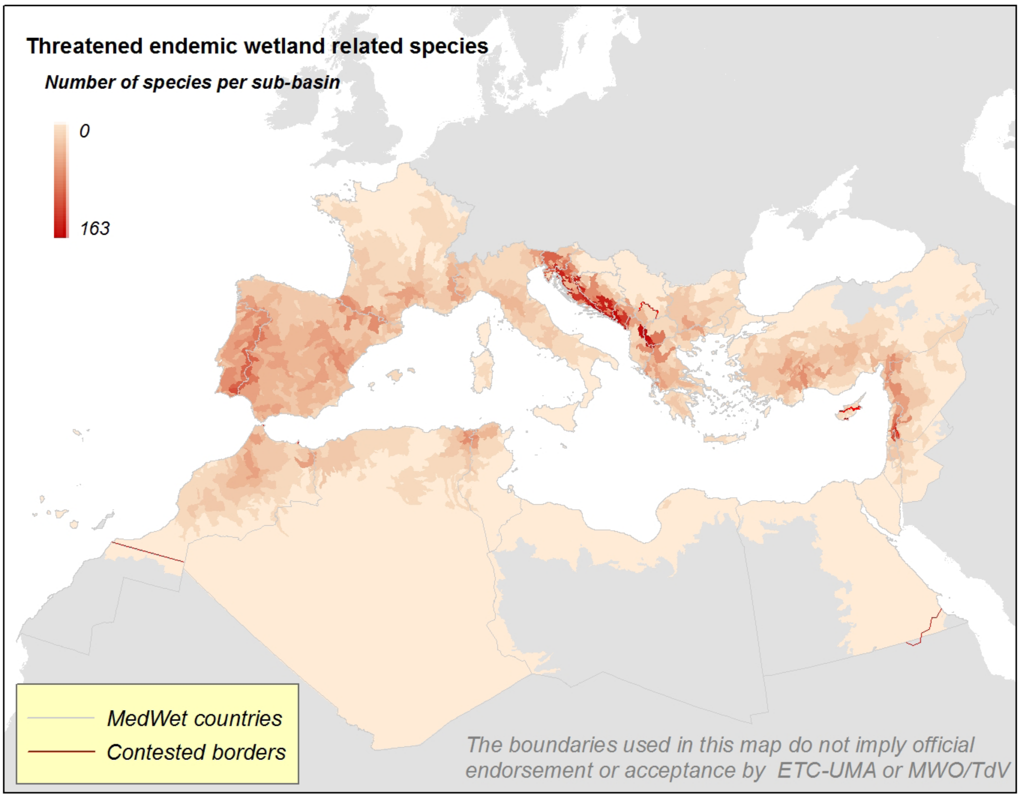


Figure 9. Threatened endemic wetland related species richness in the region (number of species per sub-basin)

3.2.2.3 HOTSPOTS FOR RELATIVE THREAT TO BIODIVERSITY

In order to identify the areas where conservation might be more urgently needed, we looked at the sub-basins with the highest share (percentage) of endemic but threatened species (Figure 10). Hotspots are visible in the eastern Mediterranean in northern Turkey, including areas such as the eastern Black Sea Mountains, Palas Lake, Ulaş Lakes, Hafik Zara Hills, South Keban Dam, Karakaya Reservoir, Bismil Plain, Dicle Valley and Eruh Mountains; the area of Burqu' in Jordan; and the Plateau Ardennais in northern France (in each of them, 100% of the endemic species are threatened).

Other areas of significance are Karlukovski Karst in Bulgaria (73% of the endemic species are threatened); Etangs d'Argonne and Vallée de l'Aisne in France; and Tuz lake and Sultan Marsh in central Turkey (75%).

In northern Africa, some of the areas with highest ratios of threatened-endemic species are the Cyrenaica coastal region of Libya and the St Katherine Protectorate in the Sinai Peninsula of Egypt, with up to 50% of threatened-endemic species occurring in a single sub-basin. In western Europe, the percentage values are higher in the Iberian Peninsula across all sub-basins, where between 20 and 40% of the endemic species are threatened. A hotspot appears in north-eastern France however, where the share of the threatened species goes up to 75%.

The knowledge generated through this assessment highlights areas where there is significant evidence of the threatened status of endemic species closely linked to wetland ecosystems. This should be guiding the prioritisation of decisions and actions towards improving the status of these habitats that are closely linked to the survival of these threatened endemic species.

3.3 MAIN THREATS TO ENDEMIC FRESHWATER BIODIVERSITY AND PRIORITY RECOMMENDED CONSERVATION SCHEMES

Far more than simply a list of species and their status, the IUCN Red List provides information about species range, population size, habitat and ecology, use and/or trade (IUCN, 2021). In addition to this, the Red List database also includes information on the major threats to freshwater species and the most appropriate conservation measures needed, as provided by species experts involved in the IUCN's Red Listing process, which relies on the willingness of scientists to contribute and pool their collective knowledge (García et al., 2010).

This chapter summarises the threats affecting freshwater ecosystems and their species across the study area, so that the key conservation measures needed to reduce the impact of identified threats are highlighted. The findings presented here appear to be in line with the recent work by Taylor et al., 2021, who identified key issues that might affect Mediterranean wetlands over the next 30 years and important research questions that could help improve their conservation. These authors also highlighted how many of the identified issues, which relate primarily to either management and monitoring or to politics and governance, are highly related and linked by feedback loops.

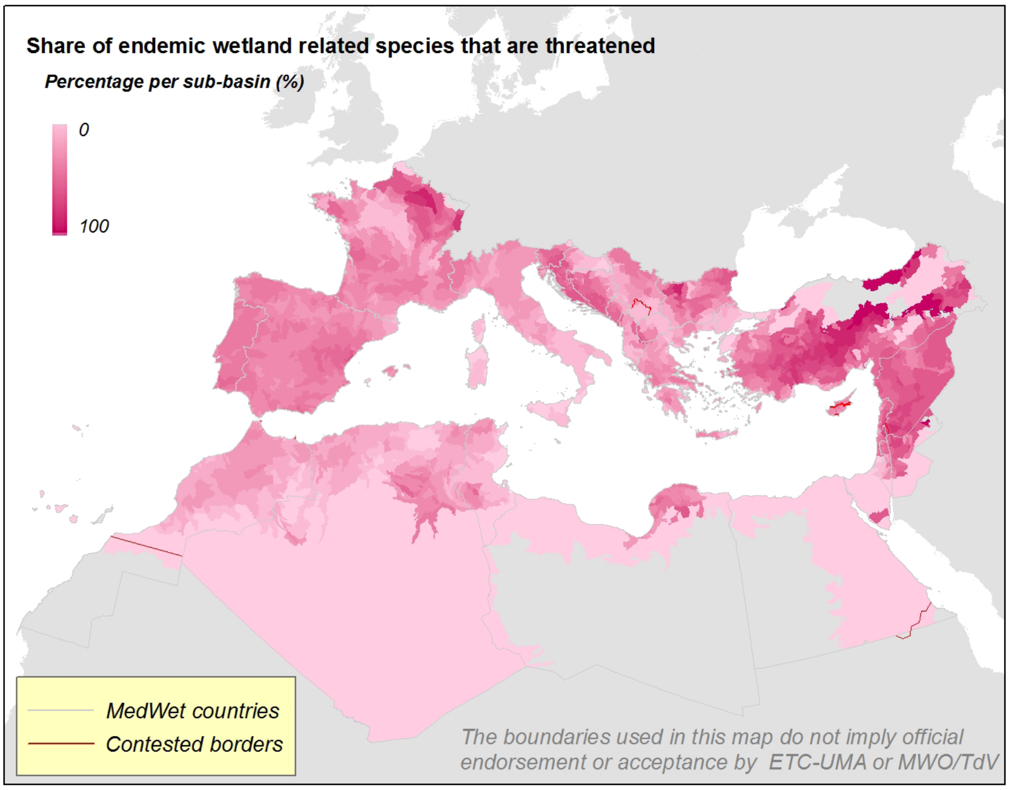


Figure 10. Share of endemic wetland related species that are threatened (Percentage per sub-basin)

3.3.1 MAIN THREATS

The assessment results show that main threats to the already threatened freshwater biodiversity in the region are largely related to natural system modifications, including dams and water abstraction, which affects 66% of the threatened endemic species.

Water pollution due to domestic and agricultural activities is the second largest threat known, impacting 59% of the studied species.

Climate change and the related current trends of atmospheric temperature increase along with rainfall decline, is known to also be a major threat for 36% of the species in this assessment, while invasive species have been identified as a threat to 19% of them.

Habitat degradation and modification due to residential and commercial development is a further major cause of decline for 14% of the freshwater-dependent species, with agriculture intensification threatening 13% of them. Additional impacts for the region are included in Figure 11.

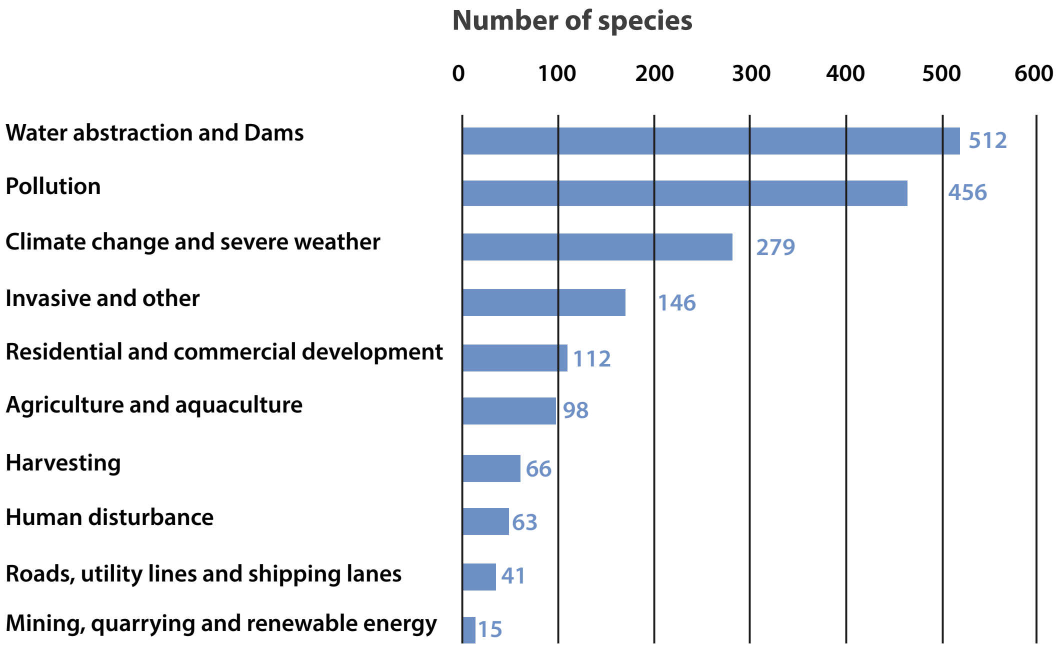


Figure 11. Major current threats to threatened wetland species endemic to the region

3.3.2 CONSERVATION MEASURES

A summary of the priority conservation needs of wetland species in the region is given in Figure 12. The results show that further research is the overarching conservation measure needed to better protect wetland biodiversity in the region and was also identified as being crucial to the future protection of 84% of the threatened endemic species assessed. It is clear that research efforts focusing on species for which there is currently little knowledge must be dramatically and urgently increased.

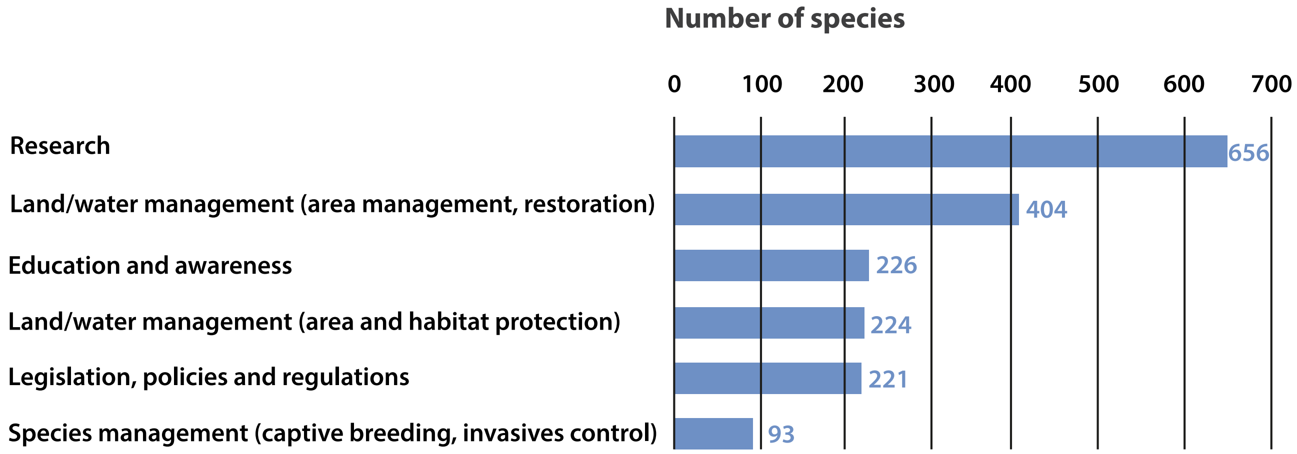


Figure 12. Priority conservation needs to wetland species identified for the region.

For more than half of the analysed species, land and water management is reported as the main conservation need, due to the fact that river basins are closed systems where biotic and abiotic components are interrelated and interact, and where human activities have direct consequences on the habitat quality of freshwater fauna and flora. Hence, taking into consideration the ecological requirements of freshwater species when planning and managing hydrological resources is essential for the maintenance of goods and services that those ecosystems provide. In particular, the connectivity of wetland ecosystems should be ensured considering their four dimensions: longitudinal (between up- and down-stream), lateral (with floodplains and riparian areas), vertical (with groundwater and atmosphere) and temporal dimensions (based on seasonality of fluxes). In this sense, Integrated River Basin Management (IRBM) is a key approach for the management of the resources and services provided by the river systems assuring their sustainable utilisation in the short, medium and long-term. It includes aspects such as regulating the effects of dam construction on the life cycle of species' populations (e.g., by providing continuous water flow and predicting where dam by-passes for migrating species could be needed), the reforestation of river margins (e.g., to reduce the amount of sediment carried by river flow), the reduction of groundwater over-extraction and the use of uncontrolled chemicals, pesticides and fertilisers, which cause water pollution, among other problems.

Freshwater ecosystems are vital to the livelihood and economies of Mediterranean countries. However, their importance is often largely underestimated by local people as well as decision makers, and they are often considered as "waste" areas. Raising awareness to change this view and to promote the sustainable use and management of wetlands is crucial for the future of these vulnerable ecosystems. Awareness raising in children is often neglected but should be established at a large scale to stop the degradation of Mediterranean ecosystems.

Finally, the establishment of protected areas in the region should include appropriate policies and management for enforcing legislation and supporting conservation. Information generated through this study should be compared with existing regional protected areas to see how much land is currently under some form of protection, either at the national or international scale. This would help highlight, and propose, new areas currently lacking protection. Other recommended conservation measures include sustainable agricultural techniques, better waste management, and targeted species management.

3.4 LIMITATIONS AND NEXT STEPS

The results of this analysis aim to provide a prioritisation scheme needed to plan conservation and restoration efforts for freshwater biodiversity in the region. The extent and complexity of the Mediterranean region should always be kept in mind - being an intersection of three continents (Europe, Africa and Asia) and a unique conjunction of geography, history and climate has led to a high diversity of habitats and species. It is evident that the conservation needs differ greatly between countries, as does the availability of information. For operational purposes, the present biodiversity assessment at the sub-basin level will need to be refined at a finer scale and integrated with complementary analyses on other aspects of pressures on wetlands and their conditions.

The results of this desktop analysis, particularly the identification of areas that are ideal candidates for conservation or restoration, would benefit from feedback provided by regional scientists and stakeholders based on their best knowledge of the region and its unique challenges. A consultation process would help to ensure the efficacy of future policies, regulations, best practices and other conservation actions planned for the region.

A series of natural sites contributing significantly to the global persistence of biodiversity in terrestrial, freshwater and marine ecosystems, known as Key Biodiversity Areas[16] (KBAs), have been identified at the global level. It would be valuable to further compare our findings with the KBAs already noted in the region to pinpoint gaps and complementarities.

A review of national, regional, and international species legislation would also be useful to ensure that all biodiversity in need of conservation is covered by some form of protection.

> “It is evident that the conservation needs differ greatly between countries, as does the availability of information

[16] http://www.keybiodiversityareas.org

4

Recommendations

Due to their nature, wetland habitats provide a wide range of ecosystem services including, among others: their capacity to mitigate the impacts of floods, capture carbon, support biodiversity and provide freshwater and recreational services.

Despite their importance, the degraded state of wetlands in the Mediterranean region is influenced by several factors mainly related to the lack of comprehensive regional policies that track wetland specific characteristics in terms of definitions, changes in use and socio-cultural values.

Furthermore, in the southern part of the basin, the knowledge gaps in wetland distribution, spatial extent and in the condition of related species, remain a significant obstacle. Data with adequate spatial and thematic accuracy are also still needed for a large part of the northern basin. Filling these gaps is a priority to ensure their adequate conservation.

Given the rapid development of the region, it is essential to provide politicians, legislators and other relevant stakeholders with key facts and figures on wetlands. In particular about their spatial extent and location, biodiversity information about the status of freshwater ecosystems and the importance of their integration into short- and long-term decision-making and planning processes.

Based on the analysis of wetland inventories carried out in the region, it appears that the restoration agenda of certain countries might benefit from the inclusion of all wetland types, natural and artificial, as well as degraded wetlands that have lost their ecological function. For example, ignoring certain wetland habitat types from the regional reporting systems, namely rice field areas, wet grasslands, degraded peatlands and temporary ponds, has a negative effect on the possibility to identify priority areas for restoration in these heavily degraded wetland habitats. This approach would enable a proper response to global and regional targets including the UNEP's (United Nations Environment Programme) call for the "protection and revival of ecosystems all around the world, for the benefit of people and nature" in the framework of the UN Decade on Ecosystem Restoration[17] (2021-2030) and the upcoming EC Nature restoration Law.

The priority areas identified as hotspots of freshwater endemism and threats can help balance development and conservation actions in ways that aim to minimise impacts to freshwater species throughout the region.

Special focus should be put on specific regions, for example while the Balkan Region stands out as an area with a high number of endemic and endemic-threatened wetland species in the region, Turkey has the highest ratio of endemic species that are threatened in the region and therefore a greater focus should be placed here. In addition, the northern Africa region in particular is in urgent need of new initiatives to conduct field surveys in its least known areas.

In terms of management efforts, Mediterranean countries need to take responsibility for developing and implementing proper management schemes that entail strict protection, conservation actions, and prioritisation of habitat restoration to ensure an improved state of irreplaceable species. Holistic and cross-thematic approaches are essential for effective management of Mediterranean wetlands.

In terms of management efforts, Mediterranean countries need to take responsibility for developing and implementing proper management schemes

A fundamental shift in the way wetland habitats are treated is essential to change the historical trends. Lack of management is widespread across the region and wetland ecosystems need to be better integrated into existing and upcoming targeted restoration policies, in addition to improving the implementation of the ongoing policies.

In this sense, forward-looking policies need to find a more comprehensive approach to promote Mediterranean wetland conservation and their wise-use, while at the same time respecting their hydro-ecological characteristics and ensuring their integrity in management (sectoral and environmental policies), conservation and protection (environmental policies). Cooperation in ecosystem governance at various spatial scales is needed.

[17] https://www.decadeonrestoration.org

Projects such as WETNET[18] and TUNE UP[19] constitute successful examples of effective governance through voluntary environmental contracts among different users. These contracts contribute effectively to the improvement of collaboration between local organisations and stakeholders and to the active participation of different actors committed to the implementation of policies for biodiversity protection. They allow for a better exchange of information between these actors and a more effective awareness of the value of these protected areas. The full methodology and the lessons learnt through these projects are being promoted across the Mediterranean region[20].

The involvement of local communities with a stake in the long-term future of freshwater species and habitats across the region, through education and awareness, is also critical to the success of conservation planning in order to assure the future sustainability of livelihoods, as well as the resources and services provided by functioning wetland ecosystems. Effective educational programs with a special focus on children need to be implemented in order to raise awareness about the importance of freshwater species, their habitat conservation and the threats increasingly faced by this biome. Moreover, educational projects on the value of water and the need for more responsible practices which utilise this resource are required.

[18] https://wetnet.interreg-med.eu
[19] https://tune-up.interreg-med.eu
[20] http://www.urbanisticatre.uniroma3.it/dipsu/?page_id=7423


5

Conclusions and next steps

The first ever harmonised knowledge base on a Mediterranean-wide wetland ecosystem will be stored on the MBPC geoportal[21] and maintained by ETC-UMA until the end of the MBPC programme (end 2022). After that, it should be feasible to store it, or mirror it, on the MWO infrastructure or through another geo-platform provided by one of the MWO's partners (e.g., "the Mediterranean Observatory on Environment and Sustainable Development" developed by the Plan Bleu).

The mapping work done for the Mediterranean region sets the foundation for a regional product that is comparable across its countries for wetland managers and stakeholders to refer to and use at regional scale, thus supporting work on protection, conservation, and restoration prioritisation. For the southern part of the Mediterranean region in particular, it sets a baseline to identify areas where, with a high probability, wetland habitats occur in the region.

In terms of ecosystem condition, this report provides a detailed overview on freshwater biodiversity in the region and where high concentrations of distinctive species, especially of molluscs and fish, found nowhere else, are located.

[21] https:// biodiversity.uma.es

The report also showed however that this valuable natural treasure is at high risk, as almost half the number of freshwater species (49%) are facing serious risk of extinction.

> The alarming status of freshwater species in the region is an indicator of the degraded status of their habitat highlighting the need for an integrated management plan

The alarming status of freshwater species in the region is an indicator of the degraded status of their habitat, highlighting the need for an integrated management plan that will guarantee the survival of these resources. Despite these urgent needs, there still remains a lack of adequate information on the extent, location and types of wetland sites for a big part of the basin. These deficiencies combined with the lack of information on many species, constitute a significant bottleneck in progress towards the effective management and conservation of the region's wetland ecosystem. It is essential that the presented baseline is maintained, updated and validated over time as data and inventories become more available in the region in order to increase its accuracy and for it to become a working tool.

It is clear that further efforts and investments are needed to produce highly detailed geospatial datasets to support wetland ecosystem mapping. A thorough pan-Mediterranean condition assessment such as the biodiversity assessment presented in this report, should be extended to other indicators, for example, connectivity, protected areas coverage and pollution from agriculture.

The biodiversity assessment presented in this report could also be combined with available information on the probability distribution of former wetland sites (Potential Wetland Areas layer), in order to set a first baseline of potential sites to be prioritised for restoration.

Such actions constitute a necessary input for integrated and transboundary basin management, which is a key conservation action required to stop degradation of the highly managed Mediterranean wetland ecosystem.

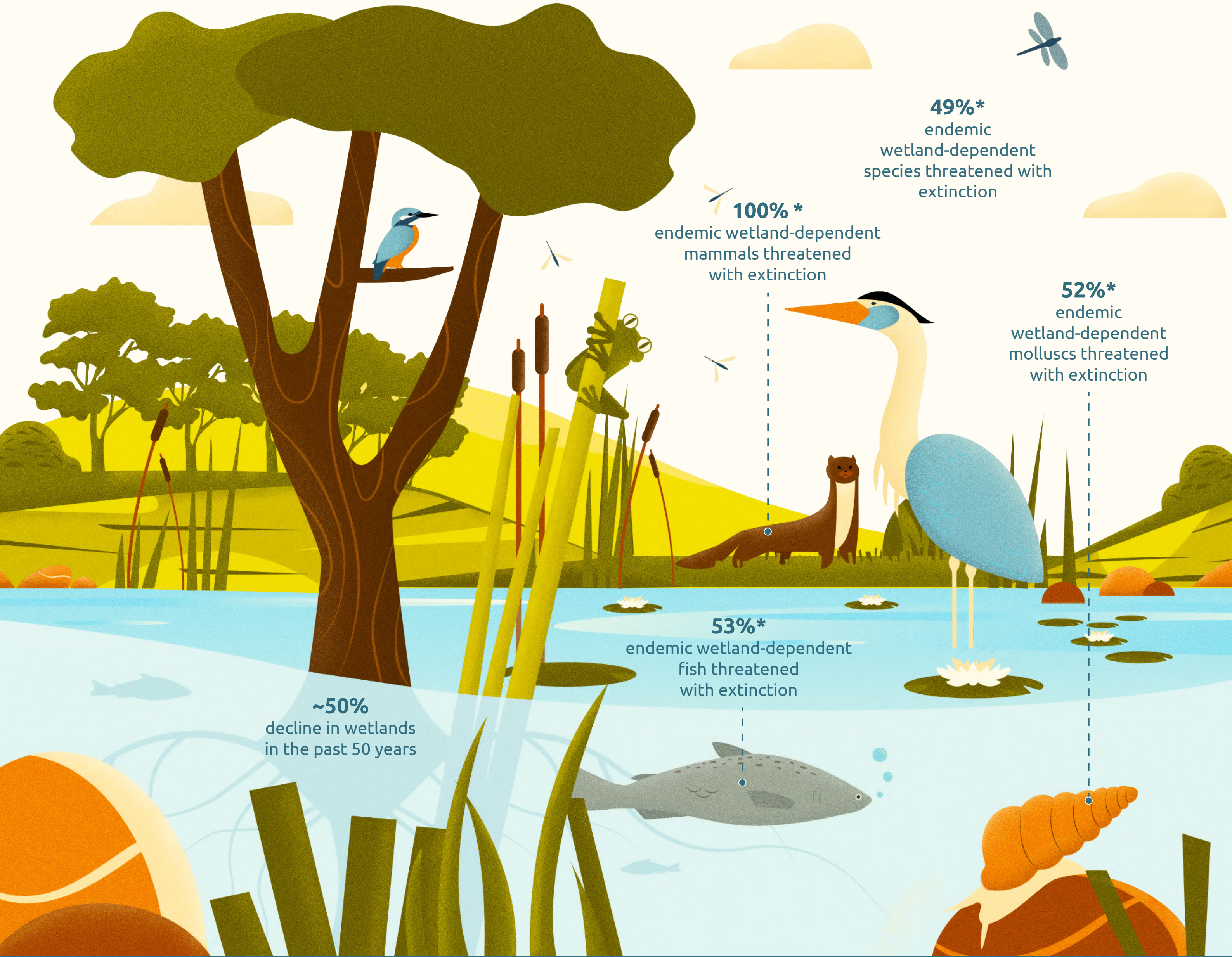
> The biodiversity assessment presented in this report could also be combined with available information on the probable distribution of former wetland sites to inform management prioritisation

State of Mediterranean wetlands: facts and figures

Mediterranean wetland species
have one of the highest extinction threat levels in the world

397 Wetlands of National Importance in the Ramsar framework

160,000km²
of wetland ecosystems



Threats

66%
Natural system modifications (including dams and water abstraction) affect **66%** of the threatened endemic species

Water Pollution (domestic and agriculture) affects **59%** of the threatened endemic species

Climate change affects **36%** of the threatened endemic species

Invasive species negatively affect **19%** of endemic species that are threatened

Residential and commercial development affects **14%** of the threatened endemic species

Solutions

Integrated River Basin Management

Wetland Restoration

Sustainable agriculture

Targeted species management

Improved waste management

Raise awareness in children

More research

* The figures shown are relative to the freshwater endemic species to the region used in this study led by ETC-UMA (coming from a selection of IUCN Red List species belonging to taxa representative of the freshwater biome).

* The data from this infographic is taken from the study led by ETC-UMA in 2022.

Interreg
Mediterranean
BIODIVERSITY PROTECTION


7

Key Messages to Policy Makers

1. Wetlands are extremely important habitats and provide several ecosystem services such as mitigating the impacts of floods, capturing carbon, supporting biodiversity and providing freshwater and recreational services. In the framework of the Ramsar Convention, there are currently 397 Mediterranean Wetlands of National Importance, while the whole Mediterranean wetland ecosystem is estimated to cover almost 160,000 km^2

2. As a result of rapid socio-economic and demographic development of Mediterranean countries, poor wetland management, and a lack of comprehensive policies, natural wetlands are under severe threat and have declined by approximately 50% since the 1970s, especially on the Eastern and Southern shores of the basin.

3. Wetland-dependent species in the Mediterranean Basin have declined by 46% (1990-2013). In fact, almost half of the endemic freshwater species in the region used in this study are threatened with extinction. In addition, 10% are Near Threatened, and 17% Data Deficient making this ecosystem one of the most threatened among all terrestrial, freshwater and marine ecosystems.

4

In addition to the loss in extent, Mediterranean wetland habitats are also expected to be severely impacted by climate change. A rising sea level in particular, will impact coastal wetlands and estuaries and changes in precipitation and droughts cycles will affect the water discharge and sediment flow of rivers and catchments.

5

There are many knowledge gaps on Mediterranean wetland distribution, spatial extent and on the condition of their related species. Filling these gaps is a priority to ensure their adequate conservation. More investment is needed in research particularly across the south and eastern part of the basin and adequate spatial and thematic accuracy data are also still needed for a large part of the northern basin.

6

The establishment of a Pan-Mediterranean harmonised wetland ecosystem knowledge base is a critical step to building a baseline of understanding on the spatial extent, distribution and condition of wetlands at a regional scale. Collaboration to improve and update the knowledge base is essential so that it can become a reference to guide management actions and evidence-based decisions in the region.

7

Identifying priority areas as hotspots of freshwater endemism and threats can help focus conservation efforts in the region and guide development aspirations in ways that aim to minimise impacts to wetland-dependent species throughout the region.

8 Wetland ecosystems need to be better integrated in existing and upcoming targeted restoration policies and these would benefit from the inclusion of all wetland types, natural and artificial, as well as degraded wetlands that have lost their ecological function.

9 There is a need for cooperation in ecosystem governance at various spatial scales and for holistic and cross-thematic approaches if Mediterranean wetlands are to be managed effectively. Local community involvement is essential to the success of conservation planning for the protection of wetlands.

10 Forward-looking policies need to find a more comprehensive approach to promote Mediterranean wetland conservation and their wise-use, building on hydro-ecological sensitivity and ensuring their integrity in broader management (sectoral and environmental policies), conservation, and protection schemes (environmental policies).

11 Education and awareness programmes with a special focus on children need to be implemented to raise awareness about the importance of freshwater species, their habitat conservation and their threats. In addition, educational projects on the value of water and the need for more responsible practices are required.

Annexes

Annex I

Crosswalk table

This annex presents the crosswalk scheme between the MAES classification, its proposed modifications, the CLC classes and the reference Ramsar classification scheme.

The classification is modified after Fitoka et al., 2017 and it is developed with a very high thematic level of detail, up to level 3 or 4 in the MAES hierarchical typology.

MAES Class Code	Modified MAES class	CLC	Relation MAES & RAMSAR	Ramsar Type
2.1.3.1	2.1.3.1 Rice fields	2.1.3	<	3 -- Irrigated land; includes irrigation channels and rice fields.
3.1.1	3.1.1.1 Riparian and fluvial broadleaved forest	3.1.1	<	Xf -- Freshwater, tree-dominated wetlands
3.1.2	3.1.2.1 Broadleaved swamp forest	3.1.1	=	Xp -- Forested peatlands; peat swamp forests
3.2.1.1	3.2.1.1 Riparian and fluvial coniferous forest	3.1.2	<	Xf -- Freshwater, tree-dominated wetlands
3.2.2.1	3.2.2.1 Coniferous swamp forest	3.1.2	=	Xp -- Forested peatlands; peat swamp forests
3.3.1.1	3.3.1.1 Riparian and fluvial mixed forest	3.1.3	<	Xf -- Freshwater, tree-dominated wetlands
3.3.2.1	3.3.2.1 Mixed swamp forest	3.1.3	=	Xp -- Forested peatlands; peat swamp forests
4.3.1	4.3.1 Managed or grazed wet meadow or pasture	2.3.1	=	4 -- Seasonally flooded agricultural land (including intensively managed or grazed wet meadows or pastures).
4.3.2	4.3.2 Natural seasonally or permanently wet grasslands	3.2.1	=	Ts -- Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes. Ss -- Seasonal/intermittent saline/brackish/alkaline marshes/pools.
5.1.2	5.1.1.3 Wet heaths (EUNIS F4.1)	3.2.2	<	W -- Shrub-dominated wetlands
5.2.2	5.1.1.4 Riverine and fen scrubs (EUNIS F9)	3.2.3	<	W -- Shrub-dominated wetlands
6.2.1.1	6.2.1.1 Beaches	3.3.1		E-- Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks. & D -- Rocky marine shores; includes rocky offshore islands, sea cliffs.
6.2.1.2	6.2.1.2 Coastal and fluvial dunes without vegetation (EUNIS B1.1, B1.2, B1.3, B1.8)	3.3.1		E-- Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

6.2.1.3	6.2.1.3 River banks	3.3.1	<	M-- Permanent rivers/streams/creeks; includes waterfalls.
6.2.1.4	6.2.1.4 Littoral zone of water bodies	3.3.1	<	O -- Permanent freshwater lakes (over 8 ha); includes large oxbow lakes. Q -- Permanent saline/brackish/alkaline lakes. P -- Seasonal/intermittent freshwater lakes (over 8 ha); includes floodplain lakes. R -- Seasonal/intermittent saline/brackish/alkaline lakes and flats. 2 -- Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha). 6 -- Water storage areas; reservoirs/barrages/dams/impoundme nts (generally over 8 ha).
7.1.1.1	7.1.1.1 Inland freshwater marshes without reeds (small ponds below 8 ha might be included)	4.1.1	<	Tp -- Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season. Ts -- Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes. Y -- Freshwater springs; oases.
7.1.1.2	7.1.1.2 Inland freshwater marshes with reeds (small ponds below 8 ha might be included)	4.1.1	<	Tp -- Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season. Ts -- Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.
7.1.2.1	7.1.2.1 Inland saline or brackish marshes without reeds (small ponds below 8 ha might be included)	4.1.1	<	Sp -- Permanent saline/brackish/alkaline marshes/pools. Ss -- Seasonal/intermittent saline/brackish/alkaline marshes/pools.
7.1.2.2	7.1.2.2 Inland saline or brackish marshes with reeds (small ponds below 8 ha might be included)	4.1.1	<	Sp -- Permanent saline/brackish/alkaline marshes/pools. Ss -- Seasonal/intermittent saline/brackish/alkaline marshes/pools.

7.2.1.1	7.2.1.1 Peat bogs with peat extraction or hydrological modification	4.1.2	<	U -- Non-forested peatlands; includes shrub or open bogs, swamps, fens.
7.2.1.2	7.2.1.2 Peat bogs without peat extraction or hydrological modification	4.1.2	<	U -- Non-forested peatlands; includes shrub or open bogs, swamps, fens.
8.1.1	8.1.1 Salt marshes without reeds	4.2.1	=	H -- Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.
8.1.2	8.1.2 Salt marshes with reeds	4.2.1	=	H -- Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.
8.2.1	8.2.1 Coastal lagoons (see attributes in comments)	5.2.1	=	K -- Coastal freshwater lagoons; includes freshwater delta lagoons. J -- Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
8.2.2	8.2.2 River estuaries and estuarine waters of deltas	5.2.2	=	F -- Estuarine waters; permanent water of estuaries and estuarine systems of deltas.
8.3	8.3 Coastal saltpans (highly artificial salines)	4.2.2	=	5 -- Salt exploitation sites; salt pans, salines, etc.
8.4	8.4 Intertidal flats	4.2.3	=	G -- Intertidal mud, sand or salt flats.
9.1.1.	9.1.1 Interconnected running water courses	5.1.1	=	M-- Permanent rivers/streams/creeks; includes waterfalls. N -- Seasonal/intermittent/irregular rivers/streams/creeks. 9 -- Canals and drainage channels, ditches.
9.1.1.1	9.1.1.1 Permanent Interconnected running water courses	5.1.1	=	M-- Permanent rivers/streams/creeks; includes waterfalls.
9.1.1.2	9.1.1.2 Seasonal/intermittent interconnected running water courses	5.1.1	=	N -- Seasonal/intermittent/irregular rivers/streams/creeks.
9.1.1.3	9.1.1.3 Highly modified natural water courses and canals	5.1.1	=	9 -- Canals and drainage channels, ditches.

9.1.2.1	9.1.2.1 Permanent separated water bodies belonging to the river system (dead side-arms, flood ponds…)	5.1.1	>	M-- Permanent rivers/streams/creeks; includes waterfalls. N -- Seasonal/intermittent/irregular rivers/streams/creeks. 9 -- Canals and drainage channels, ditches.
9.1.2.2	9.1.2.2 Seasonal/intermittent separated water bodies belonging to the river system (dead side-arms, flood ponds…)	5.1.1	>	M-- Permanent rivers/streams/creeks; includes waterfalls. N -- Seasonal/intermittent/irregular rivers/streams/creeks. 9 -- Canals and drainage channels, ditches.
9.2.1.1	9.2.1.1 Natural permanent water bodies (over 8 ha)	5.1.2	=	O -- Permanent freshwater lakes (over 8 ha); includes large oxbow lakes. Q -- Permanent saline/brackish/alkaline lakes.
9.2.1.2	9.2.1.2 Natural seasonal/intermittent water bodies (over 8 ha)	5.1.2	=	P -- Seasonal/intermittent freshwater lakes (over 8 ha); includes floodplain lakes. R -- Seasonal/intermittent saline/brackish/alkaline lakes and flats. Vt -- Tundra wetlands; includes tundra pools, temporary waters from snowmelt.
9.2.2.1	9.2.2.1 Pond and lakes with completely man-made structure (generally below 8 ha)	5.1.2	=	2 -- Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).
9.2.2.2	9.2.2.2 Artificial fish ponds (see attributes in comments)	5.1.2	=	1 -- Aquaculture (e.g., fish/shrimp) ponds
9.2.2.3	9.2.2.3 Standing water bodies of extractive mineral sites	5.1.2	=	7 -- Excavations; gravel/brick/clay pits; borrow pits, mining pools.
9.2.2.4	9.2.2.4 Other reservoirs/barrages/dams/impoundments etc (generally over 8 ha). (see attribute in comments)	5.1.2	=	6 -- Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 ha).
9.2.2.5	9.2.2.5 Inland saltpans	1.3	=	5 -- Salt exploitation sites; salt pans, salines, etc.
10.1.1	10.1.1 Marine waters less than six metres deep at low tide	5.2.3	=	A-- Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits. B -- Marine subtidal aquatic beds; includes kelp beds, sea-grass beds, tropical marine meadows. C -- Coral reefs. D -- Rocky marine shores; includes rocky offshore islands, sea cliffs.

Annex II
Datasets and features

The annex provides an overview of the datasets integrated in the knowledge base on Mediterranean wetlands and their main features.
The red/green colours on the first column refer to the part of the basin they have been used for (South/North).
*Datasets currently being updated

Dataset name & reference year	Source	Resolution/ Minimum Mapping Unit	Geographical coverage	Wetlands related classes	Reference
Potential Wetland Areas (PWA)(2017)	MWO	84m	Geographical coverage	Probability classes, Temporarily flooded, Permanently flooded	MWO, 2022
CCI Land Cover - S2 Prototype Land Cover 20m Map of Africa 2016 (2016)	ESA	20m	Africa	Vegetation Aquatic or Regularly Flooded; Open Water	CCI Land Cover - S2 Prototype Land Cover 20m Map of Africa 2016 © Contains modified Copernicus data (2015/2016) © ESA Climate Change Initiative - Land Cover project 2017[1]
Esri 2020 Land Cover (2020)	ESRI	10m	Global	Water; Flooded vegetation	Karra, Kontgis, et al. "Global land use/land cover with Sentinel-2 and deep learning." IGARSS 2021-2021 IEEE International Geoscience and Remote Sensing Symposium. IEEE, 2021.[2]
World Land Cover BaseVue 2013* (2013-2014)	Maxar	30m	Global	Wetland; Mangrove	Maxar, World Land Cover at 30m Resolution from MDAUS BaseVue. 2013.[3]
Tunisia (2020)	MWO	0.1 ha	Tunisia	Ramsar wetland types	MWO, 2020
Sebou river basin (2020)	MWO	0.1 ha	Sebou river basin, Morocco	Ramsar wetland types	MWO, 2020

[1] http://2016africalandcover20m.esrin.esa.int
[2] https://livingatlas.arcgis.com/landcover/
[3] https://www.maxar.com/products/basevue-lulc

Dataset name & reference year	Source	Resolution/ Minimum Mapping Unit	Geographical coverage	Wetlands related classes	Reference
JRC Global Surface Water 1984 – 2020	EC JRC/Google	30m	Global	Water occurrence (considered as the total extension of surface water); Water Seasonality (to distinguish seasonal and permanent floods)	Jean-Francois Pekel, Andrew Cottam, Noel Gorelick, Alan S. Belward, High-resolution mapping of global surface water and its long-term changes. Nature 540, 418-422 (2016). (doi:10.1038/nature20584)[4]
Bathymetry (2021)	GEBCO	~400m	MedWet countries	Marine waters under 6 meters depth at low tide	MWO, 2021[5]
Water & Wetness (2012-2018)	Copernicus Land Monitoring Service	10m	EEA38 + 1	Permanent/Temporary Water; Permanent/Temporary wetness	High Resolution Layer: Water & Wetness (WAW) 2018; © European Union, Copernicus Land Monitoring Service 2018, European Environment Agency (EEA)[6]
Riparian Zones product (2011-2013)	Copernicus Land Monitoring Service	10m	EEA38 + 1	Actual Riparian Zone	Riparian Zones; © European Union, Copernicus Land Monitoring Service 2018, European Environment Agency (EEA)[7]
Ecosystem types of Europe (2012)	EEA	1:100000	EEA38 + 1	Riverine and fen scrubs	Ecosystem types of Europe - version 3.1; @European Environment Agency (EEA)[8]
Corine Land Cover (2017-2018)	Copernicus Land Monitoring Service	100m	EEA38 + 1	2.1.3 Rice fields; 2.3.1 Pastures; 3.1 Forest; 3.2.1 Natural grassland; 3.2.2 Moors and heathland; 3.3.1 Beaches, dunes, sands; 4 Wetlands; 5 Water bodies	Corine Land Cover (CLC) 2018, Version 2020_20u1; © European Union, Copernicus Land Monitoring Service 2018, European Environment Agency (EEA)[9]

[4] https://global-surface-water.appspot.com
[5] http://www.gebco.net
[6] https://land.copernicus.eu/pan-european/high-resolution-layers/water-wetness
[7] https://land.copernicus.eu/local/riparian-zones
[8] https://www.eea.europa.eu/data-and-maps/data/ecosystem-types-of-europe-1
[9] https://land.copernicus.eu/pan-european/corine-land-cover/clc2018

Dataset name & reference year	Source	Resolution/ Minimum Mapping Unit	Geographical coverage	Wetlands related classes	Reference
Continental Greece (2017)	WetMainAreas / Greek Biotope - Wetland Centre (EKBY)	0.05 ha	Continental Greece	Ramsar wetland types	Wetlands of the Balkan Mediterranean territory harmonised in a regional mapping. (Project WetMainAreas, co-funded by the European Union in the frame of INTERREG TNCP BALKAN-MEDITERRANEAN 2014-2020). Fitoka, E., Petrov P, Ivanova S., Hatziirdonou L, Terziyska I. (editors). 2020. The Regional Balkan Mediterranean Wetland Mapping & Connectivity Assessment: methodological approach, findings, future considerations. WetMainAreas INTERREG BalkanMed project Technical Publication. 53 pages. (https://wetmainareas.com/wp-content/uploads/2021/11/WetMainAreas-Technical-e-Publication.pdf)[10]
Albania (2020)	WetMainAreas / National Environmental Agency of Albania	0.05 ha	Albania	Ramsar wetland types	
North Macedonia (2017)	WetMainAreas / St. Kliment Ohridski University of Ohrid	0.05 ha	North Macedonia	Ramsar wetland types	
Bulgaria (2019)	WetMainAreas / University of Forestry, Sofia	0.05 ha	Bulgaria	Ramsar wetland types	
Greek Islands (2021)	MedIsWet / WWF Greece	0.05 ha	Greek Islands	Ramsar wetland types	WWF Greece. (2013). Ygrotopio islands – Database of the Greek island wetlands. Updated: 02.2021[11]
Cyprus (2014)	MedIsWet / Terra Cypria	0.05 ha	Cyprus	Ramsar wetland types	Terra Cypria. (2014). Inventory of Wetlands of Cyprus. Updated: 09.2014[12]
Malta (2020)	MedIsWet / Nature Trust Malta	0.05 ha	Malta	Ramsar wetland types	Nature Trust Malta. (2019). MtIsWet - Database of the Maltese Islands Wetlands. Updated: 04.2020[13]
Balearic Islands (2021)	MedIsWet / WWF España	0.05 ha	Balearic Islands	Ramsar wetland types	WWF España. (2018). EsIsWet - Base de datos de los humedales insulares españoles. Actualización de la base de datos: 07.2021[13]

[10] http://185.17.146.157/maps/178
[11] http://www.oikoskopio.gr
[12] https://terracypria.org/
[13] https://sites.google.com/view/mediswet/home

Dataset name & reference year	Source	Resolution/ Minimum Mapping Unit	Geographical coverage	Wetlands related classes	Reference
Turkish Islands (2020)	MedIsWet / WWF Turkey	0.05 ha	24 Turkish Islands	Ramsar wetland types	WWF Turkey. (2018). TrIsWet – Database of the Turkish island wetlands. Updated: 04.2020[13]
Croatian Islands* (2020)	MedIsWet / Association Hyla	0.05 ha	Croatian Islands	Ramsar wetland types	Association Hyla. (2020). CroWet – Database of the Croatian island wetlands. Updated: 09.2021[13]
French Islands (2019)	MedIsWet / PIM Initiative, Corsican Environment office	0.05 ha	Corsica and islands of Provence-Alpes -Côte d'Azur	Ramsar wetland types	PIM Initiative, Corsican Environment Office (OEC). (2019). FrIsWet – Database of the French island wetlands. Updated: 09.2021[13]
Italian Islands* (2019)	MedIsWet / Unica-CCB, Unict-DBGES, PIM Initiative	0.05 ha	Sardinia, Sicily	Ramsar wetland types	Unica-CCB, Unict-DBGES, PIM Initiative. (2019). ItIsWet – Database of the Italian island wetlands. Updated: 09.2021[13]

[13] https://sites.google.com/view/mediswet/home

Annex III
Southern Mediterranean background layer input data

- **CCI LAND COVER - S2 PROTOTYPE LAND COVER 20M MAP OF AFRICA 2016 (20M):**

  The CCI Land Cover is a prototype high resolution map at 20m over Africa based on one year of Sentinel-2A observations from December 2015 to December 2016. The legend includes 10 generic classes that appropriately describe the land surface at 20m: "Trees Cover Areas", "Shrubs Cover Areas", "Grassland", "Cropland", "Vegetation Aquatic or Regularly Flooded", "Lichen and Mosses / Sparse Vegetation", "Bare Areas", "Built Up Areas", "Snow and/or Ice" and "Open Water".

- **ESRI 2020 LAND COVER (10M):**

  This dataset produced by Esri displays a global LULC map derived from ESA Sentinel-2 imagery at 10m resolution. It is a composite of LULC predictions for 10 classes throughout the year in order to generate a representative snapshot of 2020. The map was produced by a deep learning model trained using over 5 billion hand-labelled Sentinel-2 pixels, sampled from over 20,000 sites distributed across all major biomes of the world. The legend includes 10 generic class definitions: "Water", "Trees", "Grass", "Flooded vegetation", "Crops", "Scrub/shrub", "Built Area", "Bare ground", "Snow/Ice" and "Clouds".

- **WORLD LAND COVER BASEVUE 2013 (30M):**

  BaseVue 2013 is a commercial global product developed by Maxar. BaseVue is independently derived from roughly 9,200 Landsat 8 images. The capture dates for the Landsat 8 imagery range from April 11, 2013 to June 29, 2014.
  The following 16 classes of land use/land cover are listed by their cell value in this layer: "Deciduous Forest", "Evergreen Forest", "Shrub/Scrub", "Grassland", "Barren or Minimal Vegetation", "Agriculture, General", "Agriculture, Paddy", "Wetland", "Mangrove", "Water", "Ice / Snow", "Woody Wetlands", "Mixed Forest", "High Density Urban" and "Medium-Low Density Urban".

- **JOINT RESEARCH CENTRE (JRC) GLOBAL SURFACE WATER 1984 – 2020 (30M):**

  The **Water Occurrence** dataset shows where surface water occurred between 1984 and 2020 and provides information concerning overall water extension.
  This product captures both the intra- and inter-annual variability and changes.
  The provided occurrence accommodates for variations in data acquisition over time (i.e. temporal deepness and frequency density of the satellite observations) in order to provide a consistent characterisation of the water dynamic over time.

  The **Water Seasonality** product provides information concerning the intra-annual behaviour of water surfaces. It separates 'permanent' water bodies (those that are present throughout the period of observation) [nominally a year] from 'seasonal' (those that are present for only part of the year); the degree of seasonality is also represented (i.e. the proportion of the total number of observed months in which water is present).

Annex IV
Accuracy assessments

Northern part of the basin

The resulting background layer introduced in section 2.2.1.1 covers the natural and artificial wetlands of the northern Mediterranean region, based on the input datasets (Annex II). It has been validated against sub-national wetland inventories of continental Greece and Andalusia (Spain) due to fine-scale data availability in these areas. In both cases, the marine wetlands class ("Marine waters under 6 meters depth at low tide") has been excluded from the assessment since it has not been covered by the available datasets. The outcome of the validation and the main causes which explain the reported errors are shown in Table 5.

For continental Greece, the validation has been conducted based on the geospatial dataset produced by EKBY in the framework of the WetMainAreas project (see 2.2.2.1).

For this region, the overall accuracy is very high (98.9%), with an omission error for the wetland class of 16% and only 0.7% for non-wetland areas (the commission error is around 38% and 0.25% respectively).

About 59% of the omission error is related to estuarine waters, which were not included in the extended wetlands layer. These are mainly very small estuaries of streams, which are usually neglected in land cover mapping. Also, part of the omission error could be explained by the fact that the wetland layer of continental Greece may include within wetland boundaries adjacent degraded wetlands, like filled wetlands, or also road networks or artificial areas which may cross the wetland ecosystem.
These zones may be classified as non-wetland by the extended layer, given that this is a land cover map.

Several small wetlands, including small water bodies, which have not been identified in the extended layer were also found across the country, because the wetland mapping layer of continental Greece also combines photo interpretation and is able to map sites up to 0.05 ha. The omission error here can hence also be linked to the Minimum Mapping Unit (1ha) used for the background layer.

For Spain, the wetlands inventory (IHA) of the Andalusia region (southern Spain, NUTS ES61) does not include water bodies; it was then combined with the inventory of water bodies for the same region, to allow for a proper validation of the background layer for this region.

The totals of the wetland extent area are very similar in the two layers (2,031 and 2, 107 Km^2) but the confusion matrix reveals 36% and 34% of omission and commission errors respectively.

Table 5: Mapping accuracy assessment of the background wetlands layer for the northern part of the basis and main causes of error.

Region	Comission error	Comission error	Main causes of error	Overall accuracy
Continental Greece	16%	38%	Estuarine and other coastal waters not included in the extended wetland layer and/or classified as Marine waters	99%
			Different mapping accuracies	
Andalusia	36%	34%	Different mapping extent of water courses	98%
			Rice fields not considered as wetlands in the reference inventory	
			Lagoons and temporary ponds under severe desiccation mapped as dry land by recent SRS observations	

The commission errors are due to inland marshes classified as dry grassland or to different mapping extent of water courses.

Most of the error though (64% of the reported commission error) can be explained by the fact that the Extended Wetland Layer includes the class "Rice Fields" as an artificial wetland habitat, differently from the IHA classification. The extent of the "Rice fields" class in Andalusia, according to the CLC classification, covers 441 Km^2.

The omission error is instead explainable with water bodies and reservoirs which are not mapped as such in CLC.

About half of this error (53%) is due to 5 lagoons and peat bogs (Plana de inundación del Partido, Lagunas del Abalario, Lagunas de Coto del Rey, Lagunas Peridunares de Doñana, Turberas de Ribatehilos) which are classified in CLC as transitional woodland-shrub, Sclerophyllous and Coniferous vegetation, while not being classified as "Wet" or "Moist" by the Copernicus Water and Wetness product.

These areas are traditionally considered as lagoons or temporary/permanent ponds which, during the last decades, have severely suffered from groundwater exploitation for agricultural and urban uses (Díaz-Paniagua et al., 2015), showing trends of desiccation or being already dry. These trends explain why they are not mapped as wet or moist areas using recent satellite observations.

Southern and Eastern part of the basin

The resulting background layer of the south and east Mediterranean region covers the natural and artificial wetlands, based on the input datasets (see Annex II and Annex III). Its validation has been carried out using the only available wetland local and national inventories, those for the Sebou river basin in Morocco and Tunisia. Although these inventories were integrated in the Pan-Mediterranean product in order to achieve an increased accuracy, they were used as reference data to assess if the Pan-Mediterranean product could yield accurate results in similar regions and with the same type of wetlands. They were compared with the background layer which was based on four global LULC products, and with the probability classes of the PWA.

USE OF THE PWA LAYER

The use of the probability classes "High", "Medium" and "Low" of the PWA layer was tested in those areas without data on wetlands (where there are no pixels corresponding to the water classes or other wetlands) according to the four LULC layers used for the southern and eastern background layer.

An analysis of the input LULC data and the PWA probability classes showed that some classes of natural vegetation overlapped with areas of "High" and "Medium" probability and that they could add valuable information in areas around and close to correctly identified wetlands. As part of this analysis, an additional probability class was produced by overlapping the pixels of the BaseVue 2013 "Shrub/Scrub" class with the "High" and "Medium" probability classes: this resulted to be the combination of data that best optimised the trade-off between omission and commission errors.

The data resulting from this process was renamed as "Very High" probability class, being a class with a lower degree of uncertainty than the rest of the PWA probability classes. As shown in Figure 3, this complementary product was included in the accuracy assessment to test its potential usefulness in increasing the classification accuracy, but it was finally left out of the production of the final background layer and only used for the accuracy assessment. Nevertheless, the PWA layer could be used as wetland ancillary data in future refinements of the product or for supporting wetland restoration efforts.

The probability classes of the Potential Wetland Areas (PWA) layer (see section 2.2.2.3) have been in fact used for the accuracy assessment: the PWA layer identifies potential wetland areas that share a certain similarity in terms of topography, hydrology and soil, like depressions and floodplains and riparian zones, which may be identified as other types of land coverage by the global LULC data due to their mapping limitations. Despite being a probability map (hence data with a greater degree of uncertainty), many wetland sites can be identified by this layer. Using this approach, a map with different levels of confidence can be obtained. Higher accuracy classes can be used as the main source of information to show the distribution of potential wetlands; they can be useful as wetland ancillary data and they should be used with care to reduce the probability of overestimating its surface.

RESULTS

Our results show that large wetlands (i.e. with a surface extent of 100 hectares or more) and water bodies along with their associated vegetation, are well mapped, while limitations still exist for smaller wetlands and the ones with less predominant wetland characteristics (e.g. low presence of water, scarce vegetation, low soil moisture, etc.). Interestingly many of these wetlands seem to be well covered by the probability classes of the PWA analysis. However, being classes with a higher degree of uncertainty, they would require further verification before inclusion in the final Pan-Mediterranean product.

The resulting map for the whole study area and detailed views for specific regions are illustrated in Figure 13. The first example shows the El Wahda dam, in Morocco, and some of the associated water courses, which are correctly mapped due to the high presence of water. The second case shows the central part of Tunisia, mainly Chott El Jerid wetland. This wetland, like other temporarily flooded saline lakes in North Africa, has been correctly identified as it has a temporary presence of water during the year and because it presents differences in terms of the type of soil and its level of humidity. According to the updated Tunisian wetland inventory produced by the MWO (section 2.2.2.5), other wetlands in the smaller area have not been mapped as they do not present elements that can differentiate them from the surrounding desert areas, being identified as bare land or sparsely vegetated areas in the LULC input data. However, the PWA probability classes seem to identify parts of these wetland ecosystems, improving the map in the first instance. They present an overestimation of the wetland coverage, especially in the case of the Medium probability class, but the High and Very High classes are distributed around the identified water bodies.

Example number three shows the Nile Delta, where the mapped wetlands correspond mainly to Lake Burullus and Lake Manzala, located to the north along the coast. Due to land management policies implemented in recent decades (MWO, 2014), in the region there are many rice fields and aquaculture ponds omitted from the map because the input LULC data consider them as agricultural areas. Those flooded areas that are captured in the satellite images have been interpreted as such by the data regarding surface water. Since there is no reference data available for the region, it is not possible to validate this information, but they seem to represent only a small share: the error of omission only using land cover products is important in this case of artificial wetlands. Nevertheless, most of these agricultural areas seem to be well captured by the probability classes included in the map, which shows the potential usefulness of this information despite having a higher degree of uncertainty. A correct validation and refinement of the area could help to identify wetlands in the area with greater confidence.

The resulting map was compared with the reference inventories available for Tunisia and the Sebou River basin (Morocco) to assess the levels of accuracy for different combinations of input data. A first test considered the main wetland classes, excluding the probability ones derived from the PWA layer, being those that would give the highest degree of certainty (Table 6). When considering the complete inventories (including water courses) for the areas for which reference data were available, the commission error can be defined as acceptable (Congalton and Green, 1999), being around 26% in the worst case, and being very low in Tunisia (8%), where the classification is very confident according to the inventories. For the omission error, wetlands areas not included in the map, the results are very different between the two study areas (26% in Tunisia and 62% in Sebou). The error in Sebou is partly explained by the high presence of linear elements in the reference inventory, which is closely related to the watercourses of the basin.

When excluding the water courses from both inventories, the Sebou river basin shows a relevant improvement in the omission error which dropped to 53% (9% accuracy improvement). However, a large number of wetlands linked to the water courses habitat (e.g. riparian vegetation) are not included in the final map as they are defined as not-wetland classes in the input LULC data.

These results and an ancillary visual comparison with satellite images demonstrate how wetland habitats with little presence of water tend to be excluded from the final map since the vegetation and the soil associated with them are interpreted as a different type of LULC classes, being grasslands, shrubs, bare soils and agriculture the main ones.

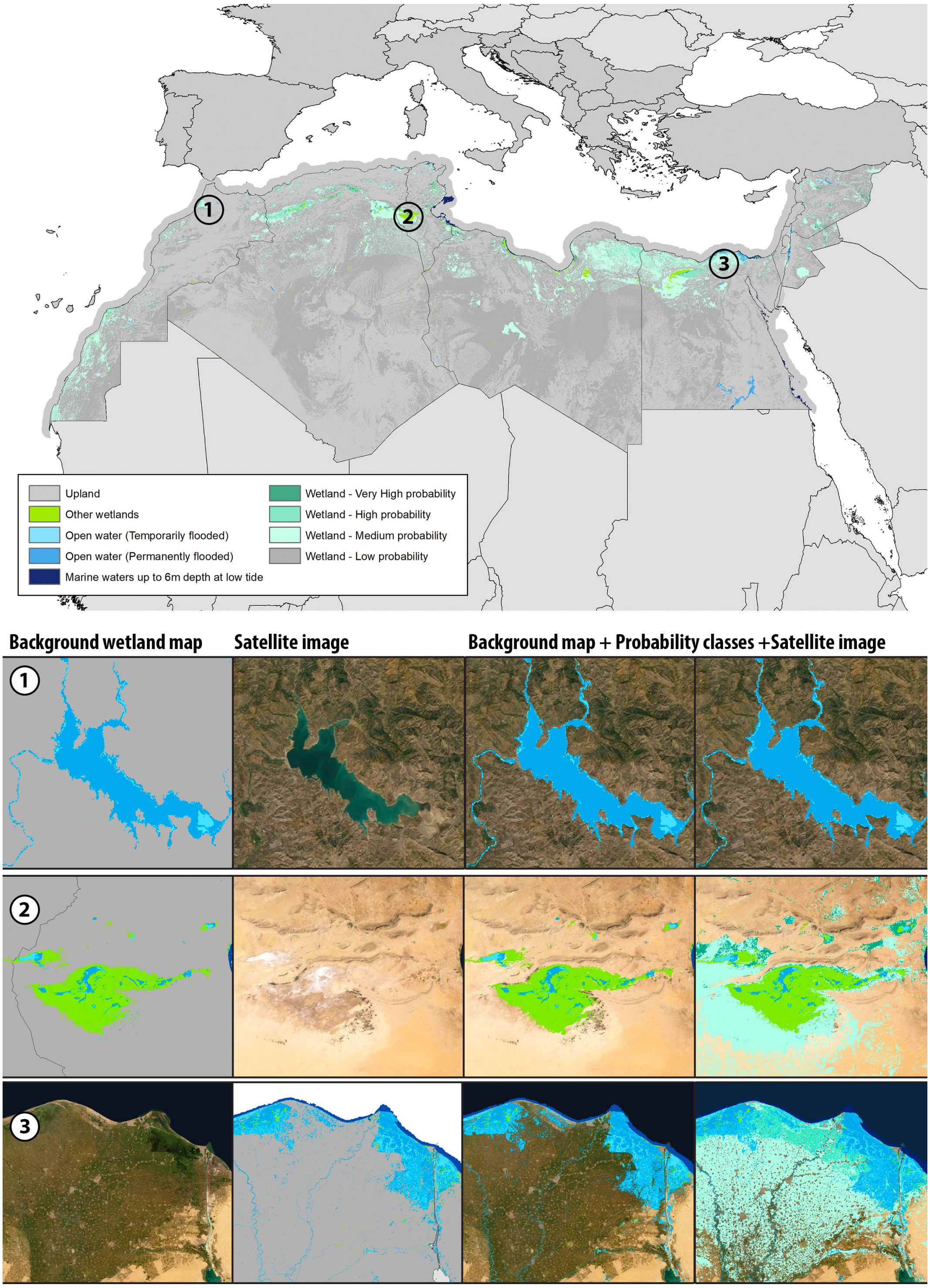


Figure 13. Background wetland ecosystem map for the southern and eastern Mediterranean and detailed views for specific regions in Morocco, Tunisia and Egypt.

Table 6: Validation results for the Sebou River watershed (Morocco) and Tunisia.

Region	Test	Omission error	Comission error	Main causes of error	Overall accuracy
Sebou River basin	Full inventory	62%	26%	Wetlands and water courses with low presence of water and vegetation associated	98%
	Excluding water courses	53%	-	Artificial wetlands related to agriculture	-
Tunisia	Full inventory	26%	8%	Arid region	97%
	Excluding water courses	26%	-	Wetlands with low presence of water and vegetation associated	-

Table 7 shows omission and commission errors when comparing the inventories adding the different probability classes. As these classes are included in the analysis, the error of omission decreases while the commission error increases.

The lines highlighted in green show the best scenarios in terms of error balance, which is obtained when using only the wetland classes and when the High Probability class is added. By including this probability class there is a decrease in the error of omission of 8% in Tunisia but only 2% in Sebou. The commission error increased by 8% and 14% respectively. The Very High, High and Medium probability class represent a considerable improvement in the error of omission, reaching 3% in Tunisia and 43% in Sebou. This would be the maximum capacity of the map to represent the wetlands in both regions. However, the increase in commission error is too high to take the ancillary information from the PWA as a reference data in wetland mapping.

Table 7: Validation results for the Sebou River watershed (Morocco) and Tunisia including probability classes. Best cases are highlighted in green.

Region	Test	Omission error	Comission error
Sebou River basin	Wetlands classes	62%	26%
	Wetlands + Very High probability	60%	34%
	Wetlands + Very High and High probability	57%	46%
	Wetlands + Very High, High and Medium probability	43%	81%
Tunisia	Wetlands classes	26%	8%
	Wetlands + Very High probability	18%	22%
	Wetlands + Very High and High probability	17%	27%
	Wetlands + Very High, High and Medium probability	3%	72%

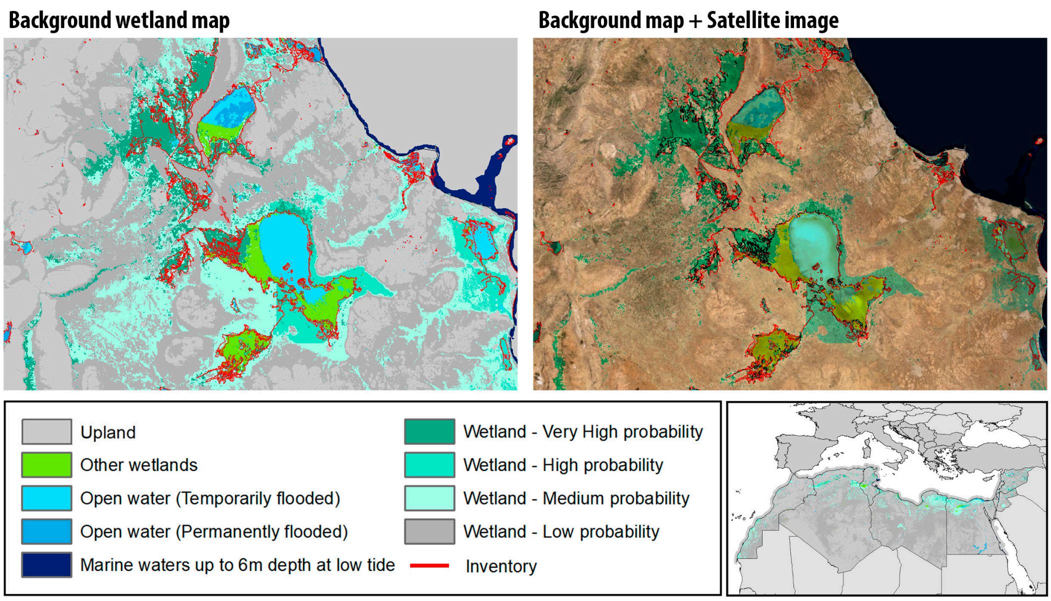


Figure 14. Detailed view of the results in Tunisia. The reference wetland inventory is shown with red lines.

Despite this high commission error, the look and feel of the probability classes is especially good in areas around or near correctly identified wetlands, especially in areas where the presence of water is detected. A large percentage of these areas appear to be wetlands, especially those identified by the Very High Probability class, although the exact value is unknown at this stage due to lack of inventories and additional field data that would allow further validation analysis.

Figure 14 shows an example in Tunisia where the Very High probability class considerably improves the delimitation of the wetland ecosystem. The High probability class also contributes to better mapping but exceeds the boundaries defined in the inventories, overestimating the area and spreading around the wetland habitats limits. The Medium probability class presents an excessive overestimation in this case, especially in areas which are far from the identified wetlands.

Figure 15 shows more examples in Algeria (1) and Libya (2) where there are no inventories available but with the help of satellite images it is possible to roughly distinguish the boundaries of some wetland habitats. In the example of Algeria, the Very High Probability class does not seem to significantly contribute much to an improved mapping, but the High Probability class does. It clearly overestimates the wetland area, but allows it to identify areas that would otherwise have been overlooked. In the second case, in Libya, the Very High and High classes allow identifying parts of a coastal wetland omitted by the global LULC data. However, it can also be observed that probability classes greatly overestimate the potential area of inland wetlands, confirming that these data must be interpreted with care and an adequate refinement is needed before using them for wetland mapping.

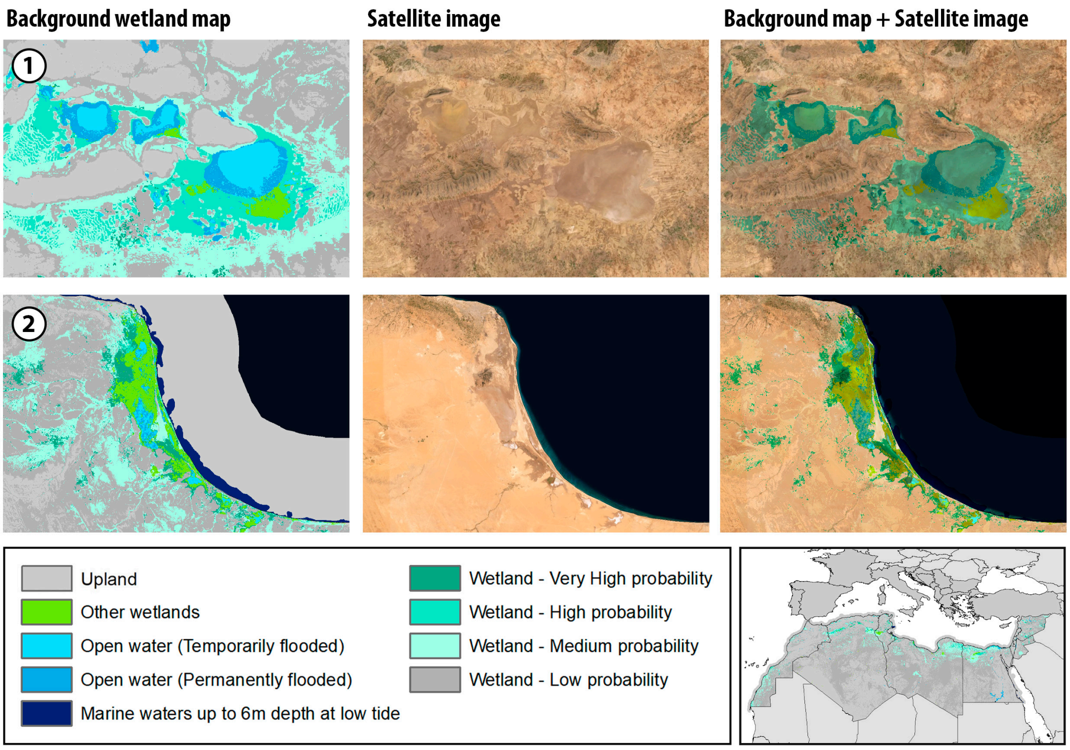
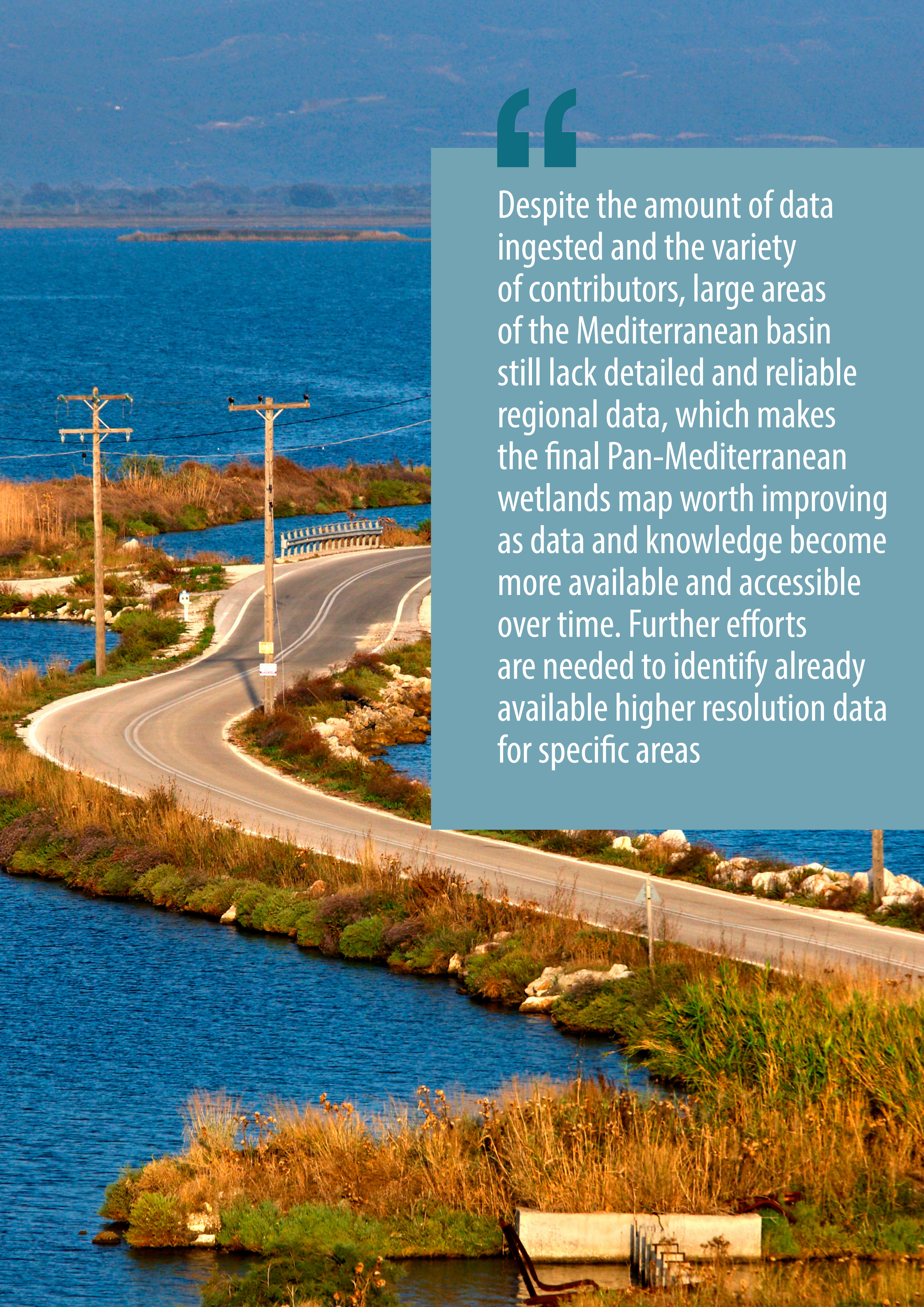


Figure 15. Detailed view of the results for wetland areas in Algeria (1) and Libya (2).

Annex V
Mediterranean wetlands biodiversity assessment information sources

- The IUCN Red List of Threatened Species™: https://www.iucnredlist.org
- 2006. The Status and Distribution of Freshwater Fish Endemic to the Mediterranean Basin
- 2006. The Status and Distribution of Reptiles and Amphibians of the Mediterranean Basin
- 2009. The Status and Distribution of Dragonflies of the Mediterranean Basin
- 2009. The Status and Distribution of Mediterranean Mammals
- 2010. The Status and Distribution of Freshwater Biodiversity in Northern Africa
- 2010. European Red List of Dragonflies
- 2011. The Diversity of Life in African Freshwaters: Under Water, Under Threat
- 2011. European Red List of Non-marine Molluscs
- 2011. European Red List of Freshwater Fishes
- 2011. European Red List of Vascular Plants
- 2014. The status and distribution of freshwater biodiversity in the eastern Mediterranean
- 2014. Freshwater Key Biodiversity Areas in the Mediterranean Basin Hotspot
- 2017. Freshwater Key Biodiversity Areas in the north-western Mediterranean sub-region



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Despite the amount of data ingested and the variety of contributors, large areas of the Mediterranean basin still lack detailed and reliable regional data, which makes the final Pan-Mediterranean wetlands map worth improving as data and knowledge become more available and accessible over time. Further efforts are needed to identify already available higher resolution data for specific areas

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THE MEDITERRANEAN BIODIVERSITY PROTECTION COMMUNITY

A collaborative Mediterranean community representing around 300 institutions are bringing together their work to identify the most effective mechanisms to manage and protect Mediterranean biodiversity.

The results of MBPC projects (ACT4LITTER, AMARE, CONFISH, ECOSUSTAIN, FISHMPABLUE2, MEDSEALITTER, MPA-ADAPT, MPA NETWORKS, MPA ENGAGE, PHAROS4MPAS, PLASTICBUSTERSMPAS, POSBEMED, TUNE UP, WETNET) are being streamlined to offer holistic solutions that bridge science, practice and policy to priority environmental challenges through an action roadmap implemented by several working groups.

The overall aim of the Biodiversity Protection Community is to increase the current understanding, knowledge and awareness of multiple environmental threats and promote best practices and Ecosystem-based Management tools as a response to address cumulative pressures and impacts affecting protected areas and functional ecosystem units in the Mediterranean.

Interreg Mediterranean
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BIODIVERSITY PROTECTION

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MedCités MedCities
UN environment programme
Mediterranean Action Plan Barcelona Convention
Plan Bleu
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Montenegro Ministry of Ecology Spatial Planning and Urbanism
MARINE INSTITUTE INSTITUT ZA MORE
CPMR CRPM

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