MEDITERRANEAN WETLANDS OUTLOOK • 3

2025

MEDITERRANEAN WETLANDS:

RESPONSES TO ONGOING CRISES

Mediterranean Wetlands Observatory

Ramsar Convention on Wetlands

MedWet

Tour du Valat

The Mediterranean Wetlands Observatory (MWO), coordinated by Tour du Valat, was established in 2008 within the framework of the Ramsar Regional Initiative for Mediterranean Wetlands: MedWet. Its mission is to assess the status and trends of wetlands in the region and raise awareness of their multiple values. Its primary objective is to improve the conservation and wise use of these ecosystems by sharing knowledge as broadly as possible, particularly with decision-makers and the general public.

www.medwetlands.org

Established in 1991, the **Ramsar Regional Initiative MedWet** is an intergovernmental network operating within the framework of the International Convention on Wetlands. Bringing together other non-governmental actors, its main objective is to promote and support policies and concrete actions involving multiple stakeholders for the conservation, restoration, and sustainable use of Mediterranean wetlands.

www.medwet.org

Tour du Valat, Research Institute for the Conservation of Mediterranean Wetlands, was founded in 1954 by Luc Hoffmann and has since pursued its mission with a consistent guiding principle: to better understand wetlands in order to manage them more effectively. Convinced that these threatened ecosystems can only be preserved if human activities and natural heritage protection go hand-in-hand, the Tour du Valat has, for decades, developed research and integrated management programmes that foster dialogue between users and scientists, mobilise a community of stakeholders, and advocate for the value of wetlands to decision-makers across the Mediterranean basin.

www.tourduvalat.org

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Foreword

Throughout the world we are witnessing increasing environmental pressures, and the Mediterranean is no exception; in fact, as a biodiversity hotspot, home to incredible cultural heritage, it is even more at risk than most other regions. With an impact from climate change 20% faster than the global average, supporting nearly 30% of the world's tourism and with an ever-increasing human population, we are seeing environmental disasters, marine heat waves and long-term trends that give great cause for alarm.

Wetlands can be seen as a victim in this scenario; drained, degraded and disappearing as the pressures on them increase. We are rapidly destroying a resource that we all depend on, and that brings people to the region in their millions. However, wetlands should also be seen as the solution to many of these issues. Their ability to store carbon, act as natural air-conditioning in urban areas, absorb water in extreme weather events and protect coastlines against erosion and storm surges all demonstrate their role as a natural protection system in the face of climate change. Coupled with the myriad services they offer, for food, tourism, culture and recreation, drinking water to name but a few.

This third Mediterranean Wetland Outlook builds on the previous two, providing an updated picture of the state of wetlands in the region, and offering an objective, scientific snapshot of how wetlands are faring. A snapshot that should give us pause for thought, and act as a clarion call to the numerous actors that impact on wetlands. Whether conservationists, governments, private sector or local communities, we all need to think about how we can protect and harness these precious environments. The Outlook offers not only a picture of the state of wetlands, but also optimism with case studies of how people, locally, nationally and regionally, are taking action to improve things.

The Mediterranean Wetland Observatory team has created a model based on the DPSIR (Drivers – Pressures – State – Impacts – Responses) framework, looking at the drivers, pressures, states, impacts and responses as they relate to wetlands. This model gives a clear, structured analysis of the situation, identifying the key points that have led to where we are today, and that can offer the solution to rectifying it.

The team has looked at data from numerous sources, from Earth Observation to government reports, academic and research results and case studies from a range of projects on the ground. This sound basis has created a well-rounded, authoritative report that will help decision-makers, global conventions, NGOs and civil society and local actors alike.

The development of this tool included many regional players such as MedWet, Plan Bleu, the Union for the Mediterranean, the Mediterranean Alliance for Wetlands to name a few. It has been years in the planning, with careful and wide-reaching research supporting its findings. The joined-up approach recognises that we need many partners to find solutions and deliver them. It should also be set in the context of the Ramsar Convention on Wetlands, and MedWet as a Mediterranean Ramsar Regional Initiative, an active and long standing agreement to support governments and partners to protect and conserve wetlands.

The conclusions may be stark in some of their messages. Yes, wetlands are facing many issues and the trends are not improving. Yes, the impacts of climate change are becoming increasingly felt, and we are still not on track to limit its progress. But we can also see signs for hope: cooperation at international and national levels; better science and monitoring tools that help us to target actions; and ideas coming from local projects that point to long term solutions. The Outlook shows that the tools are there, and it is up to us to promote them, communicate better to decision makers and local actors, and offer a positive and achievable picture of a sustainable future.

However, this document needs to be used in order to have an impact. We must use it to create changes in attitudes and behaviours. Whatever your role, wherever you are, you can take positive action for wetlands, because it means a positive change for your world, your friends and your family, and for future generations. The Mediterranean is an amazing region in so many ways, and wetlands are fundamental to that. Let's add this tool to what we are already doing to make a better world for wetlands, for biodiversity and for us.

Chris Rostron
Coordinator MedWet

Jean Jalbert
General Manager
of the Tour du Valat

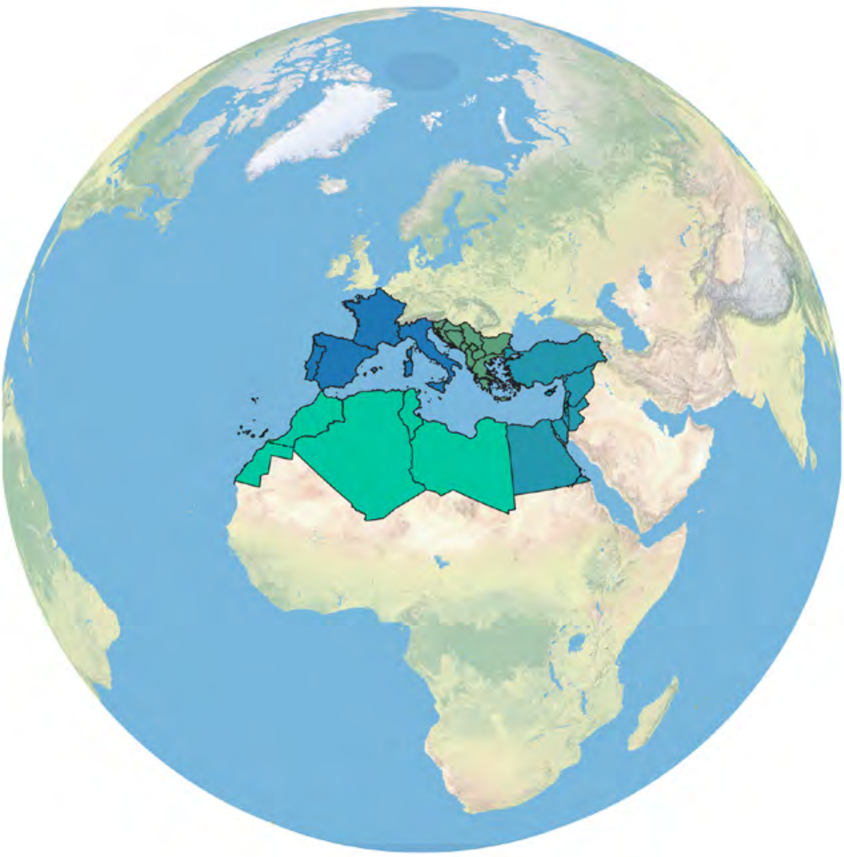
The Mediterranean Wetlands Observatory

The Mediterranean Wetlands Observatory (MWO) is a scientific and technical tool dedicated to the production, synthesis, and dissemination of knowledge on wetland ecosystems across the Mediterranean Basin. As part of the third edition of the Mediterranean Wetlands Outlook, the MWO offers a regional overview by analysing the status and trends of these ecosystems, as well as the responses implemented to protect them, with the aim of informing public policies and supporting conservation efforts.

To ensure consistency and relevance in its monitoring, the MWO develops a set of indicators aligned with the frameworks used by the Ramsar Convention, the Convention on Biological Diversity (CBD), the Sustainable Development Goals (SDGs), as well as its regional partners, particularly Plan Bleu under the Barcelona Convention.

The MWO operates at three geographical scales: regional, national, and local and works in collaboration with the 28 member countries of the Mediterranean Ramsar Regional Initiative MedWet. Its study area thus encompasses all these countries, grouped into four sub-regions: South-West Europe, the Balkans, the Middle East, and the Maghreb. The MWO adopts the definition of wetlands provided by the Ramsar Convention.
www.ramsar.org

Finally, to strengthen knowledge on wetlands at national and local scales, the MWO is developing the **Mediterranean Wetlands Geoportal (MWG)**: an online platform designed to provide access to reliable, up-to-date, and contextualised data on these ecosystems. The MWG allows users to visualise indicators tailored to each country, consult monitoring results from multiple sites across the Basin, and identify conservation or restoration priorities. Designed as a decision-support tool, the MWG targets primarily decision-makers, site managers, researchers, and civil society actors committed to the preservation of Mediterranean wetlands.
www.medwetlands.org/geoportal



MIDDLE EAST
Cyprus
Egypt
Israel
Jordan
Lebanon
Palestine
Syria
Türkiye

MAGHREB
Algeria
Libya
Morocco
Tunisia

SOUTH-WEST EUROPE
Andorra
France
Italy
Malta
Monaco
Portugal
Spain

BALKANS
Albania
Bosnia and Herzegovina
Bulgaria
Croatia
Greece
Montenegro
North Macedonia
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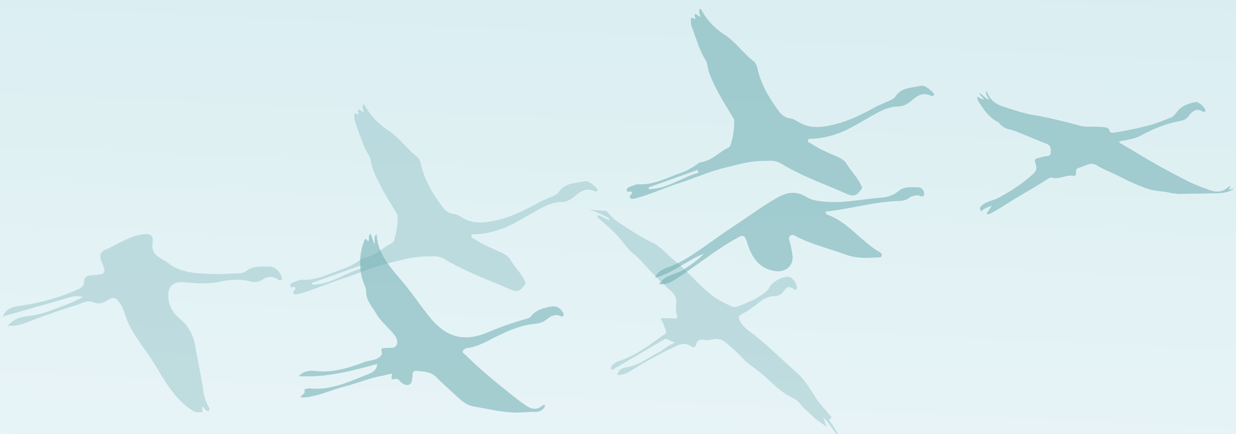

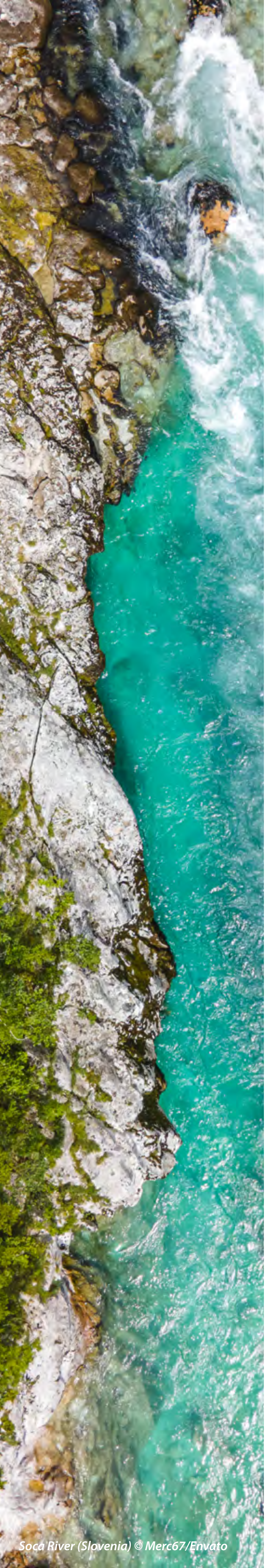

Soča River (Slovenia) © Merc67/Envato

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Key figures

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RESPONSES

36% Of Mediterranean wetland habitats are protected

Only **1/3** of the **414** Ramsar Sites have an implemented management plan

88 000 km² Of lost wetland habitats in northern Mediterranean countries could be restored with low efforts

161 Key wetlands for waterbirds have yet to be designated as Ramsar Sites

35% Less water consumption if irrigation is modernised

Only **20%** of treated wastewater is reused

IMPACTS

Drying of surface water areas since 1984

-12% In permanently flooded inland marshes

-10% In temporarily flooded coastal lagoons

Wetland habitat conversions since 1990

54% To agriculture

36% To artificial wetlands

Rivers ecological connectivity

95% Of the total length of major rivers is impacted

DRIVERS

400 M People live near a wetland

Population density is **258 inhabit./km²** (4 times the regional average)

By 2100

+1,7°C to **+5,2°C**

-1% to **-5%**

STATE

56% Of historical wetlands have potentially disappeared

-12% Decline of natural wetlands since 1990 alone

40% Of wetland-related species in a worrying conservation status

+43% Increase in wintering waterbird abundance 1995-2022

PRESSURES

+44% Built-up areas around wetlands since 2000

30% Of wetlands functional area is used for agriculture

+25% Surface area of artificial reservoirs since 1990

1/4 Of cultivated lands are irrigated

2/3 Of water abstractions are for irrigation

+0,34 m to **+1,06 m** Sea Level Rise by 2100

69% to **92%** Of coastal marshes could be lost

50% Of water bodies are classified as poor quality

Technical Summary

1. Introduction

1.1. Mediterranean wetlands at the heart of socio-ecological challenges

Wetlands are among the richest, most dynamic, and complex socio-ecological systems in the Mediterranean basin. These environments, at the interface between land and water, fulfil essential ecological functions: regulating the water cycle, naturally purifying water, maintaining biodiversity, storing carbon, and providing protection against increasingly frequent climatic hazards. These natural functions underpin a wide range of ecosystem services from which human societies benefit through multiple, and at times competing, uses: agriculture, fishing, tourism, drinking water supply, and recreational activities.

In the Mediterranean, where water-related challenges are systemic and anthropogenic pressures intense, wetlands stand as pillars of environmental and social stability. And yet, their decline is rapid. For several decades, they have been undergoing profound and often irreversible transformations, driven by the combined effects of urbanisation, agricultural intensification, overexploitation of water , and pollution. The area of natural wetland habitats continues to decline, while their fragmentation is increasing, leading to the marked decline of dependent species. These trends are further compounded by climate change, which accelerates wetland desiccation, disrupts hydrological balances, and alters species distribution.

Understanding these dynamics, anticipating future trends, and identifying effective levers for action require a rigorous and systemic analytical approach. This is precisely what the DPSIR framework (Drivers-Pressures-State-Impacts-Responses) enables, a model developed by the European Environment Agency (EEA) and now widely used in international environmental assessments.

1.2. The DPSIR Framework: A tool to understand the complexity of wetlands

The DPSIR conceptual framework is based on five interdependent dimensions that link environmental transformations to the underlying socio-economic context. It provides a structured approach to conduct a comprehensive diagnosis of the state of a given environment (in this case, Mediterranean wetlands) by integrating root causes, observable impacts, and potential responses.

Drivers refer to the underlying dynamics that shape the evolution of societies: demographic growth, economic development, sectoral policies, and climate change. These drivers directly or indirectly influence human behaviour as well as patterns of production and consumption. In the Mediterranean Basin, population pressure, climate change, food security strategies, and national energy agendas are powerful forces that shape the condition of wetlands.

Pressures are the direct consequences of these dynamics that threaten natural environments: increased water abstraction, rising sea levels, or excessive use of agricultural inputs. These are measurable and localised factors that weaken natural ecosystems and alter their functioning.

State describes the current ecological condition of ecosystems, such as habitat integrity or the conservation status of species. This diagnosis is based on biological, hydrological, or physical-chemical indicators, which help assess the extent to which wetlands retain their ability to function and provide ecosystem services.

Impacts are the tangible consequences of this degradation on biodiversity, ecological functions, and the benefits that human societies derive. The drying of a marsh leads to habitat loss for migratory waterbirds; declining water quality affects human health; the loss of a coastal wetland increases vulnerability to storm surges and erosion.

Responses encompass the policies, actions, legal, financial, or institutional mechanisms put in place to reduce pressures, restore ecosystems, and support ecological transition. These may include the designation of protected areas, ecological restoration projects, integrated water resource management plans, or economic incentives promoting sustainable practices.

The DPSIR framework offers a dual advantage. On the one hand, it helps identify causal chains linking human activity to environmental degradation and its consequences. On the other hand, it provides an operational basis for public decision-making by clarifying where interventions can occur: on drivers (e.g. agricultural policies), on pressures (e.g. irrigation intensification), on impacts (e.g. wetland drying), or on responses (e.g. wetland habitat restoration to support aquifer recharge).

MWO

1.3. A Systemic perspective in support of regional and national actions

In the Mediterranean context, marked by pronounced geopolitical, socio-economic, and environmental heterogeneity, the DPSIR approach offers a common language to compare dynamics at a regional scale. It also allows for the identification of overarching trends while highlighting the specific characteristics of each sub-region (South-West Europe, the Balkans, the Middle East, and the Maghreb), and even of each of the 28 MedWet countries[1]. This approach sheds light on differences in governance, levels of engagement, structural vulnerabilities, and potential opportunities for action.

For over a decade, the Mediterranean Wetlands Observatory (MWO) has produced regional assessments to guide public action and support conservation efforts. The first report (MWO, 2012) laid the foundations for pan-Mediterranean monitoring by introducing an initial set of DPSIR indicators. The second edition (MWO, 2018) updated this knowledge while exploring pathways towards sustainable Mediterranean wetlands. This third report (MWO-3), published on the occasion of the 15th Conference of Parties of the Ramsar Convention (Victoria Falls, Zimbabwe, 2025), provides a further update of the regional diagnosis in a context of multiple pressures, this time emphasising the central role of wetlands as responses to the major Mediterranean crises.

This new assessment is based on a structured set of 18 DPSIR indicators developed by the MWO. By combining them with spatial analyses, case studies, and field-based feedback, the MWO-3 report offers an in-depth and coherent reading of the trends affecting Mediterranean wetlands, grounded in the most recent data. To reflect the complexity of these findings while ensuring clarity, the structure of the technical summary purposely groups together the elements relating to the state of ecosystems and their ecological impacts within a single chapter, in order to better capture the interactions between biophysical dynamics and human pressures.

Beyond diagnosis, this approach brings into focus the key tensions that must be resolved in order to preserve these ecosystems, as well as the responses that need to be reinforced or scaled up. This technical summary therefore aims to provide a structured and operational narrative, to inform public policies, support national and regional strategies, and mobilise all stakeholders (decision-makers, site managers, scientists, and civil society) towards an ecological transition that places wetlands at the heart of Mediterranean priorities.

List of the 18 DPSIR indicators used for the MWO-3

DPSIR	Indicators
DRIVERS	**D1.** Human demography
	D2. Future trends in temperature and precipitation
	D3. Structural factors influencing the condition of Mediterranean wetlands
PRESSURES	**P1.** Land artificialisation and agricultural intensification
	P2. Water availability and overexploitation of the resource
	P3. Threats to water quality
	P4. Climate change pressures on wetland biodiversity
	P5. Mean Sea Level Rise
STATE	**S1.** Extent of wetland habitats
	S2. Conservation status of Mediterranean wetland species
IMPACTS	**I1.** Drying of natural wetlands
	I2. Conversion of natural wetland habitats
	I3. Alteration of river ecological continuity
RESPONSES	**R1.** Wetlands protection
	R2. Wetlands restoration
	R3. Wetlands management
	R4. Sustainable use of water resources
	R5. Political commitment to wetlands and levers for action

[1] Albania, Algeria, Andorra, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, North-Macedonia, Palestine, Portugal, Serbia, Slovenia, Spain, Syria, Tunisia and Türkiye.

2. Sociodemographic dynamics, climate change, and structural vulnerabilities: The deep-rooted drivers of wetlands' vulnerability

Understanding the underlying causes of Mediterranean wetland decline requires looking beyond the visible signs of degradation. It is the demographic, economic, political, and now climatic dynamics that are reshaping the Mediterranean Basin on a broad scale and impacting land use, water withdrawal, development pathways, and the hierarchy of policy priorities. Three major drivers stand out: concentrated population growth around wetlands; deep disparities in governance and institutional capacity between countries; and the intensifying effects of climate change, a transversal catalyser that exacerbates all existing pressures.

2.1. Population growth around wetlands

Since 1990, the population of MedWet countries has increased by nearly 38% (***Indic. D1***). This growth, far from uniform, has profoundly altered land occupation patterns. While interior rural areas are experiencing depopulation, coastal zones and major river floodplains, home to most Mediterranean wetlands, are absorbing the bulk of population flows. This demographic polarisation places wetlands at the core of contemporary territorial transformations.

The figures are unequivocal: average population density around wetlands now reaches 258 inhabitants per km^2 (***Indic. D1***), significantly surpassing even that of coastal zones (137 inhabitants per km^2). This spatial convergence between human dynamics and wetlands inevitably increases pressure on these ecosystems: demand for drinking water, agricultural expansion, economic zones, tourism pressure, and infrastructure development. Wetlands are increasingly becoming critical interfaces between human activity and ecological balances.

Beyond land uses, this dynamic exposes a deeper issue: a lack of planning in the face of demographic growth. In several southern and eastern countries of the Basin, territorial planning struggles to keep pace with human settlement, leading to informal urbanisation, land pressure on natural areas, and overstretched public services (Plan Bleu, 2025). In such contexts, wetlands are often the first to be targeted: seen as vacant land or land reserves awaiting development, they become vulnerable to illegal occupation, fragmentation, or conversion.

Akyaka (Türkiye) © Emirkoo/Envato

Case Study 1

Demographic pressures and land artificialisation around an urban wetland: The case of Sebkhet Sejoumi (Tunisia)

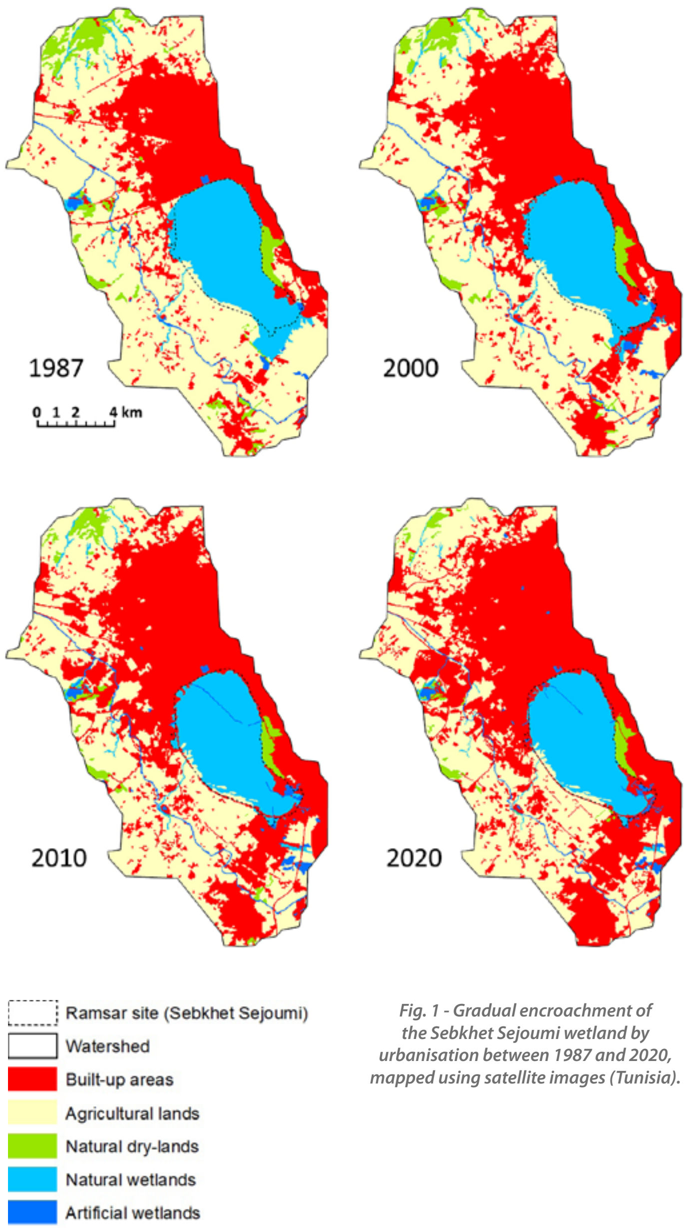


Fig. 1 - Gradual encroachment of the Sebkhet Sejoumi wetland by urbanisation between 1987 and 2020, mapped using satellite images (Tunisia).

Located on the immediate suburb of Tunis, Sebkhet Sejoumi is one of the last major peri-urban lakes in North Africa. This Wetland of International Importance provides a key refuge for several species of migratory and threatened birds, while also performing crucial hydrological functions by regulating floods in a region prone to intense rainfall events.

For over three decades, under the pressure of rapid demographic growth, urban development in Tunis has expanded in all directions (Guelmami, 2020). Once situated on the urban fringe, the lake is now encircled by residential districts, motorways, illegal dumping sites, and informal housing developments. Increasing impermeability of the soil surface around the sebkha has significantly disrupted its hydrological flows, reducing the frequency and extent of seasonal flooding and increasing the risk of pollution through urban runoff (***Fig. 1***). Untreated wastewater, the accumulation of waste, and the absence of an integrated management framework threaten both the ecological integrity of the site and the health of local human population.

This case powerfully illustrates how demographic factors, when not supplemented by adequate planning frameworks, can lead to the rapid marginalisation of an ecosystem, despite its recognised ecological value and the services it provides. It also demonstrates that the preservation of urban wetlands is not only an ecological issue, but one of land planning and public health.

2.2. Governance, political stability, and unequal institutional capacities

Even under similar levels of pressure, not all wetlands experience the same degree of degradation (Geijzendorffer et al., 2018). This disparity is often explained by the varying capacity of societies to regulate uses, anticipate disturbances, plan spatial development, and invest sustainably in environmental protection. These capacities are highly uneven across the Mediterranean Basin, shaped by contrasting historical trajectories, administrative systems, economic models, and levels of political commitment (***Indic. D3*** & ***Indic. R5***).

In South-Western European countries, institutional stability, alignment with the European legislation, and the existence of multi-level governance allow for a certain degree of control over environmental transformations (***Indic. D3***). European directives, particularly those on water, habitats, and floods require Member States to integrate environmental issues into spatial planning. Monitoring tools are in place, data is accessible, and civil society often plays an active role. While these countries do face strong land and water use pressures (***Indic. P1*** & ***Indic. P2***), they also possess a suite of instruments capable of reconciling, to some extent, development and wetland conservation. The key challenge remains in fully embedding these instruments into planning strategies, beyond the boundaries of protected areas.

The Balkans present a more heterogeneous picture (***Indic. D3***). Some states, either EU members or candidates, benefit from technical and regulatory support. Others, however, struggle to transpose or implement international standards. Human and financial capacities may be limited, environmental institutions often lack political weight, and intersectoral coordination remains weak. Yet many of these territories still host relatively unaltered wetlands, spared so far by slower urbanisation and lower agricultural pressure (***Indic. P1***). This paradox presents a rare opportunity: to prevent degradation by reinforcing governance mechanisms from the outset.

In the Maghreb and the Middle-East, tensions are more critical (***Indic. D3***). Rapid demographic growth and water stress are often compounded by chronic political or economic instability. Legal frameworks may exist but are poorly enforced. Wetlands are rarely integrated into territorial development policies, and decisions affecting them frequently take second place to more pressing social or economic emergencies. In these settings, the absence of regulation or its implementation is not necessarily deliberate but rather a symptom of weakened governance and a lack of institutional and financial means to manage socio-ecological complexity. Wetlands are lost due to a lack of capacity to defend them in the context of conflicting priorities.

Bridge of Saint Angelo, Rome (Italy) © Givaga/Envato

Case Study 2

The Mediterranean Alliance for Wetlands: A Tool for strengthening civil society

Launched in 2017, the Mediterranean Wetlands Alliance (MAW) is a collaborative platform bringing together non-governmental organisations, academic institutions, and local stakeholders committed to wetland conservation throughout the Mediterranean Basin. It was created to address a critical gap: the limited presence and influence of civil society in national and regional wetland-related policy processes.

The MAW works by facilitating the exchange of knowledge and experiences, strengthening technical capacities, and supporting project development and coordinated advocacy efforts. Its aim is to amplify the voices of local actors and ensure that community-based perspectives are meaningfully integrated into decision-making processes. Beyond advocacy, the MAW also plays a catalytic role on the ground: supporting the design and implementation of concrete projects, improving access to data and tools, and encouraging collaboration between institutions and communities.

A striking example of this impact can be seen in the restoration project of peatlands of Dar Fatma, north-west Tunisia, through the Green Light protocol. This rare and ecologically rich Ramsar-designated site is undergoing severe degradation, threatening its unique biodiversity and capacity to store carbon. In response, WWF North Africa, with support from the MAW, launched an ambitious multi-year restoration project. The initiative seeks to rehabilitate 13 hectares of peatland by restoring water flow, reviving native species, and enhancing the control on pastoralism activities. It also promotes sustainable ecotourism and actively involves local communities in site governance, monitoring, and protection. Moreover, the project has strengthened national advocacy to secure long-term legal and institutional safeguards.

The Dar Fatma project demonstrates the MAW's core mission: enabling civil society to take the lead in wetland conservation by linking ecological restoration with social, economic, and political transformation.

The Mediterranean Alliance for Wetlands in action at the Dar Fatma Peatlands Ramsar Site (Tunisia).

Dar Fatma peatlands (Tunisia) © Ferchichi A.

2.3. Climate change: A transversal driving force

Beyond social and political dynamics, another, more insidious driver is fundamentally reshaping the future of Mediterranean wetlands: climate change. Rather than replacing existing pressures, it compounds them, intensifies them and makes them more unpredictable (Leberger et al., 2020). It disrupts hydrological balances at every scale, from rainfall patterns in basins' up-streams to sediment flows shaping deltas, while increasing evapotranspiration, drying aquifers, salinising soils, and accelerating coastal erosion.

Projections are unequivocal (MedECC, 2020): the Mediterranean Basin is one of the world's most climate-vulnerable regions. Droughts are becoming longer, heatwaves more intense, rainfall events are increasingly concentrated into short, violent episodes, and flash floods are more frequent. For many habitats, particularly temporary wetlands, this growing variability alters their natural cycles, and disturbs the dynamics of some species (***Indic. P4***).

According to ***Indic. D2***, annual average temperatures in the Mediterranean are projected to rise significantly by 2100, up to +1.7 °C under an optimistic scenario (SSP1-2.6) and over +5.2 °C in a pessimistic one (SSP5-8.5). Autumn and winter are expected to see the greatest increases, with temperatures potentially rising by +11.7 °C in the autumn. Warming will not be uniform: it will be more severe in the eastern part of the basin, particularly in the Balkans.

This widespread warming will further stress ecosystems already facing water scarcity and intense anthropogenic pressures. Rainfall is also expected to decline by 1% to 5% across the basin on average, with reductions of up to -30% in the Maghreb and the Iberian Peninsula by 2100. Importantly, this overall decline masks significant seasonal shifts: summer precipitation may increase slightly, but autumn rainfall, vital for wetland recharge, is likely to fall sharply, disrupting the hydrological regimes on which wetlands depend.

Moreover, climate impacts are not confined to the wetlands themselves (***Indic. P4*** & ***Indic. P5***). The entire Mediterranean hydrological system is being reshaped by global warming. River basins, already under increasing agricultural pressure, are experiencing altered flow regimes. In response, the agricultural sector, particularly through the intensification of practices, is significantly increasing its water storage capacity, as well as abstraction during periods of water stress. This in turn reduces inflows to downstream wetlands (***Indic. P1*** & ***Indic. P2***).

Castel Guelfo di Bologna (Italy) © KGi-tim/Envato

3. Growing pressures on wetlands: Uses that damage natural ecological dynamics

3.1. When land artificialisation transforms landscapes

It is not only population growth that threatens wetlands, but rather how land is being developed. Land artificialisation (i.e. the conversion of agricultural land or natural areas into sealed or heavily modified surfaces) is among the most severe and irreversible threats to these ecosystems. This trend is driven by rapid urbanisation as well as the construction of linear and single infrastructure that cuts across or encloses wetlands: roads, railways, ports, tourist resorts, and industrial and logistic platforms.

Between 2000 and 2020, impermeable surfaces around Mediterranean wetlands increased by 44%, reflecting a spatial development model based more on expansion than densification, and more on fragmentation than ecological consistency (***Indic. P1***). These trends disrupt hydrological cycles by interfering with water circulation, hindering aquifer recharge, and reducing natural flood dissipation zones. Wetlands, increasingly isolated by surrounding infrastructure, are reduced to disconnected depressions, unable to perform their ecological functions. Beyond the degradation of ecosystem services, artificialisation increases surface runoff, pollutant transport, and prevents water infiltration into soils.

Aerial view near Venice (Italy) © Vvoennyy/Envato

Case Study 3

Habitat fragmentation in the Gediz Delta (Türkiye)

The Gediz Delta, located near the city of Izmir (Türkiye), is one of Mediterranean's most significant coastal wetlands and a designated Ramsar Site of International Importance. Despite its ecological value and protected status, the delta is under growing pressure from rapid urban sprawl, infrastructure development, and agriculture intensification.

Over the past forty years, the expansion of the Izmir metropolitan area has led to a profound transformation of the delta floodplain (Guelmami et al., 2023). The construction of roads, dykes, industrial zones, and the development of agriculture fragmented natural habitats, reducing both their extent and continuity. This increasing artificialisation of the landscape disrupts hydrological regimes, undermines the connectivity between freshwater environments and coastal areas, and isolates key habitats for migratory birds and endemic species. As a result, natural areas that were formerly part of an interconnected and dynamic ecological mosaic are becoming degraded enclaves, more vulnerable to pollution and rising sea levels.

However, the past two decades have seen a significant strengthening of scientific knowledge on the delta's ecological functioning. This growing knowledge base has helped identify concrete solutions for conservation and restoration. Their implementation is expected to accelerate, driven by the growing mobilisation of the scientific community, national and local NGOs, international partners, and committed local residents. These actions hold the promise of restoring ecological connectivity, enhancing the resilience of the ecosystem, and delivering long-term benefits for local populations, particularly in terms of water quality, risk management, and territorial value.

Colony of flamingos in the Gediz delta (Türkiye).

Gediz Delta (Türkiye) © Emirkoo/Envato

MWO

3.2. Agricultural intensification: Irrigation and input use

Agriculture remains the main factor leading to pressures on Mediterranean wetlands, not only because it expands into the margins of natural ecosystems, but also because it consumes most of the freshwater resources mobilised. Today, nearly two-thirds of water withdrawals in the basin are devoted to irrigation (***Indic. P1*** & ***Indic. P2***). Only a minority of countries, such as France and several in the Balkans, see domestic, industrial, or energy-related water use outweigh agricultural demand. Since the mid-20th century, water withdrawals have doubled, driven by the massive expansion of irrigated land: +21% since 1990, now covering over 282,000 km^2 equivalent to a quarter of all cultivated land in the Mediterranean Basin.

This expansion is largely the result of a shift from rain-fed farming to high-value irrigated crops, such as orchards, horticulture, and export-oriented vegetables, making already water-stressed areas increasingly dependent on irrigation (***Indic. P2***). In several southern and eastern countries of the Basin, irrigation is now the main pressure on freshwater resources, exacerbating competition with the water needs of downstream natural wetlands. This quantitative stress is compounded by a qualitative one: nearly half of all water bodies in the Mediterranean Basin fail to meet acceptable quality standards, largely due to agricultural runoff (***Indic. P3***).

If current demographic trends and the growth of irrigated areas continue unconstrained, agriculture-based withdrawals could double again by 2050 in southern and eastern countries, and even triple under the combined influence of rising temperatures and climate change (***Indic. P2***). The prevailing «supply-side» approach (i.e. building more reservoirs or drilling deeper) has reached its limits and risks deepening the hydrological deficit of catchments.

3.3. Overexploitation and imbalanced water resource management

Freshwater resources in the Mediterranean Basin are under critical stress, driven by population growth, agricultural intensification, and the effects of climate change. This long standing pressure has deepened over the past three decades, widening the gap between the volumes of water extracted and the natural renewal capacity of catchments (***Indic. P2***). The resulting imbalance directly affects wetlands, which rely on dynamic, seasonal hydrological regimes for their ecological functioning (***Indic. I1***).

In the Maghreb and the Middle-East, per capita water availability has dropped by 40% over the past thirty years, aggravating already severe structural water stress (***Indic. P2***). In many areas, abstraction now exceeds renewable resources, with aquatic ecosystems bearing the cost. Wetlands are increasingly deprived of the flows needed to maintain their ecological integrity. During dry seasons, many of them dry out completely or see their flooded surface area drastically reduced (***Indic. I1***).

The intensifying exploitation of groundwater is further exacerbating this imbalance. In many arid or semi-arid regions, groundwater represents a major component of water supply. However, over extraction, often far exceeding natural recharge capacities, is causing falling water tables, increased salinisation, rising pollution levels, and critical pressure on connected surface wetlands. Regional disparities are stark: while the northern part of the Basin receives 92% of natural recharge, the southern and eastern regions receive only 5% and 3% respectively. Moreover, widespread reliance on non-renewable fossil aquifers is common in these sub-regions, accounting for up to 66% of national water supply in countries such as Libya, Jordan, and Palestine. Added to this are the impacts of climate change, which could reduce aquifer recharge by 30% to 58% by 2050 depending on the country, while also worsening the salinisation of coastal groundwater reserves (Fader et al., 2020).

To address growing demand, public policies have heavily invested in artificial reservoirs designed to secure water supply for agriculture, energy production, and domestic use. Since 1990, the cumulative surface area of these reservoirs has increased by 25%, reaching a projected storage capacity of over 500 km^3 in 2025, nearly double the annual freshwater flow discharged into the Mediterranean Sea, which has itself declined significantly since the 1960s (***Indic. P2***). While these developments have helped meet human needs, they have come at the cost of severely disrupting river connectivity (***Indic. I3***) and diverting flows away from wetlands (***Indic. I1***). The ecological consequences of this storage-based water management model are profound. Natural hydrological regimes have been artificially flattened, seasonal floods eliminated, and groundwater exchange disrupted. Downstream wetlands, dependent on these dynamics, are effectively suffocated. In many cases, their ecological functioning is irreversibly compromised.

The spatial distribution of reservoirs reveals marked contrasts. Countries along the northern shore (i.e. Spain, France, Italy, Portugal, and Türkiye) historically have had the most concentrated hydraulic infrastructure (***Indic. P2***). But the Maghreb and the Middle-East, previously less equipped, have seen a recent rise in dam constructions to meet increasing irrigation demands. In Algeria, Morocco, and Syria, such development has become central to national water policies. In the Balkans, the picture is more varied: irrigation dams remain relatively limited, but hydropower projects are multiplying, often at the expense of still-intact rivers.

3.4. Climate change pressures: Mediterranean wetlands on the front line

The effects of climate change are already manifesting in Mediterranean wetlands through measurable biological signals (***Indic. P4***). Across the Basin, species that are strictly dependent on wetland ecosystems are now among those most at risk of extinction (Galewski et al., 2021). Vulnerability hotspots are concentrated not only in the core Mediterranean biogeographical zone but also along Morocco's Atlantic coast and the lower Nile Valley. The richer a wetland is in species, the more it tends to host sensitive taxa, thereby amplifying the risk of functional loss.

Wintering waterbirds provide a particularly revealing barometer of these shifts. The Community Temperature Index, which measures the proportion of thermophilic (heat-adapted) species in avian assemblages, is rising across the Basin. This upward trend indicates a shift in favour of warm-adapted species, at the expense of those dependent on cooler conditions. The clearest changes have been observed in France, Greece, and Italy.

In other countries, trends are more moderate or even locally reversed, suggesting that biological responses also depend on habitat management practices. The redistribution of wintering ranges is a large-scale indicator of community-level adjustment to changing climate conditions (***Indic. P4***).

In coastal areas, the Sea Level Rise (SLR) is pushing coastal marshes further inland. The rate of SLR currently averages 2.8 mm/year and could reach +30 cm to +1.10 m by 2100, depending on different emission scenarios SSP (***Indic. P5***). Such a rise poses a direct threat to coastal wetland habitats. According to projections, between 69% and 92% of Mediterranean coastal marshes could disappear by the end of the century if no adaptation measures are taken (Schuerch et al., 2025). Yet these habitats are essential natural defences; buffering marine submersion and storing carbon.

Molano reservoir (Spain) © Estellez/Envato

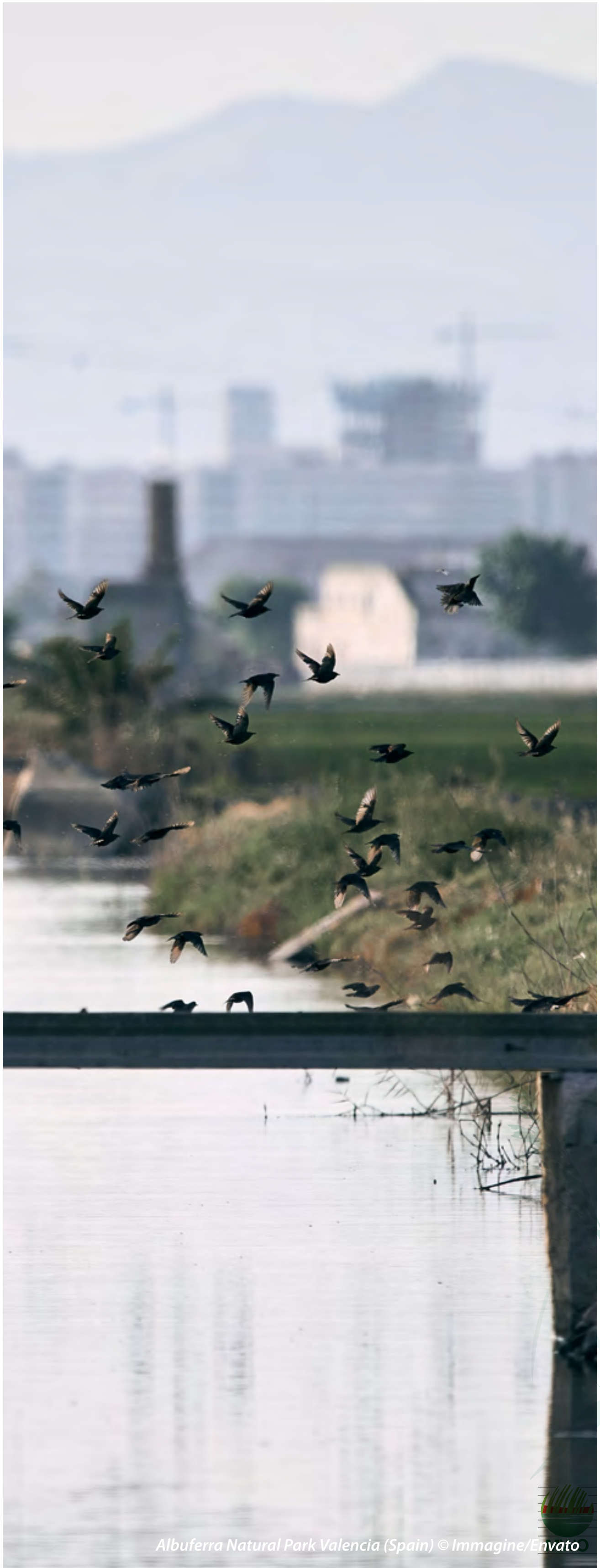
4. Wetlands under strain: Impacts on ecosystems and the services they provide

4.1. Decline of natural habitats: Conversion, artificialisation, and historical legacy

The retreat of Mediterranean wetlands is part of a long-term trend (Guelmami, 2023). It is estimated that more than half of historical wetland areas have already been lost since antiquity, and the process shows no sign of halting. Between 1990 and 2020 alone, approximately 15% of the region's remaining natural wetlands were lost (***Indic. S1***), underscoring a persistent, slow-moving erosion. This decline is unbalanced across the Basin, reflecting the unique social, economic, and hydrological trajectories of the different subregions.

According to ***Indic. S1***, remaining wetlands in the Maghreb encompass a large proportion of natural habitats, covering nearly 95% of their surfaces. These ecosystems, however, depend primarily on temporary hydrological dynamics, meaning even minor disruptions to rainfall regimes, already worsening with intensifying droughts, could put at risk their long-term viability (***Indic. I1***). In the Balkans, natural habitats cover about 78% of the total wetlands area, though hydropower infrastructure is steadily expanding (***Indic. P2***). In South-West Europe, the legacy of two centuries of land transformation has reduced natural wetland cover to 66%. In the Near East, artificial wetlands now account for a striking 41% of identified wetland surfaces, largely due to the proliferation of dams and the rapid rise of aquaculture, especially in the Nile Delta, leading to a sharp loss of both biological and functional diversity.

Conversion trends confirm this polarisation (***Indic. I2***): between 1990 and 2020, 54% of lost natural wetland habitats were converted to agriculture, while 36% were transformed into artificial wetlands (e.g. aquaculture ponds or water storage reservoirs). Only 10% were directly urbanised, but cities exert a broader influence through linear infrastructure, transport corridors, and industrial zones. Protected or designated sites offer partial defence: Ramsar-listed wetlands lost only 3% of their natural habitats over the period, compared to 11% in non-designated sites (***Indic. I2***). This relative protection underscores the value of formal recognition, but also reminds us that designation alone is insufficient without effective management and coordinated conservation efforts (***Indic. R3***).



Albuferra Natural Park Valencia (Spain) © Immagine/Envato

Case Study 4

Impacts of natural habitat loss on ecosystem services: The El Kala wetlands complex (Algeria)

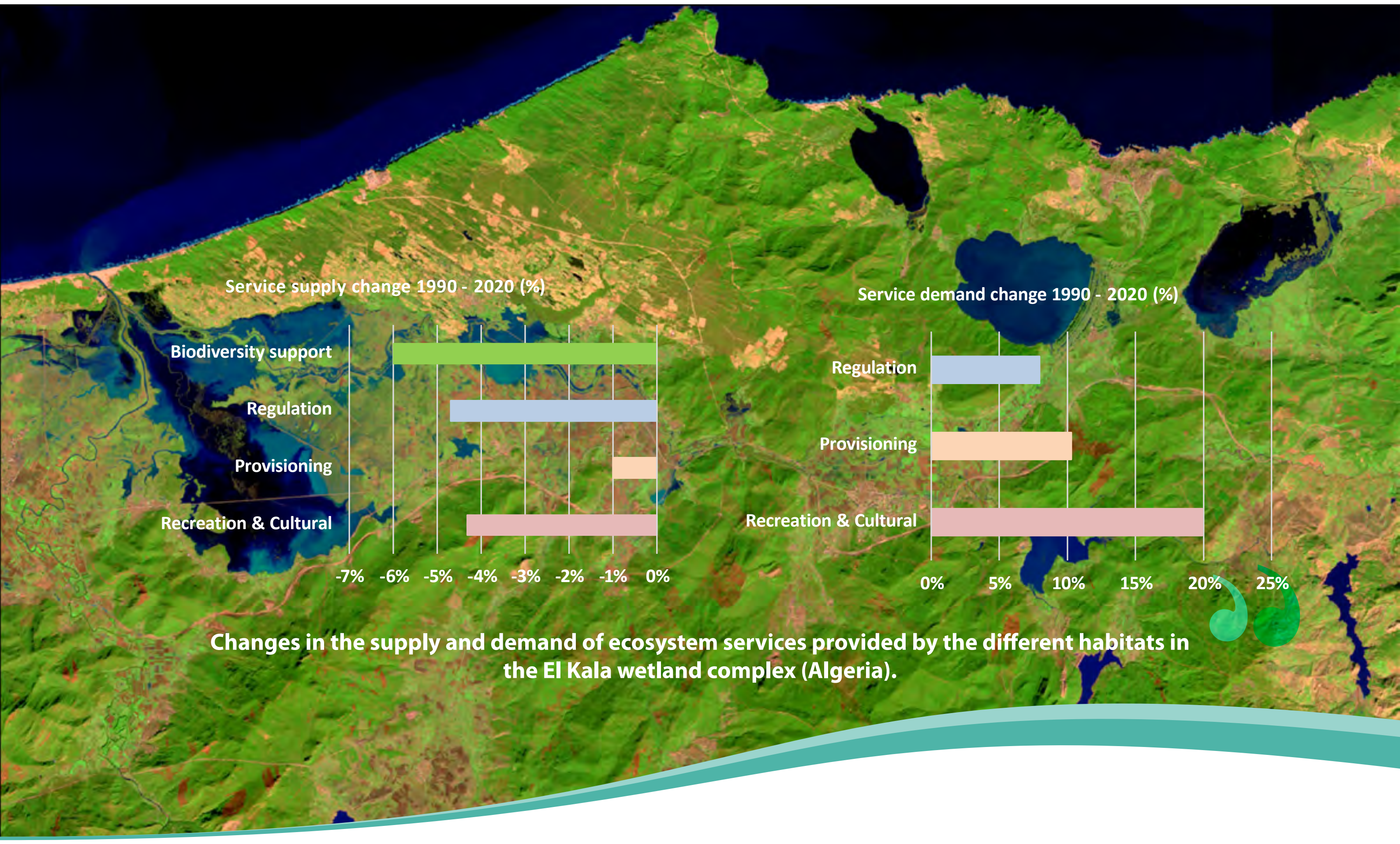
Located in north-eastern Algeria, the El Kala region is home to one of the most emblematic wetland complexes in the Mediterranean. This area, designated a UNESCO Biosphere Reserve and encompassing a national park along with nine Ramsar Sites, forms an exceptional mosaic of lakes, rivers, coastal and inland marshes, peatlands, wet meadows, riparian forests, and one coastal lagoon. It hosts remarkable biodiversity while delivering a wide range of essential ecosystem services: flood regulation, water purification, livestock grazing, carbon storage, as well as cultural and recreational benefits.

An analysis conducted across the watershed surrounding the complex's wetlands reveals a worrying decline in these services. Between 1990 and 2020, land-use changes were marked by significant artificialisation: urban areas expanded by 47% (+53 km^2), agricultural lands by 3% (+29 km^2), while natural dry habitats declined by 5% (-93 km^2) and wetlands by 2% (-3 km^2).

These transformations have fragmented natural environments, disrupted hydrological regimes, and weakened ecological connectivity, particularly impacting peatlands and shallow marshes.

As a result, the region's capacity to provide ecosystem services has significantly declined, with reductions of 4% to 6% in regulation services, biodiversity support, and cultural services. This degradation is occurring at a time when social demand for these services is sharply increasing (+8% to +20%, depending on the service), driven by demographic growth and expanding urbanisation within the complex.

This case illustrates the cumulative effects of poorly managed development on a high-value ecological system. It highlights the urgent need to reintegrate wetland conservation into land-use planning policies.



Changes in the supply and demand of ecosystem services provided by the different habitats in the El Kala wetland complex (Algeria).

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4.2. River fragmentation and loss of connectivity

Rivers and the associated wetlands they sustain form a continuous hydrological system whose proper functioning depends on the free flow of water, sediments, and species. However, this connectivity is now severely compromised. According to data from Grill et al. (2019), more than 85% of the main river networks in the Mediterranean are already fragmented, due to the proliferation of dams, diversions for hydropower or irrigation, and linear infrastructure such as roads and embankments (***Indic. I3***).

This loss of connectivity has a cascade of consequences. Sediment transport towards deltas is disrupted, accelerating coastal erosion. Floodplains are no longer naturally inundated during high-flow events. Peripheral habitats become disconnected from the river's main channel, and downstream wetlands begin to dry out (***Indic. I1***).

4.3. Wetland biodiversity: Increasing vulnerabilities and unequal responses

The Mediterranean Basin is recognised as one of the world's most important biodiversity hotspots, harbouring an exceptionally high proportion of endemic species. Though wetlands cover only a small share of the region's surface area, they support over a third of its biological wealth (CEPF, 2024). Yet recent findings from the Mediterranean Wetlands Observatory paint a worrying picture (Galewski et al., 2021): 40% of wetland-related species (i.e. species strictly associated with wetlands) assessed under IUCN Red List criteria are now classified as threatened, near-threatened, extinct, or data-deficient (***Indic. S2***).

All major taxonomic groups are affected, but the situation is particularly severe among freshwater gastropods, many of which are disappearing at an alarming rate.

Endemic species are especially at risk: nearly 70% are considered to be in a precarious conservation state, and over half are already listed as threatened or extinct. For many of these, a small group of countries, or even a single wetland, now holds the last remaining populations, as their distribution ranges are often highly localised.

The pressures affecting wetland biodiversity are well known: chronic water pollution, disruption of flood regimes through dam construction, excessive water abstraction, artificialisation of floodplains, climate change, invasive species, and poorly regulated hunting practices (***Indic. S2***). Each of these threats degrades habitats and reduces ecological resilience. When combined, they push environmental conditions beyond the tolerance thresholds of many specialised species.

Yet the situation is not entirely bleak. Long-term monitoring of wintering waterbirds between 1995 and 2022 shows encouraging signs where conservation efforts are in place (***Indic. S2***). Regional abundance indices have increased by around 43%, driven by the application of international legal frameworks such as the African-Eurasian Migratory Waterbirds Agreement (AEWA), the Ramsar Convention, and the EU Birds and Habitats Directives. However, the gains are not uniformly distributed: positive trends are evident in Algeria, France, Italy, and Spain, while populations remain stable or fluctuate in Morocco, Tunisia, Türkiye, and several Balkan countries. These contrasts reflect varying capacities to implement habitat management, enforce hunting regulations, and improve water quality.

Salmo peristericus, an endemic and endangered species of Lake Prespa (Albania, Greece, and North Macedonia).
© UNDP in Europe and Central Asia

5. Pathways for action: Towards sustainable and integrated wetland management

5.1. Protected Areas and the Ramsar network: Current status and gaps

The designation of wetlands under the Ramsar Convention has, for several decades, helped to highlight their ecological and cultural value. While Ramsar listing does not in itself constitute a strict legal protection measure, it serves as a catalyst, throughout drawing political attention, sparking local conservation initiatives, and often paving the way for more binding management tools (Geijzendorffer et al., 2019). In the Mediterranean context, where land, water, and biodiversity are under intense pressure, this visibility is a strategic asset. The Ramsar network currently includes 414 sites across MedWet countries (***Indic. R1***), reflecting international recognition of their importance. Yet significant gaps remain.

Despite this progress, only 36% of Mediterranean wetland habitats are currently included within protected areas, and just 7% benefit from a high level of legal protection (***Indic. R1***). In other words, the vast majority of these essential ecosystems still fall outside any effective regulatory framework, leaving them exposed to accelerated degradation. In some cases, Ramsar designation remains purely symbolic, without any operational measure or institutional backing to ensure ecological preservation. These designations can create a false sense of security, while failing to prevent urban encroachment, agricultural intensification, or excessive water abstraction.

The gap between recognition and protection is all the more concerning given that many key wetlands have yet to be included in the Ramsar network, despite their known importance for biodiversity (Popoff et al., 2021). A total of 161 wetlands of importance for waterbirds remain undesignated in the Mediterranean countries, mainly in the Middle-East and South-West Europe (***Indic. R1***). These often include temporary wetlands, floodplains, or coastal systems overlooked by traditional conservation strategies, yet essential to migratory species and ecological connectivity.

5.2. Restoring wetlands to revive ecological functions: Opportunities, legal frameworks, and levers for action

Recent mapping carried out for MedWet countries along the northern shore of the Basin (from Portugal to Türkiye) provides a clearer picture of areas with high potential for ecological wetland restoration (***Indic. R2***). It identifies more than 87,700 km^2 of potentially restorable lands, former wetland areas that have been converted to other uses but which would require relatively low effort to recover a degree of natural functionality. These zones, often consisting of farmlands (including abandoned fields), represent valuable opportunities for rapid, cost-effective restoration. In many cases, simply reconnecting to natural flood regimes, removing obsolete drainage infrastructure, or changing land management practices would be sufficient to reactivate ecological processes. This "restoration reservoir" offers a strategic entry point for launching large-scale action, with quick wins in biodiversity, water regulation, and climate mitigation.

At the same time, a survey conducted among wetland experts in 24 MedWet countries has already identified 224 priority restoration sites, covering nearly 4,000 km^2 of wetland habitat. Most are coastal marshes and lagoons degraded by urbanisation, tourism, or intensive agriculture (***Indic. R2***). Surprisingly, more than 80% of these sites are already listed under Natura 2000 and/or the Ramsar Convention, demonstrating that legal designation alone is not enough (***Indic. R1***). The real challenge now lies in translating these commitments into effective on-the-ground implementation.

This potential for action is unfolding within an evolving legal and policy context. In the northern Mediterranean, the European Union has strengthened its legal framework through the Water Framework Directive, the Habitats, Birds, and Floods Directives, and more recently the Nature Restoration Law adopted in 2024. The new legislation sets binding objectives: restoring 20% of degraded natural habitats by 2030, and 100% by 2050, via national restoration plans. In parallel, France's 2030 National Biodiversity Strategy aims to restore at least 25,000 km of rivers and associated wetlands. At the global level, instruments such as the Ramsar Convention, the UN Decade on Ecosystem Restoration, the Kunming-Montreal Global Biodiversity Framework, the Integrated Coastal Zone Management Protocol of the Barcelona Convention, and the Sustainable Development Goals all offer coordinated guidance to steer water, climate, and biodiversity policy towards greater restoration ambition. While many of these frameworks remain non-binding, they provide a coherent foundation for mobilising action.

This institutional momentum is increasingly supported by field-level projects that demonstrate the practical effectiveness of restoration as both a climate adaptation tool and a sustainable development strategy. In Spain, for example, wetland rehabilitation in the Albufera de València Natural Park has improved water quality while revitalising a local economy centred on sustainable agriculture and ecotourism. In France, the rewilding of part of former Camargue saltpans has strengthened coastal resilience to rising sea levels. In Venice, Italy, the creation of 2.2 km^2 of artificial wetlands now stores up to 1.8 million m^3 of water, helping to reduce flood risks. In Montenegro, community-led restoration of the Tivat Solila reserve has transformed a degraded site into a thriving wetland of international importance.

5.3. From designation to management: Strengthening implementation on the ground

While many Mediterranean wetlands today benefit from some designation statuses (particularly through the Ramsar and/or Natura 2000 networks), their actual protection too often remains theoretical. In 2024, only 47% of Ramsar sites in MedWet countries had a management plan, and just 33% had effectively implemented it (***Indic. R3***). This gap is particularly pronounced in the Maghreb, where designation efforts have been significant, but management capacities remain limited. The existence of a legal or regulatory framework, even advanced, is not sufficient. Sustainable conservation relies above all on concrete, planned, monitored, and funded actions. In this sub-region, the example of wintering waterbirds clearly illustrates this reality: populations of threatened species are significantly more abundant in sites where an operational management plan is in place. Similarly, data from the Natura 2000 network in EU-Mediterranean countries show that measures directly targeting wetland habitats allow bird communities to adapt more rapidly to the effects of climate change, compared to actions focused on species only.

One promising lever is the approach of Wetland Contracts, which emerged from the experience of River Contracts in France and Italy. By bringing together local authorities, farmers, users, associations, and institutions, these voluntary agreements establish a robust framework for local governance, based on a shared territorial vision and a concrete action plan. Their uptake is now spreading to the Balkans, the Maghreb, and the Middle-East, demonstrating their adaptability and potential for replication.

5.4. Towards sustainable water management: Efficiency, innovation, and integration

The sustainability of water management in the Mediterranean basin is now one of the key determinants of the future of wetlands. However, the results of ***Indic. R4*** reveal persistent imbalances between water withdrawals and the natural renewal capacity of resources, particularly in the southern and eastern countries of the basin. Water use efficiency remains low in these regions; especially in the agricultural sector, which accounts for the majority of consumption, despite critical water stress conditions. While countries such as Algeria, Egypt and Tunisia have invested in localised or automated irrigation systems, technical gains are often cancelled out by the simultaneous expansion of irrigated areas or the continued cultivation of highly water-demanding crops.

In response to this situation, improving efficiency must go hand-in-hand with a structural reduction in consumption. Modernising distribution networks, generalising water-saving agricultural practices, securing water volumes at the catchment scale, and better integrating the ecological value of wetlands into water allocation decisions are all essential steps. A significant share of wetland ecosystems are dependent on a minimum flow input which is now no longer guaranteed during low-water periods, or even throughout the year. Recognition of these ecological flows in water management plans remains far from fully implemented, and adaptive water resource management is still the exception rather than the rule.

In this context of scarcity, non-conventional water resources are emerging as complementary, potentially game-changing solutions, but they must be handled with care. The reuse of treated wastewater represents an effective way to reduce pressure on natural water bodies, particularly in urban areas, green spaces, recreational zones, and agricultural land. Today, more than 80% of wastewater in the Mediterranean Basin is still discharged without reuse. Yet countries such as Israel, Jordan, and Tunisia now reuse over 96% of collected volumes, mainly for agricultural purposes (***Indic. R4***). This solution helps secure water supplies for predictable uses, improves discharge quality, and reduces competition between users. In two-thirds of Mediterranean countries, a legal framework already exists, evidence of an ongoing structural shift.

Conversely, seawater desalination is generating increasing enthusiasm but raises serious concerns. This technology, already widely implemented in Algeria, Israel and Spain, is expanding in several countries across the basin. It offers a technical response to water scarcity, especially for urban uses. However, its ecological footprint is far from negligible. The process is highly energy-intensive, and large-scale deployment raises the issue of dependency on fossil fuels, or, alternatively, the high cost of low-carbon energy supply. Moreover, the discharge of concentrated brine into coastal waters can cause long-term disruption to nearby marine ecosystems, which are already weakened by coastal urbanisation, mass-tourism pressure, or eutrophication. Without strict regulation, desalination risks shifting pressure from freshwater to marine environments without structurally resolving the problem.

Case Study 5

Sebou Water Fund (Morocco): A sustainable financing mechanism for water and ecosystem management

The Sebou Water Fund (Morocco), launched in 2019, represents one of the first operational mechanisms in the Mediterranean region to finance conservation actions through a Payment for Ecosystem Services (PES) model. Developed through a partnership involving public authorities, local communities, civil society, and the private sector, it aims to improve water quality and availability in the Sebou basin, one of the country's most important watersheds, by funding upstream conservation and land restoration activities.

The fund is based on a simple principle: downstream users (such as water utilities, municipalities, and businesses) contribute financially to actions that protect the watershed at its source. These include reforestation, soil conservation, erosion control, and the promotion of sustainable agricultural practices, particularly in priority areas where degradation directly affects water flow and quality.

Managed by the NGO Living Planet Morocco, in coordination with the Sebou River Basin Agency and other local and national institutional partners, the Sebou Water Fund supports concrete projects that link ecosystem health with the sustainability of water resources. In its pilot phase, it financed several initiatives in the upstream catchments of the Baht and Middle Sebou sub-catchments, with positive impacts on soil stability, infiltration capacity, and local livelihoods. In 2024, the fund entered its second phase, with increased donor contributions and an expanded territorial scope, aiming to scale up its impact.

This innovative mechanism shows how NbS can be financed sustainably by aligning the interests of different stakeholders across a watershed. It also demonstrates the feasibility of developing PES schemes in North Africa, by combining scientific assessment, participatory governance, and targeted financial tools. The Sebou Water Fund offers a replicable model for other Mediterranean river basins seeking to reconcile ecological restoration with long-term water security.

Stakeholders from the Sebou Water Fund meet to co-design indicators for monitoring wetlands at the basin's scale (Fez, Morocco).

Sebou Water Fund Living Lab (Fes, Morocco) © LivingPlanetMorocco

6. Levers for action to reverse the trend

Despite the many warning signs highlighted in this report, the current trajectory is not irreversible. A transition remains possible, if the appropriate levers are mobilised at all levels: local, national, and regional. The challenge is twofold: to halt the degradation processes underway for several decades, and to build management models that integrate wetlands as key components of climate resilience, water security, and territorial cohesion.

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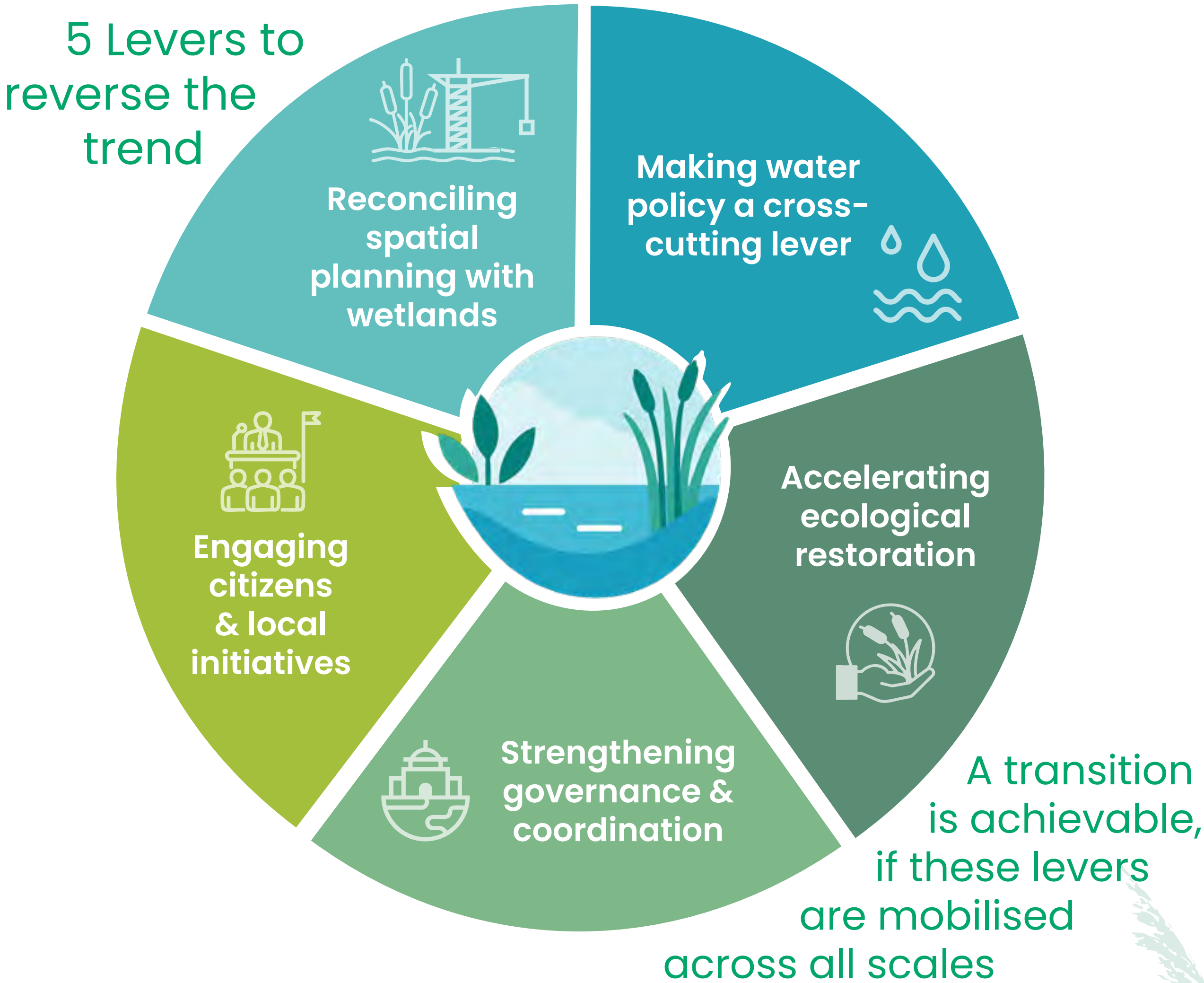

6.1. Reconciling spatial planning with wetland functioning

One of the major levers lies in aligning land-use planning policies with ecological dynamics. Even today, decisions relating to urban development, infrastructure or agriculture are often made in silos, without fully accounting for their consequences on Mediterranean wetland ecosystems. Yet these ecosystems require space, hydrological continuity, and fluctuation margins to function properly. This calls for moving beyond a logic of maximum land occupation and recognising the strategic value of wetlands in territorial planning.

This notably involves fully integrating wetlands into urban planning documents as natural infrastructure delivering Nature-based Solutions. No-build buffer zones must be established around sensitive areas, while soil artificialisation should be strictly limited. Infrastructure projects should consider cumulative impacts on ecological connectivity. Local authorities need better tools to design sustainable projects, particularly in coastal areas under growing demographic pressure. At the same time, targeted de-artificialisation strategies, such as restoring impermeable soils, re-meandering rivers, or reopening waterways that have been concreted over ('day-lighting'), can help recover critical hydrological functions. Lastly, riverine communities must be fully involved in spatial planning, with strengthened support for participatory governance.

6.2. Making water policy a cross-cutting lever for regulation

Rising tensions around water call for a fundamental rethink of sectoral trade-offs. Water can no longer be managed solely through a demand-driven lens - via network expansion, storage, or desalination - but must instead be governed according to the limits of natural resource renewal. This requires placing river basin management back at the centre of decision-making, regulating withdrawals during periods of stress, and recognising the ecological needs of wetland ecosystems.

It is imperative to move away from a residual allocation logic, where wetlands receive only what remains. Integrating environmental flows into water management plans, restoring hydrological connectivity, and coordinating human uses with ecosystem needs must become top priorities. This also means revisiting intersectoral water-sharing agreements and equipping water agencies with the tools and authority to enforce these decisions. Policies must equally foster innovation, such as treated wastewater reuse, water-saving practices, and integrated, territorial-based, and multisectoral resource management.

6.3. Accelerating ecological restoration and operationalising targets

The potential for wetland restoration in the Mediterranean is considerable, both in terms of area and the ecological, climatic, and socio-economic benefits it can deliver. Yet despite growing political commitments, tangible progress remains limited. An operational pathway must be implemented, starting with the prioritisation of sites that offer high ecological potential and low implementation barriers. This requires the mobilisation of planning and land-use tools compatible with ecosystem regeneration, the securing of long-term financing, and the strengthening of technical and institutional capacities among local stakeholders.

Restoration must go beyond habitat rehabilitation alone: it should aim to recover hydrological functions, enhance climate resilience, support biodiversity, and restore ecological connectivity. Innovative financing mechanisms such as Payments for Ecosystem Services, carbon markets, or ecological taxation must be fully explored. Finally, robust scientific monitoring and the active participation of local communities are essential to ensure the long-term sustainability of restoration efforts.

6.4. Strengthening territorial governance and regional coordination

Another key lever lies in governance. Institutional capacity gaps between MedWet countries are stark, and the fragmentation of responsibilities undermines the coherence of action. Yet wetlands can only be effectively protected if governance structures are robust, well-coordinated, and participatory.

The first step is to strengthen existing environmental institutions: by providing them with clear mandates, adequate resources, and improved cross-sectoral coordination. Local coalitions, including municipalities, NGOs, farmers, and water users, must be recognised as full stakeholders, capable of delivering pragmatic and innovative solutions.

Their efforts should be supported by stable mechanisms for funding, training, networking, and the promotion of good practices. At the regional level, cross-border cooperation, indicator harmonisation, the pooling of technical expertise, and joint financing are all key levers to build a shared governance framework.

6.5. Engaging citizens and supporting local initiatives

Finally, citizen engagement and strong local ownership are essential conditions for success. In many areas, riverine communities, farmers, associations, and researchers represent the first line of defence for wetlands. Their roles range from tackling local pressures (such as illegal killing, pollution, and overuse) to participating in ecological monitoring, supporting sustainable value chains, or engaging in ecological restoration.

These community-based dynamics must be supported through the creation of appropriate legal frameworks, decentralised funding mechanisms, technical assistance for project development, and regional knowledge-sharing networks. Environmental education, particularly targeting younger generations, must also be reinforced to foster deep cultural change. Coexistence between human societies and wetland ecosystems requires transparency in decision-making, fair recognition of local knowledge, and shared ownership of ecological transition goals

Wadi Mujib (Jordan) © Jennmaree photo/Envato

7. Conclusion: Towards a new deal between Mediterranean societies and wetlands

The findings of this report present an alarming but necessary statement: Mediterranean wetlands, despite their fundamental role in regulating water cycles, conserving biodiversity, and supporting territorial resilience, continue to face growing pressures that threaten their ecological integrity. For several decades, population growth, intensification of land and water use, soil artificialisation, overexploitation of water resources, and, more broadly, the effects of climate change have undermined some of the richest, yet most vulnerable ecosystems in the Mediterranean basin.

Beyond ecological loss alone, what is at risk is the capacity of Mediterranean societies to deal with the major crises they already face. Wetlands are critical natural infrastructure, delivering essential services such as flood regulation, water storage, natural purification, carbon sequestration, and the support of sustainable economic activities. Their degradation therefore exacerbates social tensions and weakens territorial resilience in the face of climate extremes.

This diagnosis calls for a strong response, which should go beyond sectoral or technical approaches to engage in a true ecological, territorial, and institutional transition. Such an evolution rests on four pillars: (i) better integration of wetlands into public policies, particularly in urban planning, agriculture, water, and climate; (ii) an ambitious acceleration of ecological restoration efforts, based on clear priorities and appropriate funding; (iii) more integrated governance, involving public authorities, local communities, civil society, and riverine populations; and (iv) enhanced regional cooperation to share knowledge, harmonise assessments, and support MedWet countries.

International and regional commitments now offer a favourable framework for this transformation: the adoption of the Nature Restoration Law in Europe, the United Nations Decade on Ecosystem Restoration, the goals of the Global Biodiversity Framework, and the development of the fifth Ramsar Strategic Plan. However, for these frameworks to yield tangible results, they must be translated into operational, funded, evaluated, and locally driven policies.

It is therefore urgent to act. Restoring, protecting, and enhancing wetlands is not an optional endeavour, it is a strategic solution for water security, climate change adaptation and mitigation, and territorial cohesion in the Mediterranean. This transition can only succeed through strengthened political will, collective mobilisation, and full recognition of the vital contribution wetlands make to the sustainable future of the Mediterranean Basin.

Ouzoud waterfalls (Morocco) © Akophotography/Envato

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Chebika oasis (Tunisia) © AlexVog/Envato

The indicators

List of the 18 DPSIR indicators used for the MWO-3

DPSIR	Trend	Indicators
DRIVERS		**D1.** Human demography
		D2. Future trends in temperature and precipitation
		D3. Structural factors influencing the condition of Mediterranean wetlands
PRESSURES		**P1.** Land artificialisation and agricultural intensification
		P2. Water availability and overexploitation of the resource
		P3. Threats to water quality
		P4. Climate change pressures on wetland biodiversity
		P5. Mean Sea Level Rise
STATE		**S1.** Extent of wetland habitats
		S2. Conservation status of Mediterranean wetland species
IMPACTS		**I1.** Drying of natural wetlands
		I2. Conversion of natural wetland habitats
		I3. Alteration of river ecological continuity
RESPONSES		**R1.** Wetlands protection
		R2. Wetlands restoration
		R3. Wetlands management
		R4. Sustainable use of water resources
		R5. Political commitment to wetlands and levers for action

Indicator
D1
Trend

DRIVERS

Human demography

The Mediterranean population grew by 38% between 1990 and 2020, reaching nearly 591 million inhabitants.

The population living in and around wetlands increased by 34%, from 298 to over 400 million people, with a density reaching 258 inhabit./km², four times higher than the regional average.

Demographic dynamics as a key driver of pressure on Mediterranean wetlands

Between 1990 and 2020, the Mediterranean region experienced a 38% population increase, rising from 426 to 590 million inhabitants. This growth was particularly concentrated in coastal areas, urban centres, and around wetlands. In these latter areas, the surrounding population grew by 34%, exceeding 400 million people, while density increased from 192 to 258 inhabit./km^2, nearly four times the regional average and twice as high as that of coastal zones (***Fig. 1***). This rapid densification reflects an increasing occupation of these fragile areas, which have convergence zones for urbanisation, agricultural development, and coastal settlement.

Far from being peripheral or marginal ecosystems, wetlands are now fully integrated into settled areas and are therefore subject to growing spatial and functional pressures.

Demographic growth thus emerges as a key driver of transformations affecting these ecosystems. Urban sprawl (***Indic. P1***), land conversion (***Indic. I2***), and overexploitation of water resources (***Indic. P2***) are all direct consequences of human expansion. These pressures compromise the essential functions of wetlands: flood regulation, water purification, carbon storage, biodiversity support, etc.

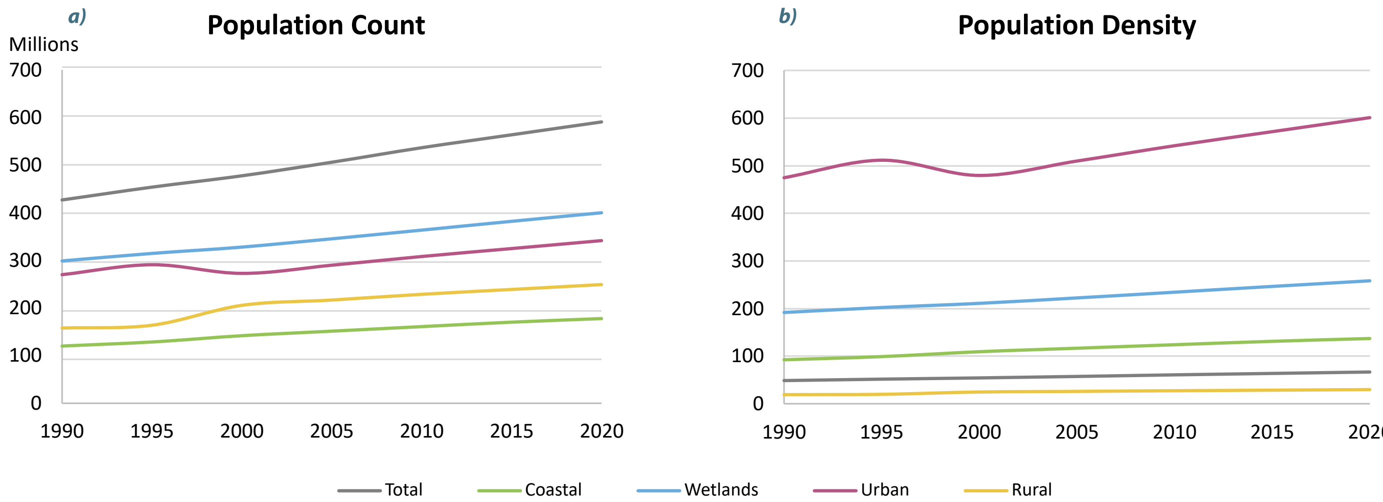

Fig. 1: Evolution of human population (a) and population density (b) in MedWet countries, 1990–2020.

MWO

Sub-regional trends

In South-Western Europe, demographic growth remained moderate, with a 12% increase over the period. However, pressure on coastal and wetland areas is extremely high: in 2020, coastal density exceeded 314 inhabit./km^2, and that around wetlands reached 237 inhabit./km^2. This sub-region has long been characterised by land artificialisation and significant ecological fragmentation. Given the already massive loss of wetlands, restoring these ecosystems is now a critical priority.

In the Balkans, the population has remained relatively stable, with a modest 8% increase over 30 years. In urban areas population has grown moderately, while rural territories have seen a gradual decline. Around wetlands, population density decreased slightly from 166 to 153 inhabit./km^2, indicating lower pressure compared to other sub-regions.

In the Middle East, population growth has been particularly marked (+67%), accompanied by rapid land artificialisation. In 2020, urban areas reached a density of over 1,160 inhabit./km^2. Around wetlands, density almost doubled, from 292 to 495 inhabit./km^2. In a sub-region already experiencing intense water stress, this high human concentration places wetlands at high risk of overexploitation of water resources, exposing their ecological integrity (***Indic. P2*** & ***Indic. I1***). In this context, the link between sustainable water management and wetland conservation is both direct and vital. Without significant changes in governance and resource use, the loss of these ecosystems could exacerbate already pronounced socio-economic tensions.

In the Maghreb, population growth has reached 59% since 1990, accompanied by rapid urbanisation. Urban density reached 637 inhabit./km^2 in 2020, while density around wetlands increased significantly from 93 to 157 inhabit./km^2 over the same period (+70%). In this context, poorly managed urban development is increasing the risk of overexploiting water resources and of irreversible wetland loss. Integrating conservation issues into spatial planning is essential to reverse current trends.

Future projections

Demographic growth in the Mediterranean region is gradually intensifying pressure on natural habitats, particularly wetlands, which now host a growing share of the population. These ecosystems, crucial for water regulation, climate mitigation and biodiversity, are facing accelerated degradation as a result of urban expansion, agricultural intensification, and the overuse of natural resources. Rising human density in these fragile areas increases competition for land use and amplifies the risks of artificialisation, fragmentation, and loss of vital ecological functions.

According to projections by the United Nations Department of Economic and Social Affairs, the total population of the Mediterranean basin could reach 660 million by 2050, and nearly 700 million by 2100. However, growth will not be uniformly distributed. As foreseen by Plan Bleu, the population in the northern shore of the basin is expected to decrease by around 10% by 2050, while it is projected to rise by 45% in the South and 30% in the East. This would mean a net gain of 125 million inhabitants in the South and a loss of 10 million in the North, resulting in three-quarters of the region's population living in the South and East by 2050. If these trends continue, pressure on wetlands, already intense, could increase significantly, threatening their long-term viability and worsening environmental, climate and socio-economic vulnerabilities for the populations who rely on them.

Seyhan River, Adana (Türkiye)
© Fatih Mehmet Şenel/Evanto

Annex

Method and reliability

Human demography constitutes a fundamental driver shaping pressures on Mediterranean wetlands. ***Indic. D1*** aims to capture the evolution of population size and density across the basin in order to provide an indirect assessment of the intensity and spatial distribution of anthropogenic pressures affecting these ecosystems. It is developed within the DPSIR framework adopted by the Mediterranean Wetlands Observatory (MWO), under the "Driver" component.

The indicator is based on two core variables: total population and population density (inhabitants/km^2), derived from the Gridded Population of the World, Version 4 (GPWv4) dataset. This global model provides georeferenced population estimates at a spatial resolution of approximately 1 km, based on harmonised national census data redistributed using an areal weighting approach. Population grids are aggregated to produce comparable calculations across different spatial units.

Analyses are conducted across multiple spatial scales. At regional and national levels, results are aggregated using the administrative boundaries of MedWet countries. Coastal areas are defined through a 100 km buffer applied to the shoreline, capturing the main zone of demographic concentration and associated pressures. The analysis of populations in relation to wetlands relies on the intersection between population data and the functional envelope derived from the mapping of Potential Wetland Areas (PWA). This approach makes it possible to account not only for mapped wetlands, but also for adjacent areas functionally connected to their hydrological dynamics.

The distinction between urban and rural areas is based on urban extent layers derived from the Global Rural-Urban Mapping Project (GRUMP), enabling a spatial differentiation of settlement patterns.

The analysis covers the period 1990-2020, with five-year intervals, ensuring temporal consistency. The reliability of the indicator is considered high for identifying medium- and long-term demographic trends and their spatial patterns. However, it is important to note that the underlying data rely on spatial modelling rather than direct high-resolution observations. As such, uncertainties may arise at finer scales, particularly in areas characterised by heterogeneous settlement patterns or limited census accuracy. Despite these limitations, the indicator provides a reliable basis for understanding demographic dynamics and associated pressure gradients on Mediterranean wetlands.

Data

Population data are derived from the global geospatial database Gridded Population of the World, Version 4 (GPWv4), which provides estimates of total population and population density in raster format at a spatial resolution of approximately 1 km. These estimates are based on harmonised national census data redistributed spatially using areal weighting methods, ensuring consistency across countries and over time.

The dataset covers the period 1990-2020, at five-year intervals. It is combined with the administrative boundaries of MedWet countries, a 100 km coastal buffer along the shoreline, the functional envelope of wetlands derived from Potential Wetland Areas (PWA), and urban extent layers from the Global Rural-Urban Mapping Project (GRUMP). This integration allows for the production of spatially explicit and comparable variables across regions and time.

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Agoulmim n'Ilker Lake, Akfadou (Algeria) © Benali Z.

Indicator
D2
Trend

DRIVERS

Future trends in temperature and precipitation

By 2100, average temperatures in Mediterranean countries could rise by +1.7°C to +5.2°C, and annual precipitation could drop by up to -30% in some parts of the Basin.

Mediterranean wetlands are becoming a key ally in tackling the impacts of these changes.

A clear rise in average annual temperatures

According to both observations and projections, the climate in the Mediterranean is warming faster than the global average. Climate models point to a widespread increase in average annual temperatures across the region by the end of the century, regardless of the socio-economic scenario considered (***Fig. 1***). This trend will have major implications for ecosystems, natural resources and human societies in the region.

By 2100, average annual temperatures are projected to be higher than today by +1.7°C under an optimistic scenario (SSP1-2.6), +4.2°C under an intermediate scenario (SSP3-7.0), and +5.2°C under a pessimistic scenario (SSP5-8.5). This increase will affect both annual minimum and maximum temperatures, compared to current values: +1.5°C (min) / +1.8°C (max) under SSP1-2.6, +4.1°C (min) / +4.4°C (max) under SSP3-7.0, and +4.4°C (min) / +5.4°C (max) under SSP5-8.5. Even under the optimistic scenario, Mediterranean countries will face a significantly warmer climate than today.

Warming will not be equally distributed across seasons. Temperature increases will be especially high in autumn (with average rises between +6.9°C and +11.7°C depending on the scenario) and in winter (+2.6°C to +6.2°C). In contrast, temperature changes in spring will be more moderate (-1°C to +2.7°C compared to the current period).

Summer temperatures will increase only slightly by +0.7°C under SSP1-2.6, but could reach +5.3°C under SSP5-8.5.

Climate projections also show slight geographic variations, with more intense warming expected in the eastern Mediterranean, particularly in the Balkans.

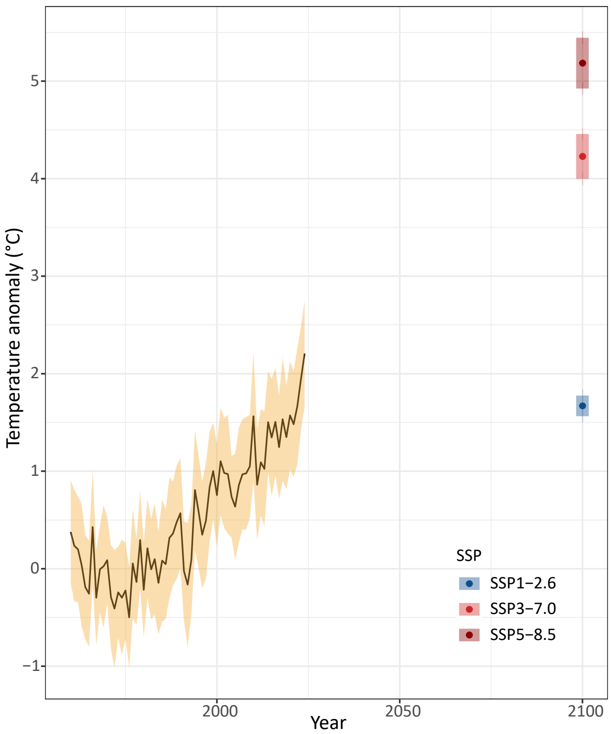

Fig. 1: Mean temperature anomalies (and standard deviations) for the current period (1960–2024) and projections for 2100, under scenarios SSP2-2.6, SSP3-7.0, and SSP5-8.5, across the Mediterranean basin.

MWO

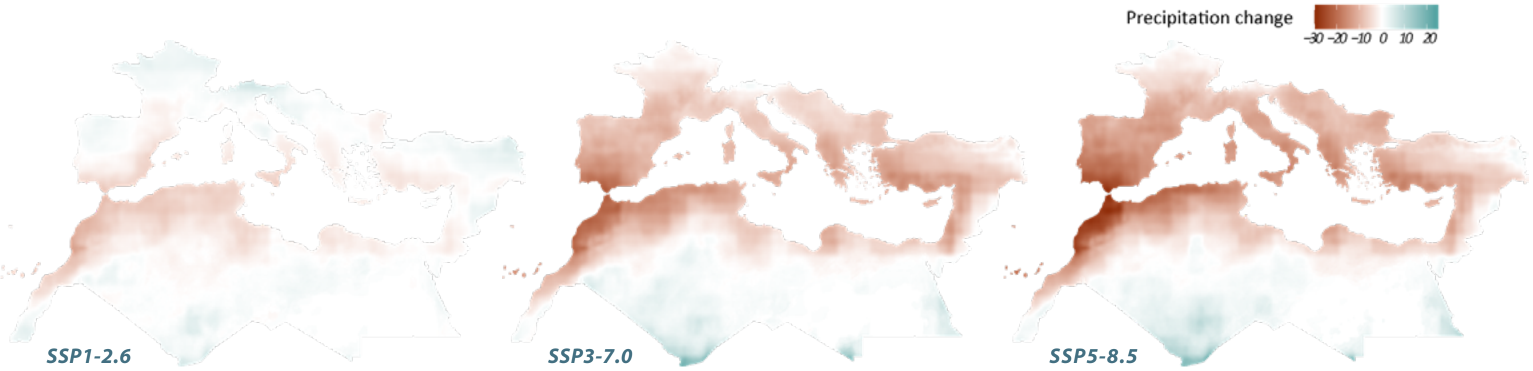

Fig. 2: Changes in precipitation (%) between 2100 and the current period, under scenarios SSP1-2.6, SSP3-7.0 and SSP5-8.5.

Contrasting trends in precipitation

Changes in precipitation will be much more contrasted spatially, regardless of the scenario (***Fig. 2***). Total annual rainfall across the Mediterranean Basin could decrease by 1% to 5%, with far greater deficits expected in the Maghreb and the Iberian Peninsula. In some western regions of the Basin, annual precipitation could drop by -30% under the SSP5-8.5 scenario.

Climate models also project shifts in seasonal rainfall patterns: moderate increases in spring (+13% to +17% depending on the scenario), significant rises in summer (+47% to +53%), but sharp declines in autumn (-24% to -28%). Winter precipitation is expected to remain stable (+2% to +3%).

A key role for Mediterranean wetlands in a changing climate

These seasonal and regional shifts will exacerbate irregular water inflows into Mediterranean wetlands, disrupting their hydrological functioning (***Indic. I1***) and threatening both biodiversity and the ecosystem services they provide (***Indic. P4***).

Paradoxically, while climate change and altered water cycles increase pressure on these habitats, their role is becoming more critical. As Nature-based Solutions, the conservation and restoration of wetlands are essential tools for both adaptation and mitigation: carbon storage, flood regulation, protection from marine submersion, groundwater recharge during droughts, and strengthening territorial resilience to extreme events.

Cracked mud in a dry lake (Spain)
© Fahroni/Envato

Annex

Method and reliability

Indic. D2 is classified under the "Drivers" component of the DPSIR framework used by the MWO. It aims to assess future climate trends in the Mediterranean Basin based on projections of temperature and precipitation, two key variables shaping the hydrological and ecological functioning of wetlands.

The indicator is based on climate projections derived from the Coupled Model Intercomparison Project Phase 6 (CMIP6). The analysis relies on spatially explicit climate datasets covering the entire Mediterranean Basin and considers three contrasted Shared Socioeconomic Pathways (SSPs): SSP1-2.6, SSP3-7.0 and SSP5-8.5 for the period 2071-2100. These scenarios represent a low-emissions pathway, an intermediate trajectory and a high-emissions pathway, respectively.

For each grid cell, monthly temperature and precipitation values are aggregated to derive two annual metrics: mean annual temperature, calculated as the average of the twelve months, and total annual precipitation, obtained by summing monthly values. Projected future values are then compared with current climatic conditions to estimate anomalies. Temperature changes are expressed in degrees Celsius relative to the reference period (1981-2010), while precipitation changes are expressed as relative variations (%) compared to the same baseline.

To reduce model-specific biases, projections are averaged across several global climate models. The results are subsequently aggregated at the Mediterranean Basin scale to provide regional estimates of temperature and precipitation changes. Additional analyses allow for the examination of seasonal patterns and spatial contrasts across sub-regions.

The overall reliability of the indicator is considered good at the Mediterranean scale. It is based on widely recognised climate models used in international assessments. However, uncertainties remain. Results depend on the socio-economic assumptions underlying the SSPs, and only the mean of model projections is considered, while variability across models, scenarios and variables may be substantial. Consequently, the results represent central tendencies rather than the full range of possible future conditions. In addition, the analysis focuses on annual averages and does not fully capture changes in extreme events or local hydrological processes, which are critical for Mediterranean wetlands.

Data

Climate projections used for ***Indic. D2*** are derived from the CHELSA database (Climatologies at High Resolution for the Earth's Land Surface Areas), version 2, based on CMIP6 simulations, with a spatial resolution of approximately 1 km at the equator.

The analysis focuses on mean annual temperature and total annual precipitation for a reference period (1981-2010) and a future period (2071-2100), under three contrasted scenarios: SSP1-2.6, SSP3-7.0 and SSP5-8.5. Projections correspond to the average of five global climate models (GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR, MRI-ESM2-0 and UKESM1-0-LL). Data are processed as raster grids covering the Mediterranean Basin and are used to compute temperature and precipitation anomalies relative to current conditions.

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Chebika Oasis (Tunisia)
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Indicator

D3

Trend

DRIVERS

Structural factors influencing the condition of Mediterranean wetlands

Development trajectories, growing water-related vulnerabilities and the heterogeneity of governance frameworks strongly influence the conservation status of Mediterranean wetlands. These structural factors, often interconnected, largely explain the pressures these ecosystems face and the differences in conservation responses between sub-regions.

This composite indicator assesses how national contexts influence the condition of Mediterranean wetlands. It is based on two key dimensions: (1) governance, including institutional stability and socio-economic conditions, and (2) systemic risks, particularly those affecting water resources.

Each dimension is constructed from a set of normalised variables, such as human development, political stability, population density and growth, water abstraction, climate vulnerability, and agricultural intensification. The data are drawn from international sources informed by national reports, and aggregated at country level to provide a comparative reading of the structural factors that either support or undermine wetlands across the Mediterranean Basin.

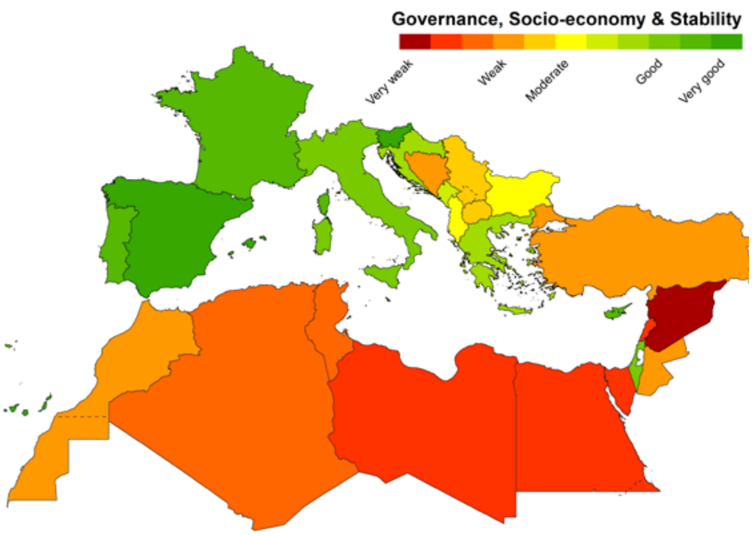

Fig. 1: Governance levels, including socio-economic and institutional stability, in Mediterranean countries (2023).

Governance, institutional stability and socio-economic context: persistent disparities

Institutional and socio-economic conditions vary significantly across Mediterranean sub-regions (***Fig. 1***), and these differences strongly shape each country's capacity to safeguard its wetlands. In South-Western Europe, countries benefit from established regulatory frameworks, relatively effective governance systems and active civil society engagement. These factors create a favourable environment for wetland protection, though land-use pressure and user conflicts remain major obstacles.

In the Balkans, the situation is more uneven. Some countries, particularly EU members, have relatively stable institutions and well-established environmental policies. Others are still in a transitional institutional phase. Civil society is becoming more active in many of these countries, but limited intersectoral coordination constrains the effectiveness of integrated wetland management efforts.

Governance in North Africa and the Middle East tends to be more fragile. Many countries face substantial economic and political constraints, with limited capacity for environmental action and national priorities often focused elsewhere. In several cases, wetlands have yet to gain full political recognition, despite recent steps towards creating dedicated institutions and policies.

Development policies: drivers of pressure on wetland ecosystems

The pressures affecting Mediterranean wetlands largely derive from development models that prioritise economic growth and land-use planning over ecosystem conservation. While often aligned with national priorities, such political choices are among the main drivers of wetland degradation.

Agricultural expansion (***Indic. P1***), actively supported by public policy in many southern and eastern countries, places substantial pressure on water resources and contributes to declining water quality through the intensive use of inputs. In the Balkans, the promotion of hydropower has led to widespread dam construction, altering hydrological regimes and disrupting natural connectivity with downstream wetlands. In the North, infrastructure and land planning policies have progressively artificialised wetland landscapes, reducing their extent and ecological function.

Across sectors, agriculture, energy, tourism or urban development, these policies tend to overlook the ecological requirements of wetlands. The lack of integration of wetlands into planning processes exposes them to multiple and persistent pressures.

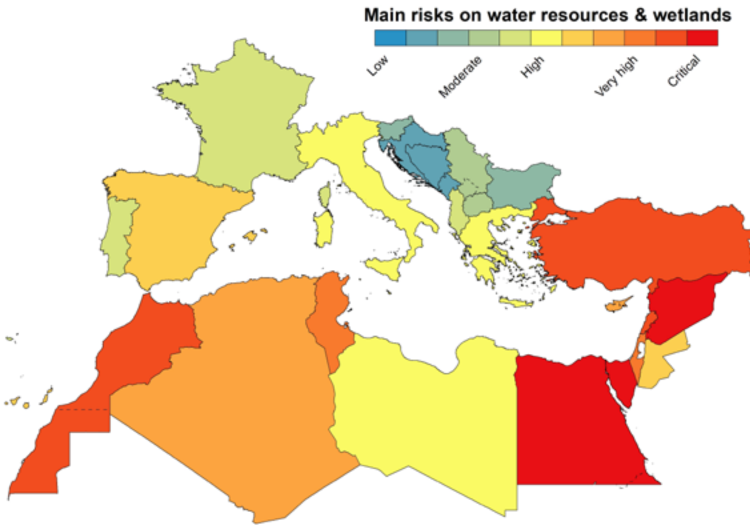

Fig. 2: Risk levels affecting water resources and wetlands in Mediterranean countries (2023).

Growing hydrological vulnerabilities

The condition of Mediterranean wetlands is strongly affected by mounting risks to freshwater resources (***Fig. 2***). In arid and semi-arid regions, notably in North Africa and the Eastern Mediterranean, pressures on water are particularly high (***Indic. P2***). Rising demand for agriculture, domestic consumption and urban growth is deepening imbalances, within an already fragile climate context (***Indic. D2***).

In the Balkans, where water availability is generally higher, the proliferation of hydropower infrastructures is significantly altering the natural dynamics of river basins. Downstream wetlands are becoming increasingly vulnerable, sometimes irreversibly, due to disrupted flow regimes and reduced ecological connectivity (***Indic. I3***).

South-Western European countries, while seemingly better equipped, are not immune to growing risk. Extended droughts, soil impermeabilisation and agricultural pressure contribute to increase vulnerability. The growing competition between users often leads to difficult and sometimes conflicting water allocation decisions.

Vacha Reservoir (Bulgaria)
© Sandsun/Evanto

Annex

Method and reliability

Indic. D3 is a composite "Drivers" indicator within the DPSIR framework, designed to assess the extent to which national contexts influence the condition of Mediterranean wetlands. It is based on two complementary dimensions: (1) governance, including institutional stability and socio-economic conditions, and (2) systemic risks, particularly those affecting the water resources on which wetlands depend.

The "Governance, institutional stability and socio-economic context" dimension is built from a set of normalised variables (scale 1-10), including Gross Domestic Product per capita, economic growth, the Democracy Index, the Human Development Index, political stability, perceptions and control of corruption, as well as indicators reflecting societal capacity such as civil society participation, civil liberties and political participation.

The "Systemic risks affecting water resources" dimension is based on similarly normalised variables describing factors likely to increase pressure on water resources. These include the contribution of agriculture to the economy, water withdrawals (total and per capita) and their share used for agriculture, demographic dynamics (density and growth, including around wetlands), vulnerability to climate change, water stress, riverine flood risk, and the availability of renewable freshwater resources per capita.

All variables were normalised on a common scale from 1 to 10 using global reference values specific to each variable, enabling cross-country comparability. Depending on the interpretation of each variable, transformations were applied either directly or inversely to ensure internal consistency. The harmonised variables were then aggregated using a simple arithmetic mean, without weighting, within each of the two dimensions to produce synthetic country-level scores. These results provide a comparative reading of structural contexts that may enhance or, conversely, undermine the resilience of wetlands across the Mediterranean Basin.

The reliability of the indicator is considered moderate to good. However, it should be interpreted with caution, as the underlying data are primarily derived from international datasets based on heterogeneous national sources, which may introduce comparability biases between countries. Some variables are themselves composite indicators or model-based estimates, and therefore subject to methodological uncertainties. Uneven data availability, particularly in politically unstable contexts, may also affect the robustness of regional comparisons. Finally, the indicator reflects structural conditions rather than the ecological status of wetlands themselves, and should therefore be interpreted alongside other indicators within the DPSIR framework of the MWO. Despite these limitations, it provides a useful tool for identifying regional gradients of vulnerability and for contextualising the pressures affecting Mediterranean wetlands.

Data

The data used to build ***Indic. D3*** are drawn from recognised international statistical databases, including the World Bank, the United Nations Development Programme (UNDP), Freedom House, Transparency International, FAO AQUASTAT and the World Resources Institute. These sources cover a wide range of domains, including socio-economic indicators, governance, demography, water resources and climate-related risks.

Variables were collected for all MedWet countries using recent reference years (mainly 2020-2024), then harmonised and normalised using a common scale to ensure comparability. The results were aggregated at the national level to produce synthetic metrics enabling comparative analysis across the Mediterranean Basin.

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Gediz Delta, Izmir (Türkiye)
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Indicator
P1

Trend

PRESSURES

Land artificialisation and agricultural intensification

Between 2000 and 2020, impermeable surfaces around Mediterranean wetlands increased by 44%, while agriculture, covering 30% of their functional area in 2020, intensified particularly in Türkiye, Spain, France, and Algeria.

These dynamics have led to a 9% decline in vegetated wetland habitats across the Basin.

Soil sealing: the main driver of land use changes in the Mediterranean

The conversion of natural habitats into agricultural land or built-up areas is one of the main pressures on Mediterranean wetlands. This process not only leads to habitat loss and degradation but also disrupts the ecological functions essential for maintaining the services provided by these ecosystems.

Across Mediterranean countries, soil sealing through urban sprawl, transport infrastructure, and the expansion of industrial or commercial zones has highly increased in recent decades, +34% between 2000 and 2020. This is by far the main driver of land use changes over this period (***Fig. 1***).

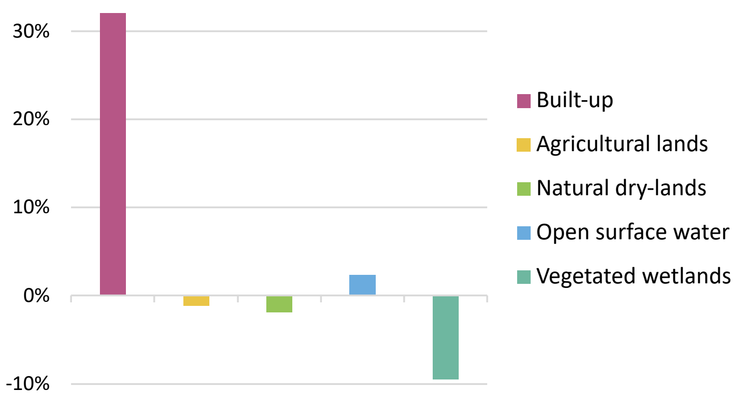


Fig. 1: Changes of main land use categories between 2000 and 2020 in Mediterranean countries (%).

Agriculture in transition

During the same period, agricultural land declined moderately across the Basin (-1%). However, this relative stability hides more complex dynamics. Over the two decades analysed, more than 114,600 km² were newly brought under cultivation, mostly at the expense of natural areas other than wetlands such as forests, scrubs, natural grasslands and steppes. This agricultural expansion was counterbalanced by two opposite trends: urban sprawl at the detriment of arable lands, and agricultural abandonment leading to the natural regeneration of some plots, particularly in South-Western Europe.

In addition, despite the slight net reduction in agricultural surfaces, the intensification of farming practices, notably through increased irrigation (***Fig. 2***), has also contributed to the degradation of natural resources vital to wetland ecosystem functioning, especially water. This leads to indirect impacts on wetlands, by reducing water availability due to excessive water abstraction (***Indic. P2*** & ***Indic. I1***) and/or degrading its quality through the overuse of agrochemicals (***Indic. P3***).

MWO

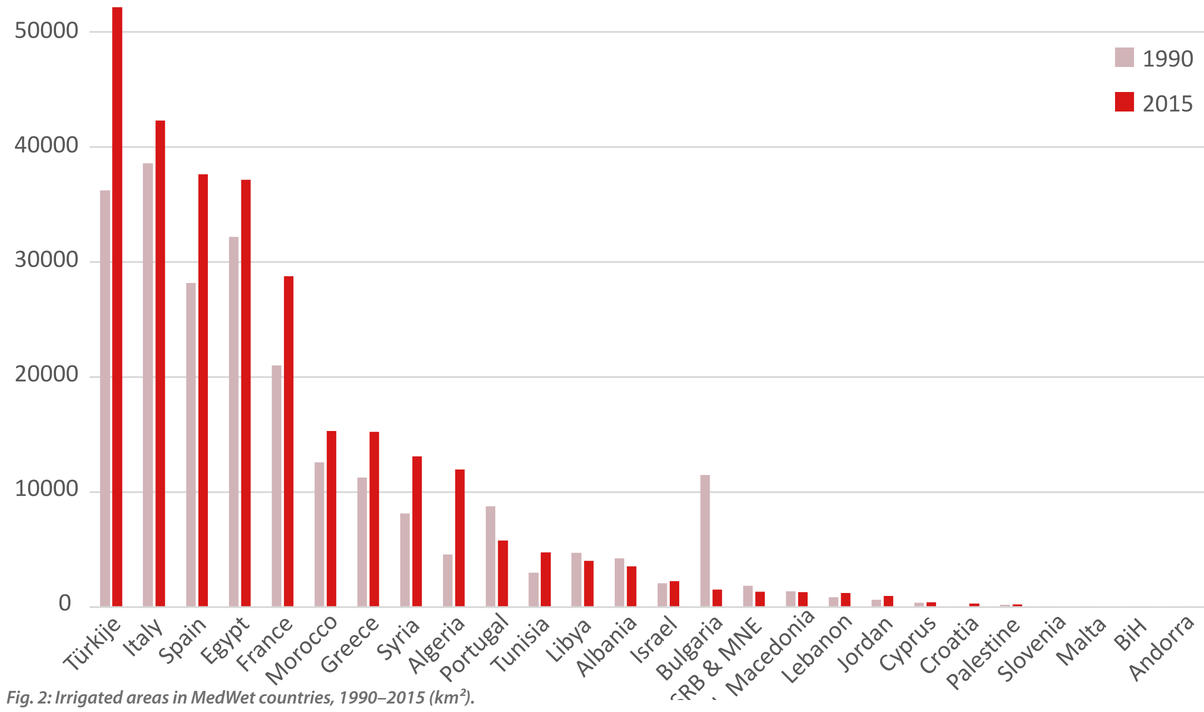


Fig. 2: Irrigated areas in MedWet countries, 1990–2015 (km²).

Wetland habitats: artificial gains, natural losses

At the Mediterranean scale, open water surfaces increased by 2% over the study period, largely due to the construction of new artificial reservoirs (***Indic. P2***). However, this upward trend does not necessarily reflect an improvement in the status of natural wetlands. Reservoirs are often created at the expense of natural wetland habitats (***Indic. I2***), and they also fragment rivers and heavily impact their ecological continuity (***Indic. I3***).

Although urban expansion and agricultural growth mainly affected natural dry-land habitats (with a 2% loss), the most significant regression between 2000 and 2020 concerns vegetated wetland habitats, which declined by 9%. Although these habitats do not represent all natural wetlands in the Mediterranean Basin, this decline is worrying and threatens key ecosystem services such as flood regulation and carbon storage.

Trends around wetlands

Within the functional area of wetland ecosystems (***Indic. S1***), cultivated land decreased by 3% since 2000, with wide regional disparities: a marked decline in South-Western Europe (-7%) and the Balkans (-6%), relative stability in the Middle East (-1%) and a sharp increase in the Maghreb (+11%), particularly in Libya (+21%), Algeria (+14%), and Tunisia (+13%). Despite this overall decline, agriculture remains the main pressure on Mediterranean wetlands, covering nearly 30% of their functional area in 2020, with particularly high levels in the Balkans (77% in Serbia, 62% in Greece).

Built-up areas cover an average of 9% of the wetlands functional space, and this has increased by 44% since 2000, especially in South-Western Europe. This trend is of particular concern, as restoring wetlands converted into built-up areas is far more difficult and costly compared to conversions into crops (***Indic. R2***).

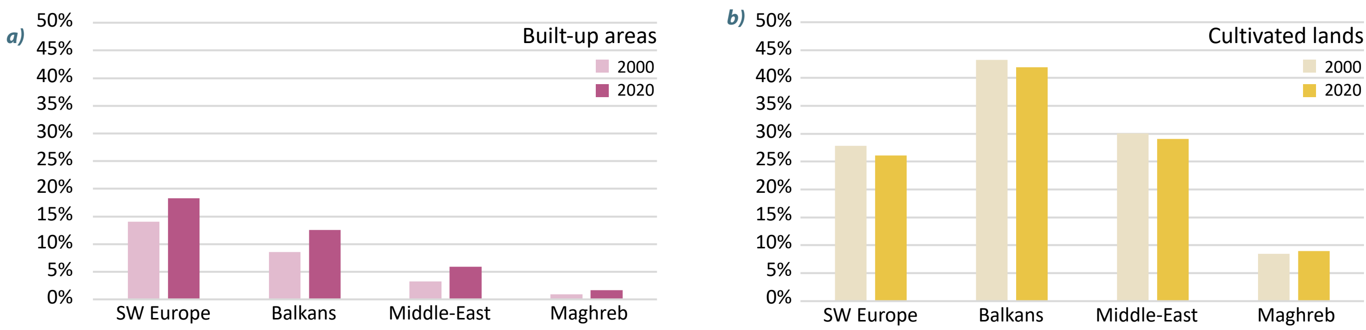
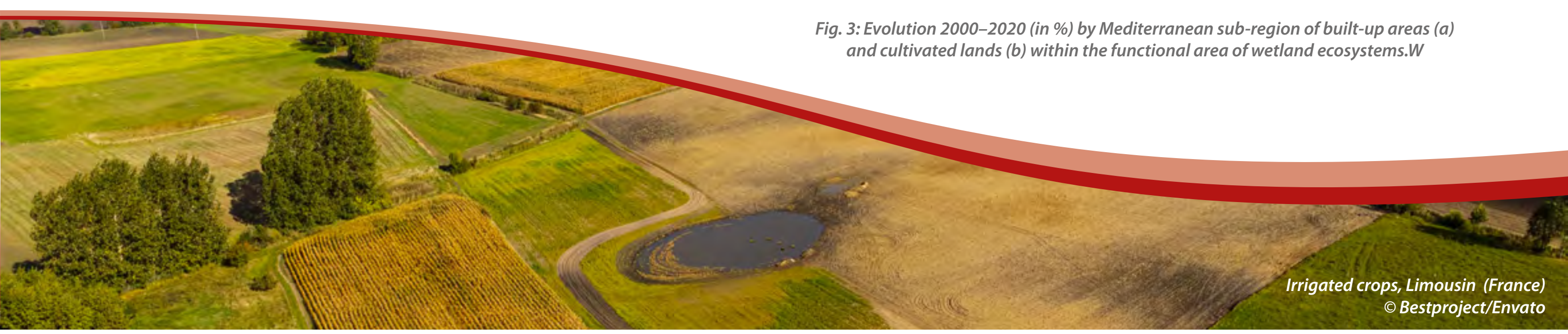


Fig. 3: Evolution 2000–2020 (in %) by Mediterranean sub-region of built-up areas (a) and cultivated lands (b) within the functional area of wetland ecosystems.W



Irrigated crops, Limousin (France)
© Bestproject/Envato

Annex

Method and reliability

Indic. P1 falls under the "Pressures" component of the DPSIR framework adopted by the MWO. It aims to characterise land artificialisation and agricultural intensification dynamics that exert pressure on Mediterranean wetland ecosystems. The approach is based on a spatial analysis of land use change combined with the identification of areas functionally associated with wetlands.

Changes in the main land use categories between 2000 and 2020 were assessed using the global Land Cover and Land Use Change (LCLUC) dataset derived from Landsat time series. These data allow the identification of transitions between different land uses, including the expansion of built-up areas, agricultural conversions, and variations in surface water, at a spatial resolution of 30m, suitable for regional-scale analyses of land use dynamics. Classifications rely on machine learning methods applied to multi-temporal spectral metrics derived from the Landsat archive, ensuring consistent and comparable mapping over time.

To better capture pressures affecting wetland ecosystems, the analysis was restricted to their functional space, defined using the Potential Wetland Areas (PWA) layer developed by the MWO. This hydro-geomorphological approach identifies areas with a high probability of wetland occurrence by combining environmental variables such as topography, hydrological indices, and climatic conditions. Land use dynamics were then analysed within this functional envelop to detect changes likely to affect the hydrological and ecological functioning of wetlands.

Agricultural intensification is assessed through changes in irrigated areas, considered as an indirect proxy of pressure on water resources. The analysis combines global spatial datasets on irrigation with national statistics to capture regional trends in the expansion and modernisation of irrigation systems.

The reliability of the indicator is considered good for assessing trends at the Mediterranean basin scale. It is based on the use of consistent satellite observations and scientifically validated classification methods. However, uncertainties remain at the local scale, particularly due to the thematic resolution limits of LCLUC maps and the variability of national statistics on irrigation practices. Despite these limitations, the indicator provides a robust basis for characterising pressures related to land use changes and agricultural intensification on Mediterranean wetlands.

Data

The analysis primarily relies on the global Land Cover and Land Use Change (LCLUC) 2000-2020 dataset developed by the Global Land Analysis and Discovery Lab at the University of Maryland. Derived from Landsat archives, this product provides bi-temporal land cover maps at a 30m spatial resolution, enabling the detection of changes in agricultural areas, built-up land, and surface water.

The delineation of wetlands functional space is based on the Potential Wetland Areas (PWA) layer produced by the MWO. This layer is derived from a hydro-geomorphological model combining topographic variables from the Copernicus DEM90 and climatic variables from the WorldClim database.

Agricultural intensification is further characterised using the Global Area Equipped for Irrigation 1900-2015 dataset, complemented by national statistics from the FAO AQUASTAT system, which documents water use by sector and irrigated areas at the country level.

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Olive groves in the Middle-Atlas (Morocco) © Przemekklos/Envato

Indicator

P2

Trend

PRESSURES

Water availability and overexploitation of the resource

Driven by demographic pressure and the impacts of climate change, water availability per capita has dropped by 40% over the past 30 years in the southern and eastern Mediterranean.

Agriculture uses 2/3 of total water abstractions, the surface area of artificial reservoirs has increased by 25% since 1990, and the overall water demand could triple by 2050.

Unequal distribution of a declining resource

The Mediterranean region is experiencing a sharp increase in water demand (***Fig. 1a***), linked to population growth (***Indic. D1***) and changing production and consumption patterns. This demand is leading to pressures on a resource that is very unevenly distributed: the northern Mediterranean hosts 36% of the population but holds over 70% of renewable water resources, compared with only 20% for the East (24% of the population) and less than 10% for the South, where 40% of the region's population lives.

In the Maghreb and the Middle East, water availability per capita has dropped by 40% in 30 years, with reductions exceeding 50% in Jordan and Palestine (***Fig. 1b***). Despite this growing scarcity, water abstraction continues to rise, particularly in Algeria, Egypt, Syria, and Türkiye, already among the region's largest consumers, thereby increasing pressure on limited resources to the detriment of the ecological functioning of wetlands (***Indic. I1***).

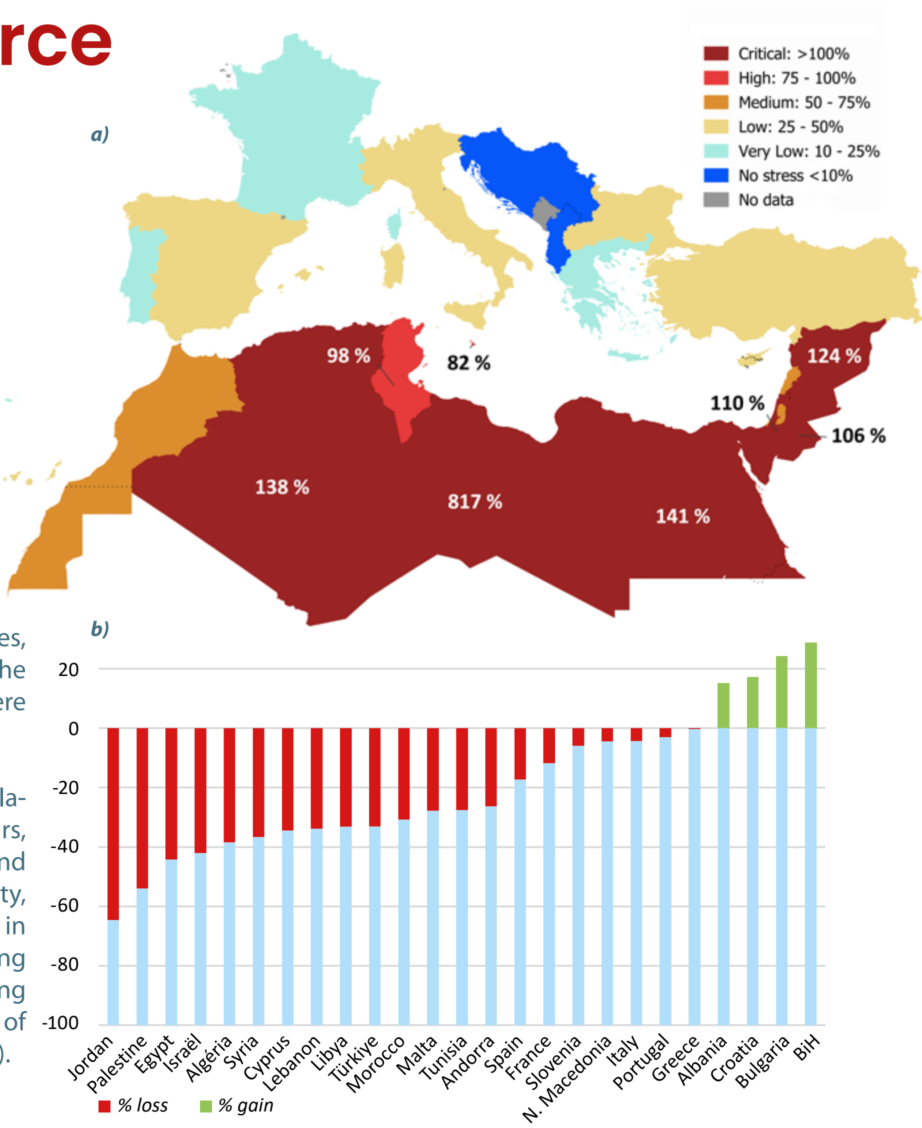

Fig. 1: Water stress in Mediterranean countries in 2020 (a) and trends in per capita renewable freshwater resources, 1992–2020 (b).

MWO

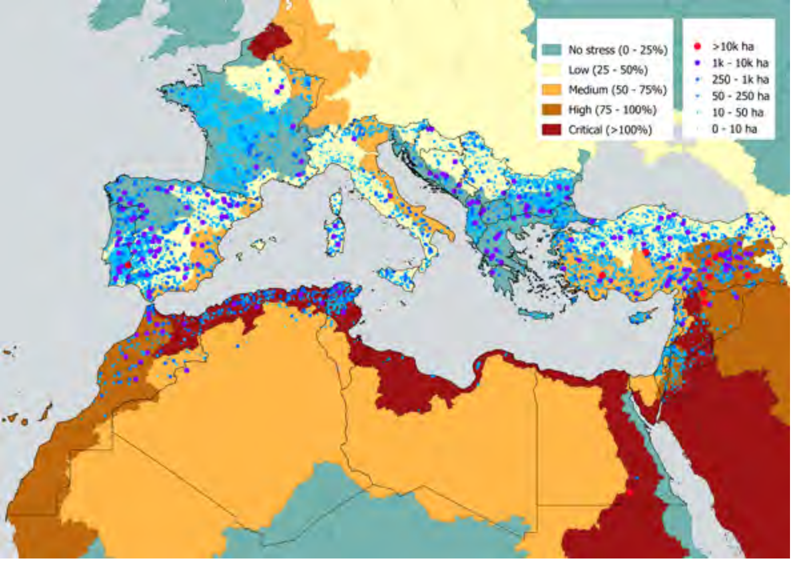

Fig. 2: Water stress levels in main Mediterranean river basins and distribution of artificial reservoirs (2020).

Continued increase in artificial reservoirs

In response to rising water demand, the construction of artificial reservoirs has intensified since the 1990s, with a 25% increase in surface area (from 14,800 km^2 to 18,500 km^2). Their combined storage capacity now exceeds 500 km^3, nearly double the annual volume of freshwater flowing into the Mediterranean from rivers (estimated at around 300 km^3 in 2000 and steadily declining since the 1960s). These infrastructures significantly disrupt the ecological continuity of rivers (***Indic. I3***) and greatly reduce freshwater inflows to wetlands (***Indic. I1***), ecosystems already highly vulnerable to climate change (***Indic. P4***).

The geographic distribution of these reservoirs remains unequal (***Fig. 2***). The northern shore, particularly Spain, France, Italy, and Türkiye, concentrates the majority of infrastructure, some with extensive surface areas. Morocco and Syria also have significant reservoirs, while Egypt's Aswan Dam remains an exceptional case due to its dimensions.

The development of artificial reservoirs has accelerated in the Maghreb and Middle East since 1990 to meet the needs of intensive agriculture (***Indic. P1***) and growing populations (***Indic. D1***). In Spain, Portugal, and Türkiye, the trend continues, while the Balkans are seeing the emergence of numerous hydroelectric projects.

Irrigated agriculture: A major driver of water pressure

In Mediterranean countries, two-thirds of all water abstraction is used for agriculture (***Fig. 3***). While the Balkans and France channel more water to industry, energy, or domestic uses, most countries prioritise irrigation. Since the mid-20th century, agricultural water withdrawals have doubled, linked to the expansion of irrigated land which exceeded 282,000 km^2 in 2015, or a quarter of the total cultivated lands in the region (***Indic. P1***). The shift from rain-fed to irrigated farming often involves intensifying production of high-value crops that require more water. In most MedWet countries under water stress, irrigation is the main pressure on water resources.

Despite its dominant share, irrigation remains inefficient due to outdated infrastructure and unsuitable technologies, causing major water losses (***Indic. R4***). If current trends continue, water abstraction could double by 2050 in the southern and eastern parts of the region, or even triple under the effects of climate change. According to MedECC, total water demand could rise by 26% to 92%, with 4% to 18% due to climate change and 22% to 74% linked to population growth and tourism. Sea level rise is also expected to increase irrigation water salinity in coastal areas, with salinity levels potentially tripling in some locations (***Indic. P5***).

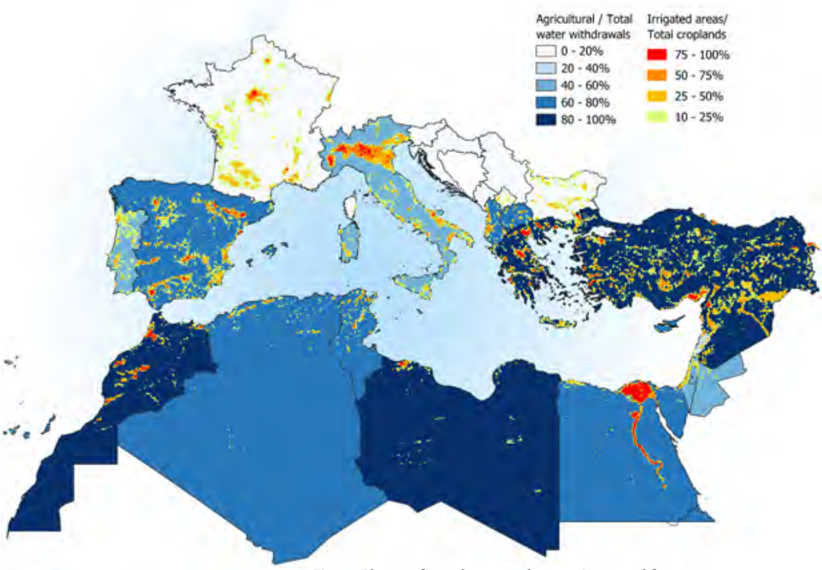

Fig. 3: Share of total water abstraction used for agriculture and distribution of irrigated lands.

El Charco del Cura Reservoir (Spain)
© Cristian Blaz Mar

Annex

Method and reliability

Indic. P2 falls within the "Pressures" component of the DPSIR analytical framework used by the MWO. It aims to characterise the intensity of pressures exerted on water resources across the Mediterranean Basin and their implications for the hydrological functioning of wetlands.

The indicator is based on a combined analysis of several variables that capture the dynamics of water resource use: trends in renewable water availability per capita, water abstraction volumes and their sectoral distribution, the expansion of irrigated areas, and the development of water storage infrastructure. This integrated approach combines hydrological, socio-economic and land-use metrics in order to identify the main drivers of pressure on water resources.

Water availability is estimated by dividing the total volume of renewable freshwater resources by the national population, expressed in m^3/capita per year. This variable is calculated by relating a country's total renewable water resources to its population for a given year. Its temporal evolution provides insight into trends of increasing scarcity or relative improvement, particularly in relation to demographic growth, climatic variability and changes in water use.

The intensity of water use is further assessed through abstraction volumes and their distribution across major sectors (agriculture, domestic uses, industry and energy). Particular attention is given to irrigated agriculture, which accounts for the largest share of water withdrawals in the Mediterranean region. Changes in irrigated areas are therefore used as an indirect proxy for increasing water demand.

Finally, the indicator incorporates an assessment of the development of hydraulic infrastructure, particularly dams and artificial reservoirs. These structures significantly alter natural hydrological regimes by regulating flows and redistributing water within catchments. As a result, they can reduce freshwater inputs to wetlands and disrupt river ecological continuity.

The reliability of the indicator is considered good to high for analysing regional trends. Data on dams and artificial reservoirs, as well as their evolution between 1990 and 2020, are derived from analyses conducted by the MWO using Earth Observation (EO) data, notably time series of Landsat TM and Sentinel-2 satellite imagery covering the two annual hydrological periods considered. However, some limitations should be acknowledged. Statistics on water abstraction and irrigated areas rely primarily on national datasets, whose collection methods may vary between countries. In addition, the analysis is conducted mainly at the national scale, which may mask significant variations between river basins within individual countries.

Data

The analysis primarily relies on the global Land Cover and Land Use Change (LCLUC) 2000-2020 dataset developed by the Global Land Analysis and Discovery Lab at the University of Maryland. Derived from Landsat archives, this product provides bi-temporal land cover maps at a 30m spatial resolution, enabling the detection of changes in agricultural areas, built-up land, and surface water.

The analysis draws on several international and regional databases relating to water resources, sectoral water use and hydraulic infrastructure.

Data on renewable water resources, abstraction volumes and sectoral distribution primarily originate from the FAO AQUASTAT database, which provides the main harmonised global dataset on water resources and water use. These data are complemented by statistics from international organisations and regional assessments of water resources in the Mediterranean. Information on irrigated areas is also sourced from AQUASTAT, alongside regional syntheses on irrigated agriculture across the basin.

Data on artificial reservoirs and their spatial evolution are based on analyses carried out by the MWO using time series of Landsat TM and Sentinel-2 satellite imagery, enabling the identification, delineation and monitoring of these infrastructures between 1990 and 2020.

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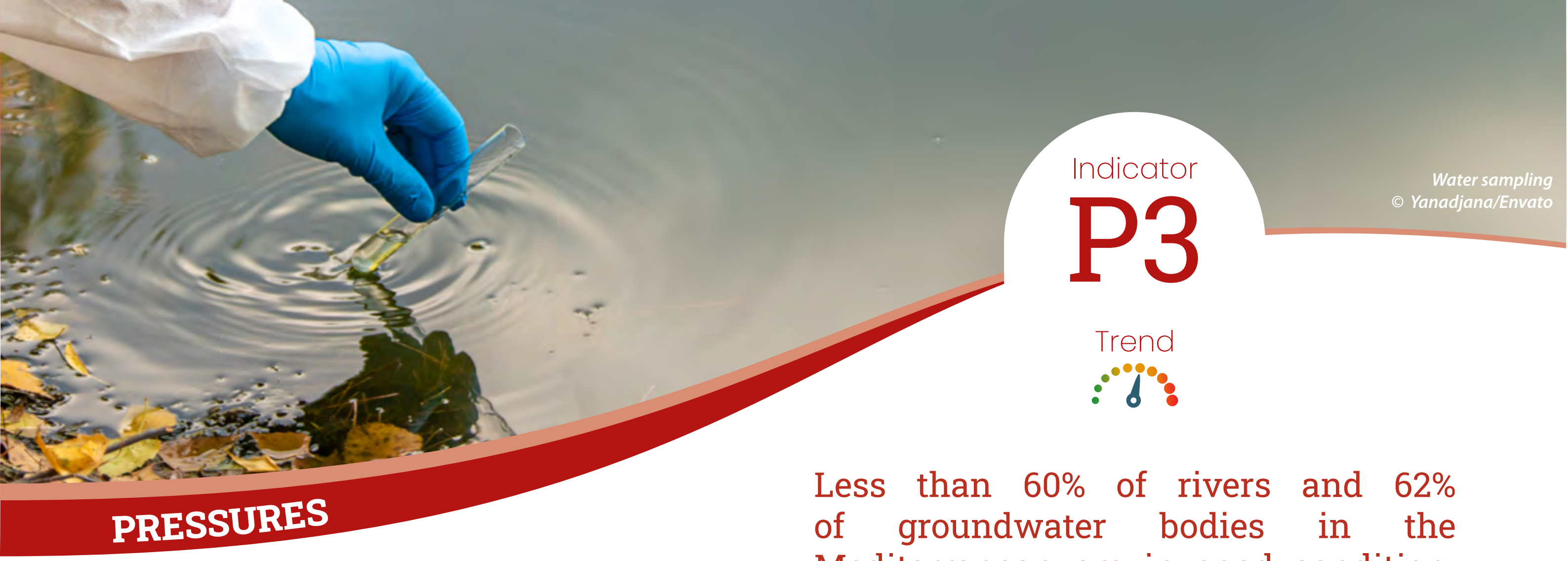

Water sampling
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PRESSURES

Indicator

P3

Trend

Threats to water quality

Less than 60% of rivers and 62% of groundwater bodies in the Mediterranean are in good condition. In some countries (Spain, Bulgaria, Lebanon), this figure falls below 40%.

Only 63% of wastewater is treated in southern Mediterranean countries, while pesticide use exceeds global averages in over one-third of the region's countries.

Diffuse pollution: a persistent threat to wetlands

Water quality is critical to the ecological integrity of Mediterranean wetlands. Despite progress made, particularly through the Water Framework Directive (WFD) in EU Member States, many pressures persist, continuing to impact the chemical and biological quality of aquatic ecosystems.

Diffuse pollution, mainly from agricultural runoff rich in fertilisers and pesticides, as well as atmospheric deposition, remains a major source of degradation. In several countries of South-Western Europe and the Balkans (Spain, Italy, Bulgaria, Portugal, Malta), more than half of groundwater bodies are in poor condition, particularly due to high nitrate concentrations. While data are more limited for the Maghreb and the Middle East, available information points to similar trends.

Nutrient inputs (nitrogen and phosphorus) have decreased over the past two decades in the northern part of the Basin but increased in the South and East, driven by agricultural intensification, urbanisation and industrial development. Nevertheless, coastal water bodies in the northern Mediterranean remain among the most heavily polluted.

More than one-third of MedWet countries exceed global averages in pesticide and fertiliser use per hectare. The most vulnerable ecosystems, such as lakes, rivers, lagoons, estuaries and coastal marine waters, are particularly exposed to eutrophication risks due to nutrient overloads.

Water quality remains insufficient in many countries

Since 2017, a harmonised indicator has been used to monitor the quality of water bodies in relation to the Sustainable Development Goals (SDGs). The available data reveal a concerning situation across much of the Mediterranean region (***Fig. 1***). In several countries, less than 40% of water bodies are in good ecological condition, including Albania, Bosnia and Herzegovina, Bulgaria, Spain and Lebanon. Other countries, such as Italy, Serbia and Portugal, perform slightly better, with 40% to 60% of water bodies classified as being in good status. North Macedonia, Morocco and Türkiye show more encouraging results, with 60% to 80% of water bodies in good condition. Lastly, countries such as Croatia, France, Jordan and Tunisia stand out with over 80% of their water bodies meeting the good quality threshold.

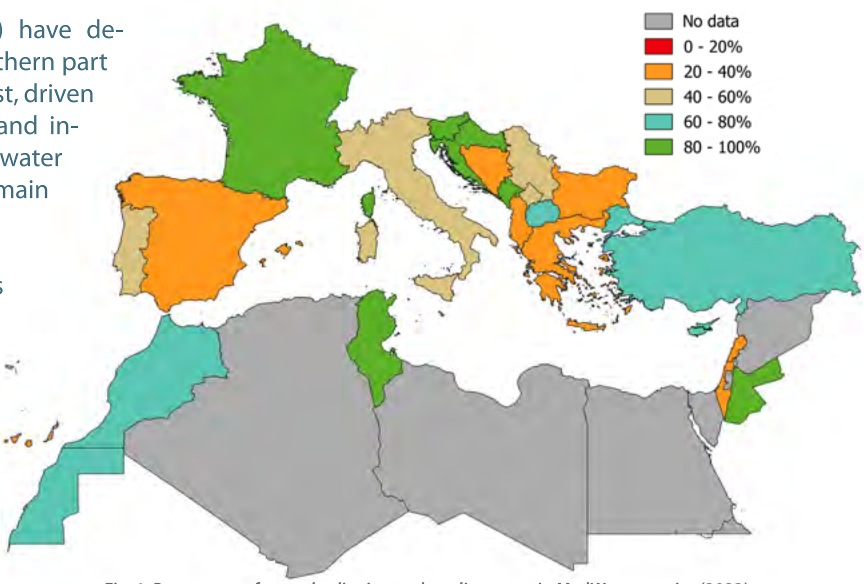

Fig. 1: Percentage of water bodies in good quality status in MedWet countries (2023).

MWO

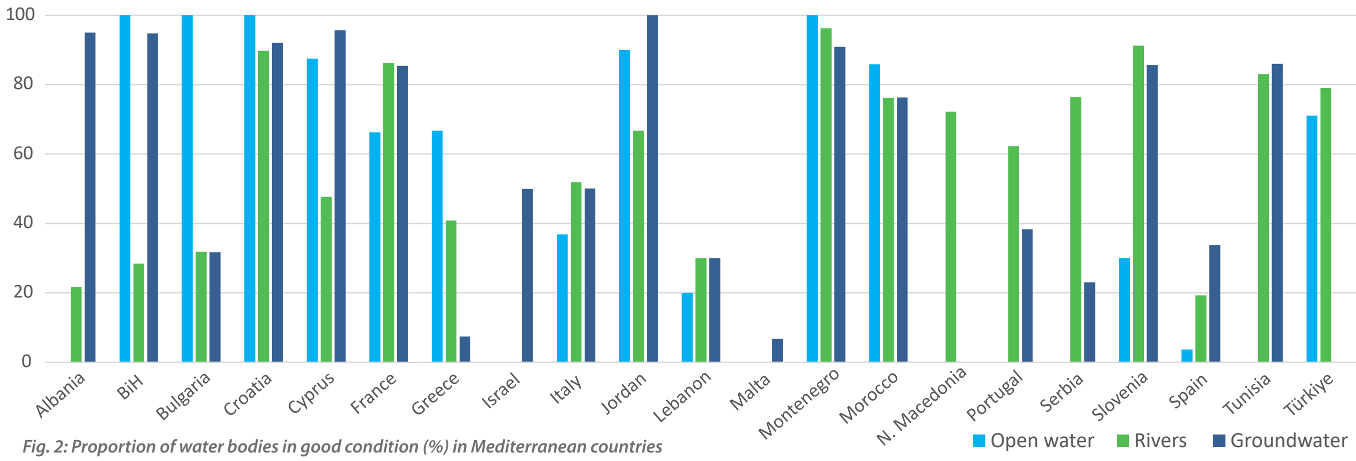

Fig. 2: Proportion of water bodies in good condition (%) in Mediterranean countries in 2023, based on SDG indicator 6.3.2.

The available data highlight a marked heterogeneity in water quality across Mediterranean countries (***Fig. 2***). On average, only 60% of rivers and 62% of groundwater bodies are in good condition, compared to 68% for standing surface waters (lakes, coastal lagoons, artificial reservoirs, etc.). Countries such as Croatia, Jordan and Montenegro report better results, often exceeding 85% across all water categories. In contrast, significant deficits are observed in several countries in the northern and eastern parts of the basin, including Bulgaria, Spain, Italy and Lebanon, where less than half of water bodies meet good ecological standards, especially rivers. These differences reflect varying levels of pressure on aquatic systems, differing wastewater treatment capacities, and disparities in water management effectiveness (***Indic. R4***).

Furthermore, monitoring programs reveal the growing presence of emerging pollutants in aquatic ecosystems: PFAS, PCBs, pharmaceutical residues, nanoparticles, the effects of which remain poorly known. These substances, along with heavy metals such as mercury and cadmium, are frequently detected, particularly in areas under high agricultural or industrial pressure.

These forms of pollution affect biodiversity and the functioning of ecosystems. Despite some local improvements, a large share of Mediterranean water bodies still fail to meet the criteria for good ecological status, underlining the need to strengthen pollution reduction efforts and integrated water management at the river basin scale.

Hydrological alterations and impacts on water quality

Water quantity and quality issues, long treated separately, are now recognised as closely linked. In the Mediterranean, hydromorphological changes and excessive abstraction (***Indic. P2***) are disrupting the natural water regime, reducing flows available to downstream ecosystems, particularly wetlands. This leads to a series of impacts: drying and loss of natural wetland habitats (***Indic. I1***), reduced sediment supply (***Indic. I3***), and, above all, a decline in the capacity of water bodies to dilute and self-purify pollutants. Pollutant concentrations increase, making water more toxic for living organisms, while physical-chemical disturbances (pH changes, temperature rise, lower dissolved oxygen) further degrade aquatic ecosystems. Rivers, lakes, lagoons and estuaries downstream thus become particularly vulnerable, with disrupted ecological functions and declining biodiversity.

Point-source pollution and wastewater treatment

Wastewater discharges represent another major source of point-source pollution. While countries in South-Western Europe and the Balkans treat around 96% of their municipal wastewater, in the southern and eastern Mediterranean only 63% of wastewater is currently treated. Thus, despite notable progress in treatment capacity, pollutant inputs, especially nutrients, remain high in many coastal catchments, particularly in the Maghreb and the Middle East.

Factory on the edge of a wetland, Treviso (Italy)
© A. Callegaro

Annex

Method and reliability

Indic. P3 is categorised as a "Pressure" within the DPSIR framework adopted by the MWO. It aims to characterise the pressures affecting water quality in Mediterranean wetlands. It is based on the analysis of the status of water bodies and the main pressures likely to alter their physico-chemical and biological quality, notably diffuse pollution from agriculture, wastewater discharges, and hydrological alterations affecting flow regimes.

The quantification of ***Indic. P3*** relies primarily on the proportion of water bodies in good condition, as defined under the indicator 6.3.2 of the Sustainable Development Goals (SDGs) "Proportion of bodies of water with good ambient water quality". This indicator is calculated using national water quality monitoring data, by comparing measured parameters (including nutrients, dissolved oxygen, conductivity, pH and chemical contaminants) against reference thresholds defining good status. Results are aggregated at national level as the percentage of water bodies classified as being in good condition across the main hydrological categories (rivers, groundwater and standing surface waters). This metric currently represents the most harmonised approach available for enabling international comparisons across Mediterranean countries.

This information is complemented by data on nutrient loads, agricultural pressures, wastewater discharges and hydromorphological changes, derived from various international and regional sources. Qualitative information from scientific literature and institutional reports is also used to document regional trends, particularly regarding emerging pollutants, heavy metals and the effects of hydrological alterations on aquatic environments.

The reliability of the indicator is considered moderate for analysing broad regional trends across the Mediterranean. However, it is constrained by several important limitations. Knowledge of water quality remains fragmented, and no pan-Mediterranean database currently compiles all the parameters required for a comprehensive assessment. The Waterbase database of the European Environment Agency (EEA), developed under the Water Framework Directive, is currently the most structured and up-to-date source, but it mainly covers MedWet countries along the northern Mediterranean shore. More generally, data availability varies significantly between countries, with more comprehensive coverage in European Union Member States than in countries in the southern and eastern parts of the Basin. Monitoring methods, measured parameters, observation network density and assessment thresholds may also differ between national contexts, affecting the comparability of results. In addition, certain key pressures, such as plastic pollution, emerging contaminants and hydromorphological impacts, remain insufficiently documented at the regional scale.

Despite these limitations, the indicator provides a coherent overview of pressures on water quality in Mediterranean wetlands and constitutes a relevant tool for identifying regional trends, comparing national situations and informing integrated water management policies at the river basin scale.

Data

The analyses are primarily based on international datasets on water quality, in particular those derived from SDG indicator 6.3.2, compiled within the GEMStat database of the United Nations Environment Programme (UNEP). This database provides harmonised information on the proportion of water bodies in good condition for rivers, groundwater and surface waters.

Additional data are drawn from European and international databases relating to nutrient loads, agricultural pressures, wastewater discharges and hydrological characteristics, as well as from institutional reports and scientific publications used to document regional trends and explanatory factors. The temporal coverage depends on national data availability, with a focus on recent years, particularly since 2017, corresponding to the implementation of SDG indicator monitoring process and the progressive improvement in the availability of comparable data across countries.

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Aythya ferina
© Oskanov Y.

Indicator

P4

Trend

PRESSURES

Climate change pressures on wetland biodiversity

By 2100, Mediterranean wetlands could experience a temperature rise of between +1.6 °C and +4.7 °C and a decrease in precipitation of up to -30%, depending on climate scenarios.

Wintering waterbirds could face major shifts in community composition as a result of climate change.

A growing climate threat to Mediterranean wetlands

Climate change is placing increasing pressure on Mediterranean wetlands due to rising temperatures and declining precipitation across most sub-regions (***Indic. D2***). These changes disrupt hydrological regimes, accelerate the drying of habitats (***Indic. I1***) and degrade habitats essential to biodiversity.

By 2100, the 350 wetland sites monitored by the MWO (spread across the Mediterranean Basin) could face average temperature increases of +1.6 °C under an optimistic scenario (SSP1-2.6), +3.8 °C under an intermediate scenario (SSP3-7.0), and up to +4.7 °C under a pessimistic scenario (SSP5-8.5). Precipitation could decrease on average by 2.4% to 11%, depending on the scenario. However, exposure varies: sites experiencing the highest temperature increases are often less affected by reductions in rainfall. Overall, projections show a range of precipitation changes from -10% to +5% under the optimistic scenario and up to -30% under the most pessimistic (***Fig. 1***).

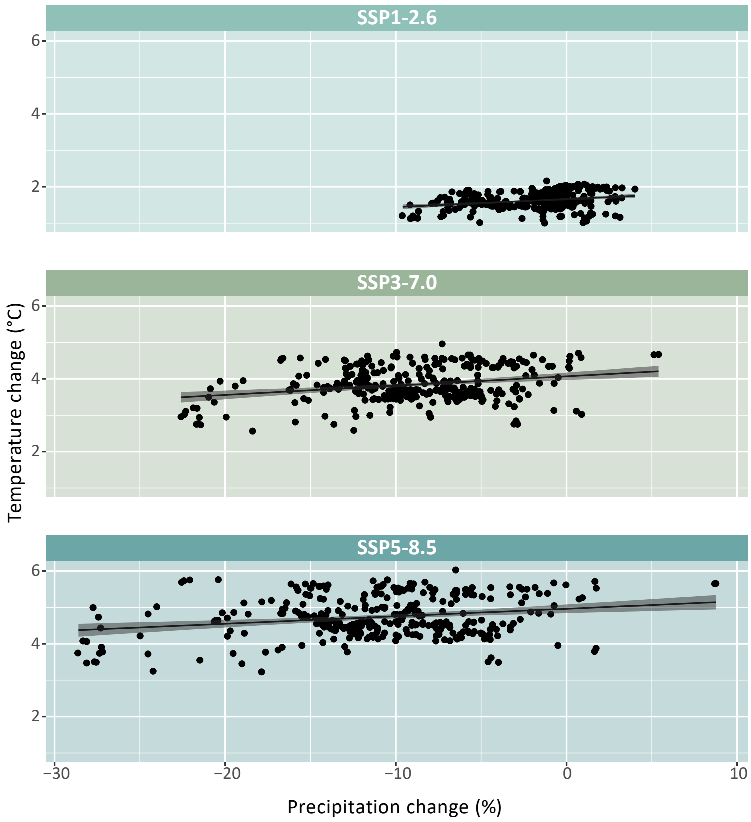


Fig. 1: Changes in temperature (°C) in relation to changes in precipitation (%) between the baseline period (1981–2010) and the future (2071–2100), based on SSP1-2.6, SSP3-7.0 and SSP5-8.5, for the 350 sites monitored by the MWO.

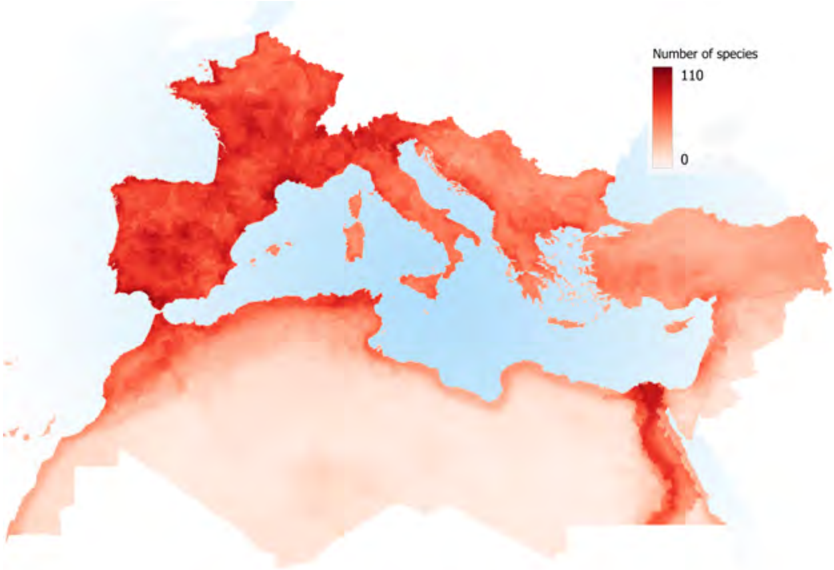


Fig. 2: Distribution of wetland-related species vulnerable to climate change

Biodiversity already impacted across the region

The climate change pressure is already resulting in visible impacts on biodiversity. Species under direct threat are found in all countries around the Mediterranean, highlighting the amplitude and geographic extent of this pressure. Areas richest in species are also those where climate-vulnerable species are most concentrated. Key hotspots of vulnerability are found in the Mediterranean biogeographical area, along the Atlantic coast and along the Nile River (***Fig. 2***).

Significant changes in wintering waterbird communities

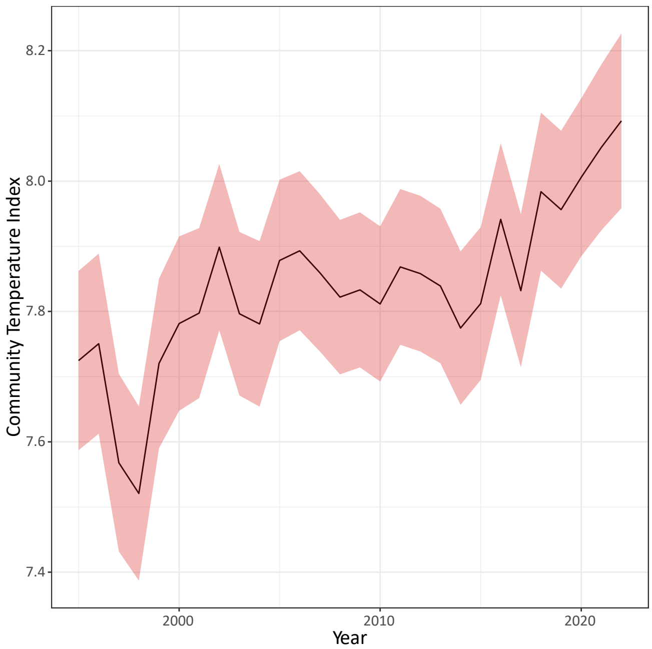
Wintering waterbirds provide a clear illustration of climate change effects, through shifts in distribution and gradual changes in community composition based on species' thermal affinities. Their Community Temperature Index (CTI) is increasing across the Mediterranean region (***Fig. 3***), reflecting a rise in warm-affinity species at the expense of cold-adapted ones. This trend is particularly pronounced in France, Italy, and Greece. Elsewhere, changes are weaker or even contrary to expectations, showing a redistribution of species in response to warming.

In conclusion, the biodiversity of Mediterranean wetlands is under severe threat from rising temperatures and declining precipitation. It is therefore essential to mitigate the drivers of climate change as much as possible. Many species are highly vulnerable and the more severe the climate scenario (SSP), the greater and more widespread the impacts.

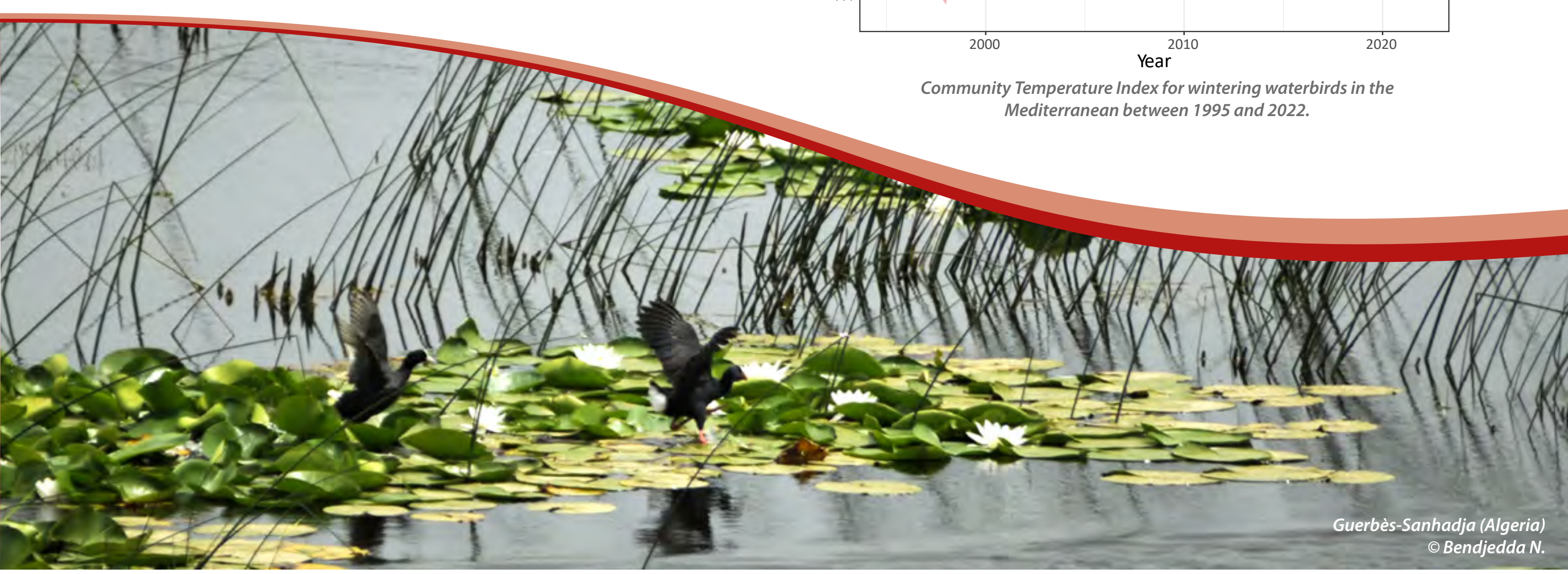
In the case of waterbirds, warming is leading to rapid shifts in community structure and species distribution. Ecosystem services they provide (e.g. hunting, recreation, etc.) may also be geographically displaced.

As several studies suggest, and assuming all MedWet countries experience warming, the lack of a positive trend in the CTI over time may reflect a maladaptation of these communities, likely driven by the loss or degradation of wetland habitats (***Indic. I1*** & ***Indic. I2***).

It is therefore vital to strengthen protection (***Indic. R1***) and sustainable management (***Indic. R3***) of wetlands, particularly by preventing their destruction and artificial modification, in order to support species adaptation.



Community Temperature Index for wintering waterbirds in the Mediterranean between 1995 and 2022.



Guerbès-Sanhadja (Algeria)
© Bendjedda N.

Annex

Method and reliability

Indic. P4 is classified under the "Pressures" component of the DPSIR framework adopted by the MWO. It aims to characterise the intensity of climate-related pressures affecting wetland biodiversity across the Mediterranean Basin through three complementary approaches: (1) the analysis of future climate projections, (2) the assessment of species vulnerability to climate change, and (3) temporal changes in the composition of wintering waterbird communities.

The climate analysis is based on a comparison between a reference period (1981-2010) and a future period (2071-2100), using three Shared Socioeconomic Pathways (SSPs) from the Coupled Model Intercomparison Project Phase 6 (CMIP6): SSP1-2.6, SSP3-7.0 and SSP5-8.5. These scenarios represent, respectively, a strong mitigation pathway, an intermediate trajectory, and a high-emissions pathway. Projections correspond to the means of five global climate models, in order to reduce model-specific biases. The selected metrics are annual mean temperature (averaged over 12 months) and total annual precipitation. Changes are assessed relative to the reference period rather than pre-industrial conditions. The analysis focuses on annual averages and does not account for seasonal variability, extreme events (such as droughts or heatwaves), or fine-scale hydrological processes, although these are critical for wetland functioning.

Species vulnerability is assessed using data from the International Union for Conservation of Nature (IUCN) Red List. The metric is based on the number of species identified as vulnerable to climate change, whose distribution overlaps within a given spatial unit.

Changes in wintering waterbird communities are assessed using the Community Temperature Index (CTI). The CTI represents the average thermal affinity of species present within a community, weighted by their relative abundance. Species thermal affinity is defined as the mean temperature during winter months across the species' wintering distribution.

The overall reliability of the indicator is considered moderate to good at the Mediterranean scale. It relies on internationally recognised datasets and scientifically validated methods, but remains subject to several limitations. Climate projections depend on SSP assumptions, and only means are used, whereas variability across models, scenarios and variables may differ, meaning that results may reflect only part of the range of future conditions. IUCN assessments reflect the current state of knowledge and show taxonomic and geographical biases. Moreover, the use of species counts may accentuate contrasts in species-rich areas that have been more extensively assessed. Finally, the CTI is based on monitoring networks with uneven spatial and temporal coverage across countries and provides an aggregated functional signal at community level, without identifying the underlying ecological mechanisms.

Data

Climate projections used for ***Indic. P4*** are derived from the CHELSA (Climatologies at High Resolution for the Earth's Land Surface Areas) dataset, version 2, based on CMIP6 simulations (spatial resolution ~1 km at the equator). Analyses focus on annual mean temperature and total annual precipitation for the periods 1981-2010 and 2071-2100, under three socio-economic scenarios (SSP1-2.6, SSP3-7.0 and SSP5-8.5). Results correspond to the mean of five global climate models (GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR, MRI-ESM2-0, UKESM1-0-LL).

Data on species vulnerability to climate change are derived from the IUCN Red List for species associated with Mediterranean wetlands. The dataset (15/04/2025, spatial resolution ~5.6 km at the equator) includes taxonomic groups (Animalia, Fungi, Plantae), assessment scope (Global, Mediterranean), MedWet countries, threat category (11 – Climate change & severe weather), habitat types (1.7. Forest - Subtropical/Tropical Mangrove Vegetation Above High Tide Level, 1.8. Forest - Subtropical/Tropical Swamp, 12. Marine Intertidal, 13. Marine Coastal/Supratidal, 15. Artificial/ Aquatic & Marine, 4.6. Grassland - Subtropical/Tropical Seasonally Wet/Flooded, 5. Wetlands (inland), 9.10. Marine Neritic - Estuaries, 9.8. Marine Neritic - Coral Reef), and taxonomic level (species).

The CTI analysis is based on waterbird count data from the International Waterbird Census (coordinated by Wetlands International), monthly temperature data for November to January from HadCRUT5 (Met Office Hadley Centre, University of East Anglia), and winter distribution maps provided by BirdLife International.

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Indicator
P5
Trend

PRESSURES

Mean Sea Level Rise

The mean sea level in the Mediterranean is currently rising at an accelerated rate of 2.8 mm/year, with projections reaching up to +0.34 m or even as much as +1.06 m by 2100.

Between 69% and 92% of coastal marshes could disappear by the end of the century, and over 34% of coastal wetlands important for waterbirds are already at risk.

Trends and projections

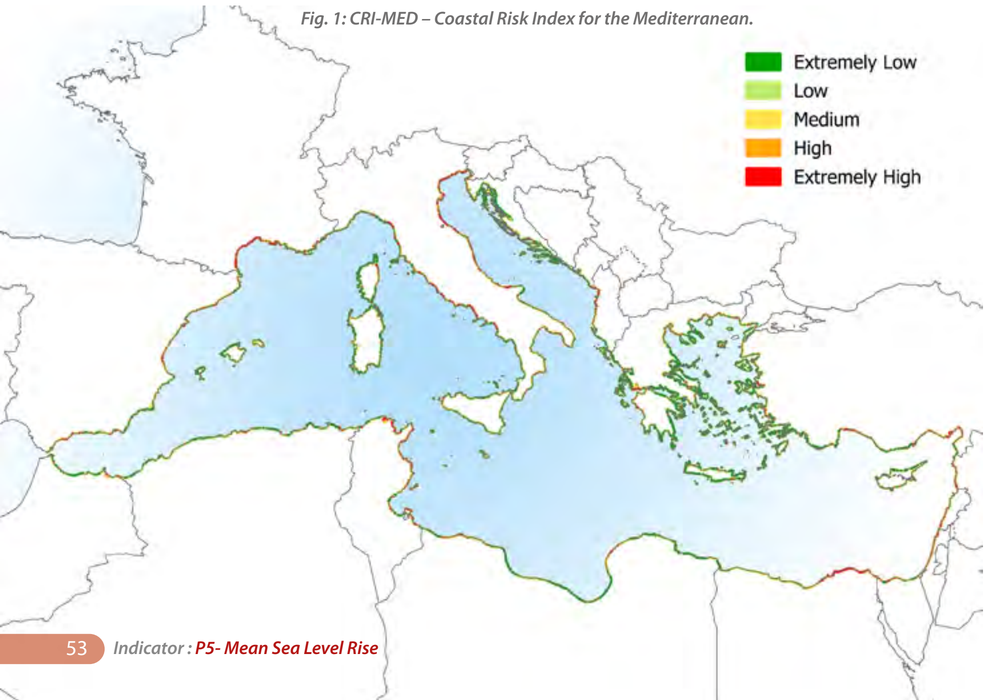
Over the 20th century, Sea Level Rise (SLR) in the Mediterranean reached an average rate of around 1,4 mm/year. Since the 1990s, this rate has doubled to approximately 2,8 mm/year (±0,1 mm). According to MedECC, by 2050, average sea level is projected to rise by 16 to 33 cm compared to 1995–2014 levels, and could reach between 0,34 m and 1,06 m by 2100 depending on emission scenarios (SSP). This rise is expected to lead to a significant increase in the frequency of extreme events: coastal floods considered centennial today may become annual by the end of the century.

Vulnerability factors

Coastal wetlands are among the ecosystems most exposed to SLR, particularly in the Mediterranean, where several vulnerability factors combine. The region's microtidal regime limits vertical and lateral adaptation, while its often steep topography restricts inland migration of wetlands. The phenomenon of "coastal squeeze" exacerbates the issue: dense coastal development and infrastructures (dikes, roads, urban areas) act as physical barriers, trapping wetland habitats between the rising sea and built-up areas.

Since 1990, the Mediterranean coastal population has grown by 49%, intensifying shoreline artificialisation (***Indic. D1***). The construction of dams (***Indic. P2***) has drastically reduced sediment inflow (***Indic. I3***), by up to 98% in some river basins (Ebro, Nile, Po, Medjerda), limiting wetlands' ability to keep pace with SLR. In addition, rising tourism pressure increases land-use competition and speculation, reducing the options for conserving or restoring these critical ecosystems.

Fig. 1: CRI-MED – Coastal Risk Index for the Mediterranean.



MWO

Risk assessment

Le *Coastal Risk Index for the Mediterranean* (CRI-MED) is a spatial analysis tool for assessing sea level rise-related risks. It integrates three dimensions: climatic driving (SLR, storms, coastal flooding), physical vulnerability (topography, population density), and socio-economic exposure (land use, infrastructures).

At the Mediterranean scale (***Fig. 1***), CRI-MED shows that 36% of coastal zones are exposed to moderate to high risk. The most vulnerable countries are in the Maghreb, the Middle East, and South-Western Europe, where exposure is high and adaptive capacity is low.

Wetland-specific projections: the case of Mediterranean coastal marshes

Between 1975 and 2020, approximately 10% of natural coastal wetland habitats in the Mediterranean were lost, mainly due to urbanisation and conversion to agricultural lands or artificial wetlands. Today, the growing threat of marine submersion adds to these pressures, directly endangering coastal marshes. Without adaptation measures, between 69% and 92% of these ecosystems could disappear by 2100, even under moderate climate scenarios. Some countries, including Algeria, Egypt, France, and Italy, may face complete loss in certain areas (***Fig. 2***). Preserving these wetlands will depend heavily on two factors: the availability of space for inland migration and sufficient sediment supply.

Biodiversity impacts

Mediterranean coastal wetlands are vital for biodiversity, particularly as habitats for waterbirds. A study covering nearly 1,000 coastal sites important for waterbirds across eight Mediterranean countries (Algeria, Croatia, France, Greece, Italy, Libya, Morocco, and Tunisia) found that over 34% could be submerged by 2100, even under the most optimistic climate scenarios. Paradoxically, more than 70% of at-risk sites are located within protected areas, which are 1.5 to 2 times more exposed to SLR than other sites.

In this context, identifying priority conservation areas and strengthening protected area networks, while ensuring space for wetland migration, are key adaptation strategies in response to SLR.

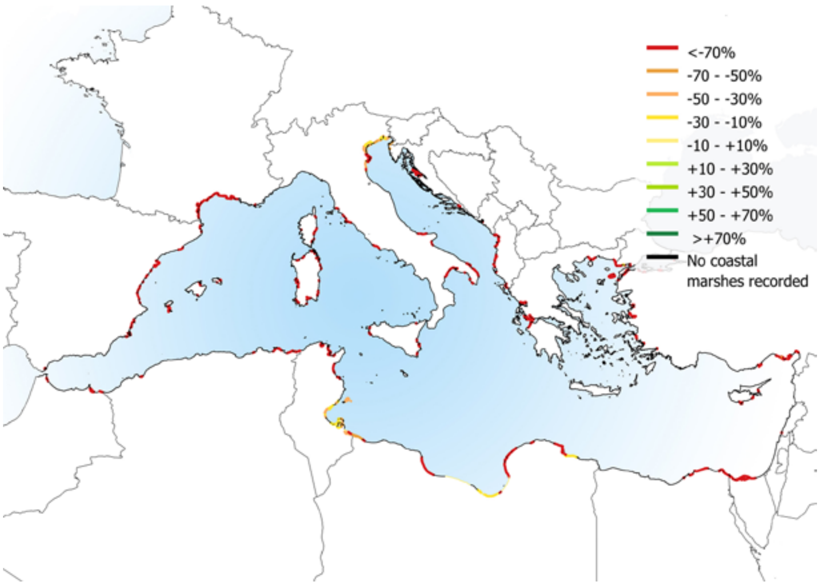


Fig. 2: Projected impact of SLR on Mediterranean coastal marshes by 2100 under an intermediate climate scenario (SSP2-4.5).

Véran dike, Camargue (France)
© Thibault M.

Annex

Method and reliability

Indic. P5 is classified as a "Pressure" within the DPSIR framework adopted by the MWO. It is built on recent scientific work conducted at multiple scales (regional, national and site level) and aims to assess the vulnerability, exposure and risk faced by Mediterranean coastal wetlands in relation to mean Sea Level Rise (SLR), in interaction with increasing anthropogenic pressures along the coastline.

Observed trends and projections of SLR are derived from the regional assessments of Mediterranean Experts on Climate and Environmental Change (MedECC), based on the evaluations of the Intergovernmental Panel on Climate Change (IPCC), which provide climate projections under Shared Socioeconomic Pathways (SSPs). These assessments integrate the various physical drivers of SLR, including thermal expansion, glacier and ice sheet melt, and regional ocean dynamics, and provide regionally refined estimates for the Mediterranean Basin.

The assessment of impacts on Mediterranean coastal marshes is based on the approach developed by Schuerch et al. (2025), relying on a regionalised version of the Global Coastal Wetland Model (GCWM). This integrated model simulates the spatial evolution of coastal marshes by combining several processes, including relative SLR, vertical sediment accretion, sediment availability, coastal topography and the potential for inland migration. It operates through a spatially explicit framework using topographic, land cover and population density data, and enables the simulation of different climate, demographic and coastal management scenarios in order to estimate potential losses or gains in coastal marsh extent depending on sediment supply and migration space.

Coastal risk analysis also draws on the Coastal Risk Index for the Mediterranean (CRI-MED), developed by the MEDSEA Foundation in line with the IPCC conceptual framework. This approach is based on a multiplicative model combining three sub-indices: hazard (climate forcing affecting coastal areas, including SLR, storms and flooding), vulnerability (elevation, coastal slope and geomorphological characteristics) and exposure (land use and population density). Variables are standardised, weighted and aggregated within a Geographic Information System to produce continuous risk maps across the Mediterranean Basin, allowing the identification of coastal "hotspots" where high exposure coincides with limited adaptive capacity.

Potential impacts of SLR on biodiversity have been assessed through a study analysing the exposure of 938 Mediterranean coastal sites monitored under the International Waterbird Census (1993-2017). Potential inundation is estimated using a bathtub hydrologically connected approach applied to the Copernicus DEM-90 digital elevation model, based on multiple SLR projections derived from IPCC CMIP6 scenarios. Exposure corresponds to the proportion of current terrestrial surface within each site that could be inundated. Results are then intersected with Ramsar site and protected areas boundaries (derived from ***Indic. R1***) to assess their importance for non-breeding waterbirds.

The reliability of the indicator is considered good to high for the characterisation of mean SLR trends, as it relies on consolidated IPCC assessments. Uncertainties primarily relate to future emission pathways, ice melt contributions and local processes such as subsidence or changes in sediment supply. Results from coastal marshes modelling also depend on assumptions regarding coastal management and the availability of space for inland migration. Despite these uncertainties, the indicator is grounded in scientifically validated methodological frameworks and provides a robust basis for assessing the pressure exerted by SLR on Mediterranean coastal wetlands.

Data

Data on observed trends and projections of mean SLR are derived from MedECC regional assessments, based on IPCC 6th Assessment Report (AR6) evaluations and SSP scenarios.

Estimates of impacts on Mediterranean coastal marshes are based on a regional application of the GCWM model. Land use data used to parameterise and spatialise the model primarily originate from the database of sites monitored by the MWO, which documents habitat dynamics and land-use/land-cover transitions across the Basin, as well as from the global saltmarsh dataset (Global Distribution of Saltmarsh, version 4.0) developed by the UNEP World Conservation Monitoring Centre (UNEP-WCMC). This dataset compiles information from scientific publications, institutional databases and inventories based on remote sensing and field surveys, provided as vector layers with associated metadata.

The spatial analysis of coastal risk is based on the dataset developed within the CRI-MED framework, which integrates harmonised climatic, topographic, demographic and land-use variables within a Geographic Information System at the Mediterranean scale.

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Umm Al Maa Lake, Awbari (Libya)
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Indicator
S1
Trend

STATE

Extent of wetland habitats

Half of the historical Mediterranean wetlands have already disappeared and the trend continues: -12% between 1990 and 2020.

In the Maghreb, 95% of identified wetland habitats remain natural, but are mostly temporarily flooded. These ecosystems are highly vulnerable to climate change and are at risk of rapidly disappearing.

Mapping potential wetland areas: a strategic tool for management and restoration

Large-scale mapping of potential wetland areas (***Fig. 1***) is a key instrument for guiding conservation policies. By combining Earth observation data, climate models, soil maps, and topographic variables, this approach identifies not only existing wetlands but also those that have been lost over time, primarily due to drainage, agricultural conversion, or land sealing. In the Mediterranean basin, these analyses reveal that approximately 56% (± 7%) of historical wetlands have been lost, particularly in intensively transformed floodplains.

Comparing current land use with the potential extent of wetland ecosystems makes it possible to identify and delineate priority areas for restoration, where hydrological, geomorphological, and climatic conditions remain favourable.

These results offer a robust basis for prioritising action: restoring lost habitats, reconnecting hydrological corridors, protecting existing wetlands, and improving degraded but still functional ones. They also provide a decision-making tool to anticipate land-use conflicts, integrate biodiversity into spatial planning, and contribute to regional objectives for climate resilience and sustainable water management.

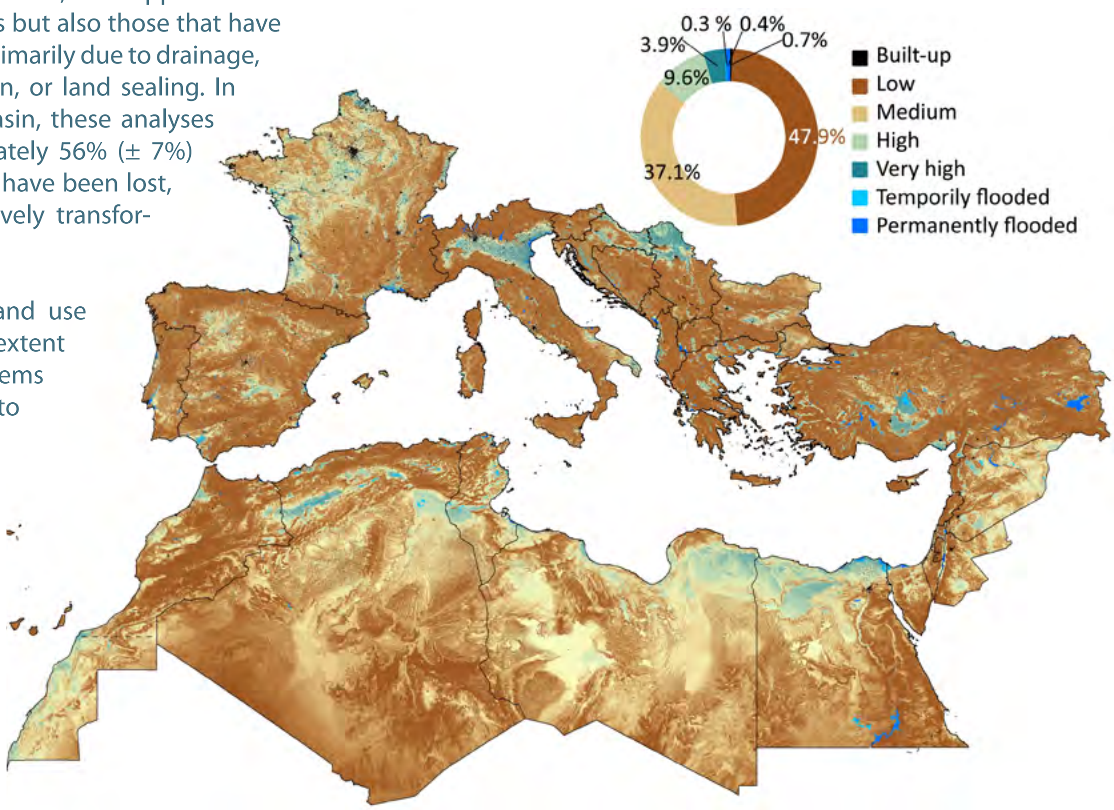

Fig.1: Map of Potential Wetland Areas across MedWet countries, showing the total coverage of probability occurrence classes (in %).

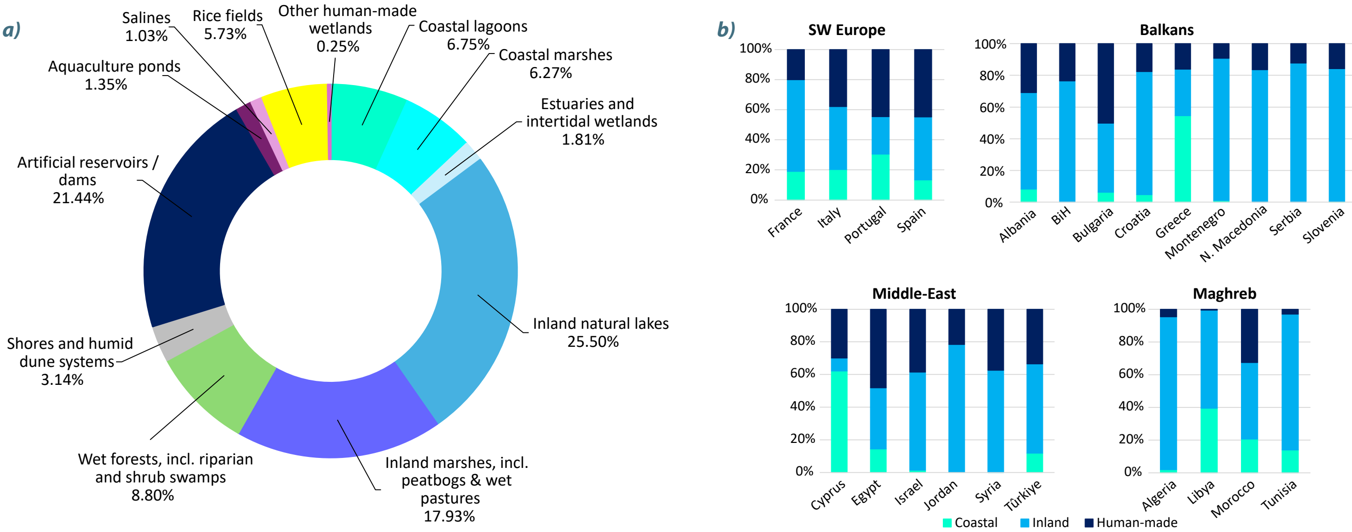

Fig.2: Proportions of wetland habitat types (excluding rivers) across the Mediterranean Basin (a) and; Distribution according to Ramsar reporting classes for each MedWet country where data is available (b).

Ongoing loss of natural wetlands

Over the past decades, Mediterranean natural wetlands have continued to decline. According to the WET Index, based on data from over 440 monitored sites, the region lost on average 12% (± 3%) of its natural wetlands between 1990 and 2020. This trend is driven by urbanisation and agricultural intensification (***Indic. P1***), hydraulic infrastructure (***Indic. P2***), and the growing impact of climate change (***Indic. P4***). These combined pressures increase habitat fragmentation and weaken the ability of wetlands to regulate floods, store water, and maintain biodiversity.

This situation calls for urgent and coordinated actions: to protect still functional ecosystems (***Indic. R1***), restore degraded habitats (***Indic. R2***), and promote sustainable wetland management (***Indic. R3***). Without collective mobilisation, a critical part of the Mediterranean's ecological resilience is at risk.

Extent of existing wetlands

According to ***Fig. 2a***, natural wetlands represent 72% of all identified wetland areas in the Mediterranean, shared between inland (56%) and coastal habitats (16%). Artificial wetlands, which are expanding rapidly (***Indic. P2***), represent 28% of the total. These include dams, agricultural tanks, rice fields, salt pans, and aquaculture ponds.

The analysis per sub-region (***Fig. 2b***) reveals marked contrasts. The Maghreb shows an exceptional level of naturalness: 95% of identified wetlands remain natural, most of which are temporarily flooded and heavily dependent on precipitation (***Indic. I1***). In the Balkans, the proportion remains high at 78%, although hydraulic infrastructure is developing. In South-West Europe, historical transformation has been more extensive and long-standing, with only 66% of remaining wetland habitats considered as natural. In the Middle East, artificial wetlands represent 41% of the total, largely due to the expansion of dams and coastal aquaculture, particularly in the Nile Delta (***Indic. S2***).

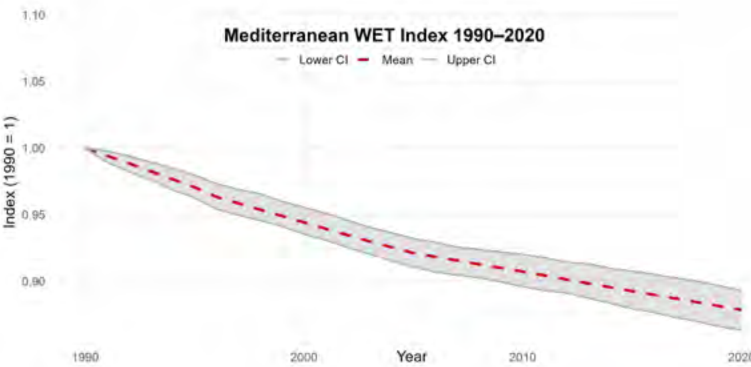

Fig.3: Estimated loss of natural wetlands in the Mediterranean, based on the WET Index calculated from over 440 sites.

Yovkovtsi dam (Bulgaria)
© EdVal/Envato

Annex

Method and reliability

Indic. S1 aims to characterise the extent of wetland habitats across the Mediterranean Basin and their evolution over time. It falls under the "State" component of the DPSIR framework adopted by the MWO and is based on an approach combining spatial data production, harmonisation of existing inventories, and the analysis of temporal trends.

The estimation of current wetland extent is based on the pan-Mediterranean dataset developed by the European Topic Centre at the University of Malaga (ETC-UMA), in partnership with Tour du Valat, which constitutes the first harmonised mapping of wetland ecosystems at the regional scale. This baseline has been significantly strengthened by the MWO within the framework of ***Indic. S1*** through the production and consolidation of national mapping inventories at the most detailed classification level (Level 3) for all countries initially available only at aggregated levels (Level 1). This process involved the integration of complementary national sources, the harmonisation of typologies according to a hybrid CORINE Land Cover – Ramsar classification, and the correction of spatial inconsistencies. It has enabled the generation of a more accurate, robust and comparable estimate of the extent of natural and human-made wetland habitats across the Mediterranean Basin.

The identification of Potential Wetland Areas (PWA) relies on a hydro-geomorphological approach developed by the MWO, combining topographic, hydrological and climatic variables to model the probability of wetland occurrence. The estimation of lost wetland areas is derived from the spatial overlay between the PWA layer and multi-source Land Use / Land Cover (LULC) datasets, including CORINE Land Cover, Copernicus Global Land Cover and ESA WorldCover, allowing the identification of areas historically suitable for wetlands but currently converted to other land uses.

The temporal evolution of natural wetlands is assessed using the WET Index (Wetland Extent Trends Index), a method developed by the UNEP – World Conservation Monitoring Centre (UNEP-WCMC) in collaboration with the Ramsar Convention Secretariat. This metric adapts the Living Planet Index approach to wetland surface dynamics, based on time series derived from sites monitored over several years. For each site, rates of change are calculated between available dates and then aggregated by sub-region and wetland type using weighted geometric means, in order to minimise biases linked to uneven data availability and to avoid the over-representation of certain wetland types. The WET Index is subsequently calculated as the average of trends estimated for each "wetland type × sub-region" combination and reflects an overall regional trend rather than an absolute change in surface area.

The overall reliability of the indicator is considered high for all analyses presented. It relies on the combination of harmonised regional datasets, extensive data consolidation and mapping production efforts, internationally recognised LULC sources, and scientifically validated analytical methods. Some residual uncertainties remain, notably in the calculation of the WET Index due to the heterogeneity of monitored sites, and in the estimation of historical wetland losses linked to the use of global LULC datasets that may present limitations in spatial or thematic resolutions. Despite these limitations, the indicator provides a robust reference for monitoring wetland extent across the Mediterranean Basin.

Data

The analysis is primarily based on the regional wetland extent dataset developed by ETC-UMA and Tour du Valat, further improved and enriched by the MWO to enhance the thematic and spatial accuracy of available national mapping.

PWA are derived from hydro-geomorphological models integrating global topographic data (Copernicus DEM90), climatic variables (WorldClim), and hydrological indices. Historical wetland losses are estimated by overlaying high-probability PWA pixels with multiple LULC datasets, including CORINE Land Cover, Copernicus Global Land Cover and ESA WorldCover.

The analysis of temporal trends in natural wetland extent is based on the WET Index, calculated using the LULC change monitoring database developed by the MWO for a sample of more than 350 sites across the Mediterranean Basin. This database captures all observed land cover transitions, including those affecting wetland classes, enabling the assessment of changes in wetland extent over the period 1990-2020.

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Lestes macrostigma
© Piney B. INPN

STATE

Conservation status of Mediterranean wetland species

40% of species found in Mediterranean wetlands are in a worrying status, a figure that rises to 69% for endemic species.

The abundance of wintering waterbirds increased by 43% between 1995 and 2022, illustrating the effectiveness of certain targeted conservation policies.

An alarming status of biodiversity in Mediterranean wetlands

The Mediterranean Basin is a global biodiversity hotspot, characterised by a high diversity of species, many of which are endemic. Mediterranean wetlands contribute disproportionately to this richness, hosting over a third of the region's species.

Regular assessments of the conservation status of these wetland-related species provide a means of tracking progress in the fight against biodiversity loss and help inform conservation priorities. The most recent results confirm the concerning situation highlighted in previous analyses.

According to IUCN Red List criteria, 40% of assessed species are now considered globally threatened with extinction or already extinct (23.4%), near threatened (7.5%), or data deficient (8.4%). All major taxonomic groups are affected, with gastropod molluscs among the most impacted (***Fig. 1***).

The situation is even more critical for endemic species, which account for 13% of the assessed species. Among these, 69% are of conservation concern: 58.7% are threatened or already extinct, 10.4% are near threatened, and 15.9% lack sufficient data. As these species are found nowhere else on Earth, Mediterranean countries have a major responsibility for their protection and the prevention of their extinction.

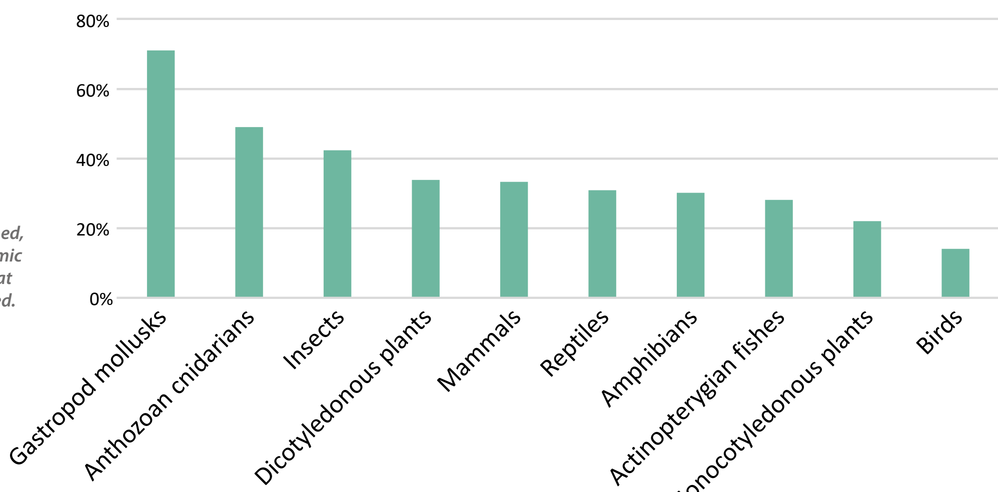


Fig. 1: Percentage of species that are threatened, near threatened, or data deficient by taxonomic class. Only species occurring in wetlands in at least one Mediterranean country are included.

MWO

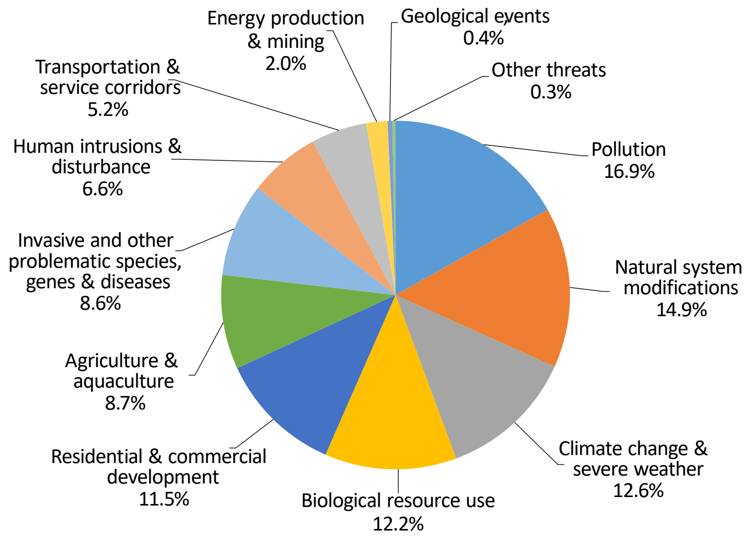


Fig. 2: Frequency of threats affecting species in Mediterranean wetlands based on IUCN Red List data.

Impact of conservation policies on wintering waterbirds: A regionally varied trend

There is, however, some encouraging news. Wintering waterbirds in Mediterranean countries have shown a relatively consistent increase from 1995 to 2022, with their abundance index rising by 43% over the period (***Fig. 3***). These species are the direct focus of several international conservation instruments, such as the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), the Ramsar Convention, and the Birds and Habitats Directives for EU Member States. Their relatively favourable conservation status suggests that the implementation of these policies has been effective (***Indic. R1*** & ***Indic. R3***). However, this trend reflects an overall average; some species do not follow it and are even in decline. At the national level, where data are sufficient to calculate a trend, there is significant variation. Marked increases are seen in Algeria, Spain, France and Italy, while trends are stable or fluctuating in Bulgaria, Croatia, Greece, Morocco, Slovenia, Tunisia and Türkiye.

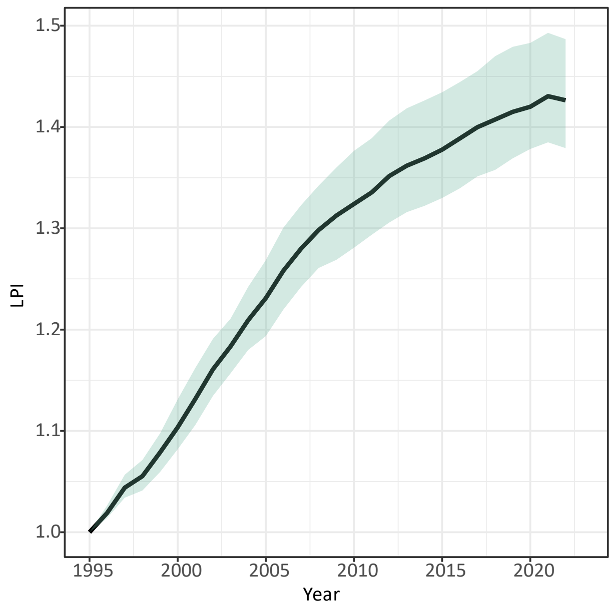
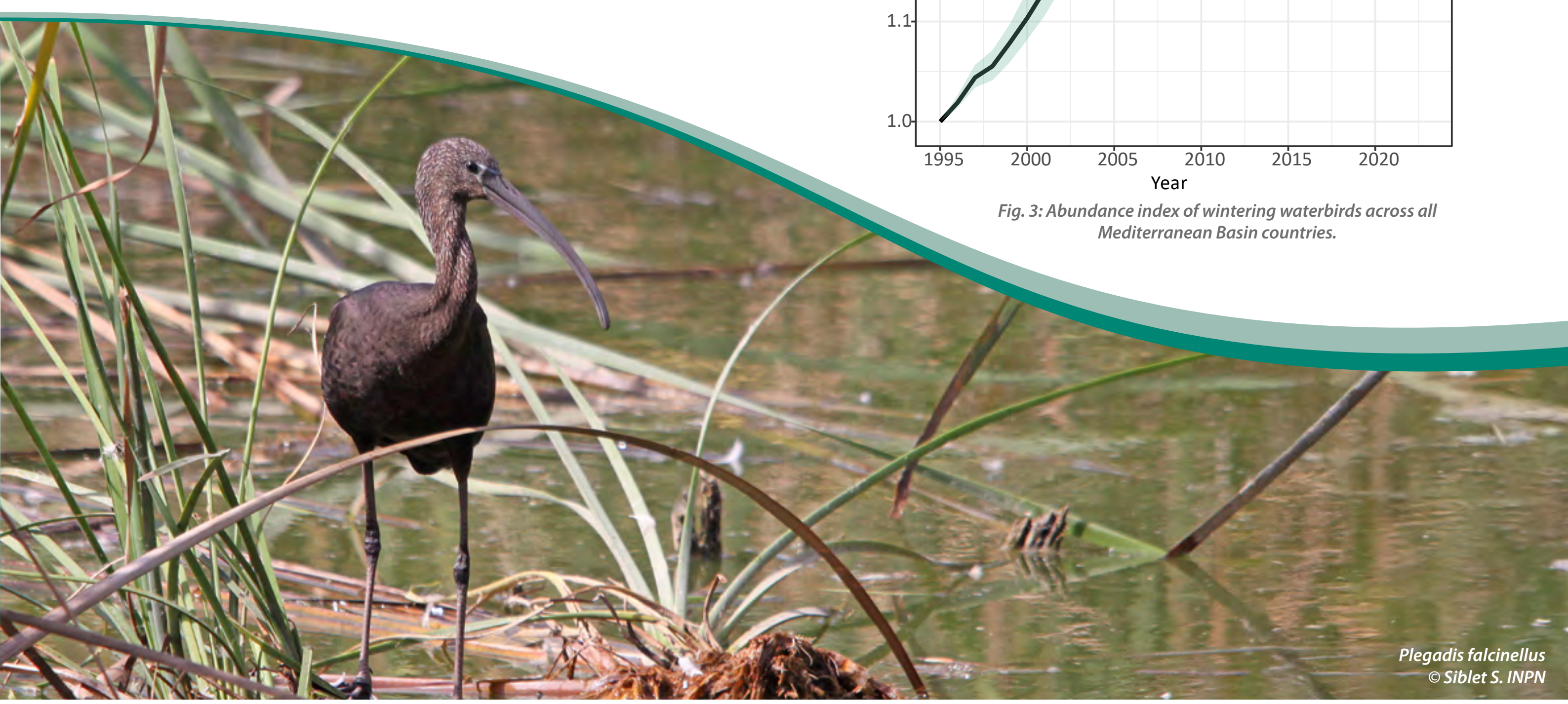


Fig. 3: Abundance index of wintering waterbirds across all Mediterranean Basin countries.

Causes of species decline in Mediterranean wetlands

Species in Mediterranean wetlands face a wide range of human-induced pressures that threaten their survival. Among the most widespread threats (***Fig. 2***) are water pollution (***Indic. P3***), the transformation of natural systems, particularly through dam construction and water abstraction (***Indic. P2***), climate change (***Indic. P4***), and urban sprawl (***Indic. P1***). These pressures primarily lead to the degradation or complete loss of habitats (***Indic. I1*** & ***Indic. I2***). Certain species are also subject to direct exploitation, such as hunting, fishing, or collection. Additional pressures include disturbance from human activities and competition or predation by invasive alien species.



Plegadis falcinellus
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Annex

Method and reliability

Indic. S2 falls under the "State" component of the DPSIR framework adopted by the MWO. It aims to characterise the conservation status of species associated with Mediterranean wetlands, as well as trends in the abundance of selected species groups at the regional scale.

The assessment of species conservation status is primarily based on the analysis of categories from the International Union for Conservation of Nature (IUCN) Red List. The species considered are those occurring in wetland habitats in at least one country within the Mediterranean Basin, as defined by the IUCN habitat classification. The analysis covers all biological kingdoms (Animalia, Plantae and Fungi) and includes the following categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Data Deficient (DD). A specific analysis is also conducted for species endemic to the Mediterranean region, in order to highlight their particular level of vulnerability.

Pressures affecting these species are identified based on threats documented in IUCN Red List assessment accounts. During the assessment process, experts record factors likely to affect species survival using the IUCN Threats Classification Scheme, a standardised framework describing the various categories of pressures acting on biodiversity. Threats associated with the species included in ***Indic. S2*** were extracted from this database and subsequently grouped into broad pressure categories (e.g. pollution, natural system modifications, climate change, urban development, or invasive alien species). The frequency of each type of pressure was then estimated by counting the number of species for which the threat is reported in the IUCN assessment. This approach makes it possible to identify the most frequently reported drivers of decline affecting Mediterranean wetland species at the regional scale.

Trends in wintering waterbird populations are analysed separately in order to provide a dynamic measure of biodiversity change in Mediterranean wetlands. The calculation is based on an approach derived from the Living Planet Index, implemented using the rlpi statistical package. Each time series corresponds to counts carried out at a given site as part of the International Waterbird Census conducted in mid-January. Selected time series include at least three counts over the study period (1995-2022), including at least one observation before 2004, one between 2005 and 2014, and one after 2015. Trends are calculated both at national level and across the Mediterranean region.

Overall, the reliability of the indicator is considered to be good for assessing broad regional trends. IUCN Red List categories constitute the international reference for evaluating species extinction risk. However, some limitations remain. Assessments do not cover all taxonomic groups evenly, and certain species remain insufficiently documented. In addition, threats reported in Red List assessments may be incomplete for some species. Finally, analyses of waterbird population trends depend on the availability and geographical distribution of monitoring programmes, with some countries and species still under-represented in international datasets.

Data

The analysis is based on data from the IUCN Red List, queried for species occurring in the Mediterranean region and associated with wetland habitats. The query includes the kingdoms Animalia, Plantae and Fungi and covers all countries of the Mediterranean Basin. The IUCN data extraction (15/04/2025; spatial resolution ~5.6 km at the equator) includes taxonomic group (Animalia, Fungi, Plantae), assessment scope (Global and Mediterranean), MedWet countries, threats (11 - Climate change & severe weather), habitats (1.7. Forest - Subtropical/Tropical Mangrove Vegetation Above High Tide Level, 1.8. Forest - Subtropical/Tropical Swamp, 12. Marine Intertidal, 13. Marine Coastal/Supratidal, 15. Artificial/ Aquatic & Marine, 4.6. Grassland - Subtropical/Tropical Seasonally Wet/Flooded, 5. Wetlands (inland), 9.10. Marine Neritic - Estuaries, 9.8. Marine Neritic - Coral Reef), and taxonomic level (species). Extracted information includes species conservation status, endemicity (distribution restricted to the Mediterranean region), and documented threats.

The analysis of wintering waterbird trends relies on data from the International Waterbird Census (IWC), coordinated by Wetlands International. This international monitoring programme provides standardised annual counts of waterbirds across several hundred sites in Mediterranean countries, enabling the estimation of relative population abundance trends over the period 1995-2022.

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Coastal marshes near Kalloni, Lesbos (Greece) © CreativeNature NI/Envato

Indicator

I1

Trend

IMPACTS

Drying of natural wetlands

Between 1984 and 2021, the surface area of permanent open water in Mediterranean inland marshes decreased by -12%, while temporarily flooded areas in coastal lagoons declined by -10%, highlighting a worrying trend of natural wetlands drying.

Over the same period, artificial wetlands recorded a +42% increase in permanent water surfaces.

Natural wetlands: declining surface water in the most sensitive ecosystems

Between 1984 and 2021, the permanent surface water area of Mediterranean natural wetlands remained broadly stable (+0.15%). However, this apparent stability hides contrasting dynamics depending on wetland types, with a marked decline observed in the most sensitive habitats (***Fig. 1***).

In inland wetlands, the decline in surface water is particularly pronounced. Inland marshes, including wet meadows and peatlands, recorded a 12% reduction in permanent surface water and 10% in temporarily flooded areas. Interdunal wet depressions, especially widespread in North Africa, showed comparable declines: -13% for permanent surface water and -8% for temporarily flooded areas. These changes reflect a combination of increasing pressures: excessive water abstraction (***Indic. P2***), drainage or fragmentation of hydraulic networks (***Indic. I3***), and declining natural inputs linked to reduced precipitation (***Indic. D2***).

Still in inland wetlands, natural lakes show a more contrasted trend. Their permanent surface water raised slightly (+0.6%), while seasonal water increased significantly (+29%). This suggests a partial shift from permanent to intermittent hydrological regimes, potentially due to reduced annual recharge and increased evaporation. Rather than improvement, this shift likely indicates the gradual drying of some Mediterranean lakes and growing vulnerability to water stress.

Coastal wetlands show more heterogeneous trajectories. Coastal marshes increased slightly, with a 3% rise in permanent surface water and 8% in temporarily flooded areas. In contrast, coastal lagoons declined: permanent surface water remained stable (-0.1%), but seasonal surface water dropped significantly (-10%). This trend is mainly driven by reduced freshwater inputs from upstream catchments, resulting from an intensification of hydraulic infrastructures, overexploitation of water resources, and declining rainfall. The weakening of hydrological connections with upstream systems deeply affects the seasonal dynamics and salinity balance of Mediterranean lagoons.

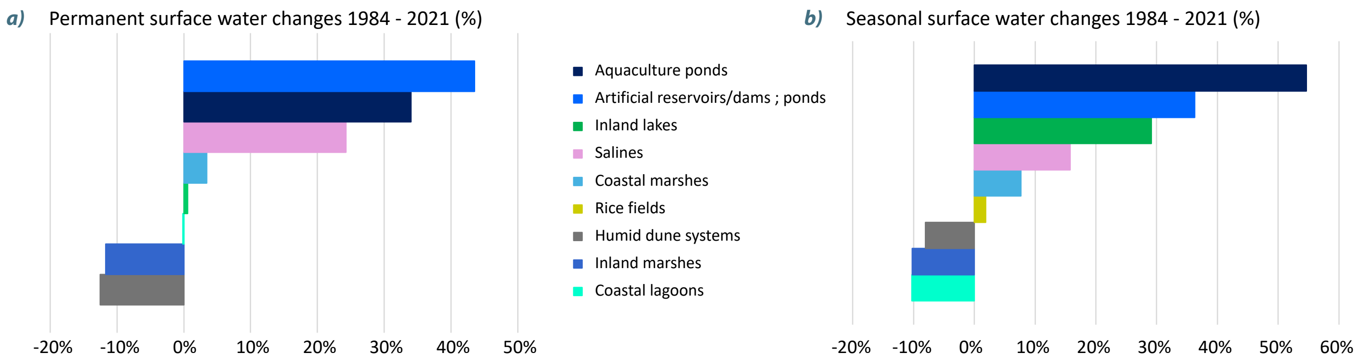

Fig. 1: Changes 1984-2021 in permanently (a) and temporarily (b) flooded areas in Mediterranean wetlands.

Artificial wetlands: strong increase in surface water areas

In contrast with natural systems, artificial wetlands in the Mediterranean experienced a strong increase in both permanent (+42%) and seasonal (+30%) surface water areas between 1984 and 2021.

This trend is explained by the continued development of hydraulic infrastructures, including dams, reservoirs and agricultural ponds (***Indic. P2***), whose permanent surface waters increased by 43%. Aquaculture also expanded significantly, with a 34% increase in permanent water and 55% in temporarily flooded areas. Salt pans, while more limited in area, also recorded a 24% rise in permanent surface water.

The expansion of surface water in artificial wetlands reflects a technical response to growing water stress in the region. However, it has consequences for natural wetlands: by capturing a substantial part of upstream freshwater flows, these infrastructures reduce the volumes reaching downstream ecosystems, exacerbating the drying trends already observed in marshes, lagoons and temporary lakes.

Moreover, this expansion is not associated with an equivalent functional gain. Artificial wetlands, designed for specific uses (e.g. storage, production, etc.), only partially substitute the services provided by natural wetlands: water filtration, flood regulation, biodiversity support, carbon storage, etc. These artificial environments are generally ecologically poorer, less resilient to climate extremes, and heavily dependent on human management.

Climate change: accelerating hydrological imbalances

Climate change amplifies the drying trends observed in Mediterranean natural wetlands. Declining rainfall, combined with rising temperatures, exacerbates water deficits, shortens seasonal flooding periods and increases evaporation, especially in temporary or shallow wetlands.

In response, water management strategies are increasingly turning towards artificial storage and production infrastructures, to the detriment of ecosystem-based approaches. This growing reliance on artificial wetlands reinforces a technically-driven adaptation pathway and contributes to the artificialisation of wetland landscapes. Thus, climate change acts as an accelerator of existing imbalances, making it harder to sustain the ecological functions of natural wetlands and highlighting the need for a transition towards more integrated, nature-based adaptation solutions.

Common midwife toad
© Corail M.

Annex

Method and reliability

Indic. I1 falls within the "Impacts" component of the DPSIR framework adopted by the MWO. It aims to assess the consequences of anthropogenic and climatic pressures on the hydrological functioning of wetlands by analysing changes in surface water within these ecosystems. The indicator does not measure changes in the spatial extent of wetland habitats as such, but rather the evolution of hydrological states within them, distinguishing between permanent and temporary surface water. As such, it provides a direct signal of hydrological regime alteration and, potentially, of drying processes.

The analysis is based on the "Transitions" layer of the Global Surface Water (GSW) dataset, which allows the identification of changes occurring between the beginning and the end of the Landsat time series covering the period 1984-2021. This layer characterises, at pixel level (30m spatial resolution), transitions between three hydrological states: non-water, seasonally (temporarily) flooded and permanently flooded. Each pixel is assigned a class describing its initial and final state, enabling the distinction between unchanged surfaces, net water losses, water gains, and conversions between permanently and temporarily flooded areas.

The determination of the initial state relies on the identification of a so-called representative year, selected on the basis of monthly recurrence profiles that ensure a minimum level of confidence in water presence or absence. The final state corresponds to the last available year in the time series. This approach makes it possible to identify structural changes occurring over more than three decades, independently of intermediate interannual variability.

Within the framework of ***Indic. I1***, the "Transitions" layer was intersected with the harmonised Mediterranean wetlands extent map developed for ***Indic. S1***. This step restricted the analysis to surfaces located within wetland polygons and enabled differentiation between inland natural wetlands, coastal natural wetlands and human-made wetlands. Transitions corresponding to losses of permanent or seasonal water surfaces, as well as conversions from permanently to temporarily flooded areas, were interpreted as manifestations of drying or decreasing hydrological stability. Surface areas were aggregated by wetland type and variations were expressed as percentages between the initial and final states.

The reliability of the indicator is considered high for identifying long-term regional trends. It is supported by the continuity and consistency of the Landsat archive since 1984, the methodological robustness of the GSW processing chain, and the uniform application of the analysis across the Mediterranean Basin. However, uncertainties remain at the local scale, particularly due to the 30m spatial resolution, limitations in detecting shallow or highly turbid water, and the presence of emergent vegetation. In addition, the "Transitions" layer only compares hydrological states at the beginning and the end of the study period; it does not capture intermediate interannual variability or short-lived events.

Data

The indicator is based on the Global Surface Water dataset (GSW, version 2) produced by the Joint Research Centre of the European Commission under the Copernicus programme. This dataset results from the automated processing of more than 4 million Landsat images acquired between March 1984 and December 2021. Data from Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI sensors were used to ensure temporal continuity of observations at a spatial resolution of 30m.

The analysis relies on the "Transitions" raster layer, in which each pixel value corresponds to a specific type of hydrological transition between its initial and final state. The classes include unchanged permanent water, losses of permanent water, unchanged seasonal water, losses of seasonal water, conversions from seasonal to permanent water and from permanent to seasonal water, as well as ephemeral classes representing temporary occurrences of water during the period.

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Indicator
I2
Trend

IMPACTS

Conversion of natural wetland habitats

Between 1990 and 2020, natural Mediterranean wetlands were mainly converted into agricultural land (54%) and artificial wetlands (36%).

Ramsar Sites appear to be better protected against conversions, with only 3% of their natural wetlands lost, compared to 11% for non-Ramsar sites.

Decline of natural habitats under agricultural and urban pressures

From 1990 to 2020, Mediterranean wetlands experienced a major shift in land use, marked by increasing artificialisation and a significant decline in natural habitats (***Indic. P1***), severely impacting the region's overall wetland surface area (***Indic. S1***).

Monitoring of 340 sites across 23 of the 28 MedWet countries (excluding Bulgaria, Malta, Monaco, and Serbia) reveals clear trends (***Fig. 1***): natural wetland habitats were primarily converted into agricultural land (54%) and artificial wetlands (36%), reflecting mounting pressure from agriculture both for crop expansion and for hydraulic infrastructures development. At the same time, natural dry-land habitats were also heavily lost to agriculture, with 85% of the conversions since 1990.

Urbanisation is also a significant driver, responsible for the loss of 7% of natural wetlands and 11% of natural dry-land habitats, now replaced by built-up areas.

Sub-regional trends (***Fig. 2***) reveal significant disparities. In the Middle East, 62% of natural wetland habitat losses are due to conversion into artificial wetlands, driven by dam construction in Türkiye (***Indic. P2***) and the expansion of aquaculture in Egypt and Israel (***Indic. S1***). In the Maghreb, agricultural pressure is dominant, with over 83% of losses linked to expansion of cultivated land, a trend also observed in the Balkans (68%). In South-West Europe, conversions are split between agriculture (46%) and artificial wetlands (40%), while losses due to urbanisation reach a regional high of over 11%.

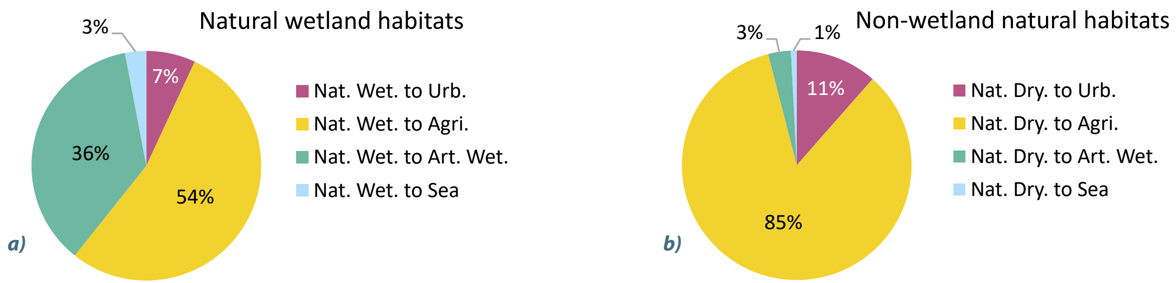

Fig. 1: Main conversions observed between 1990 and 2020 across the 340 sites monitored by the MWO for (a) natural wetland habitats and (b) natural dry-land habitats.

MWO

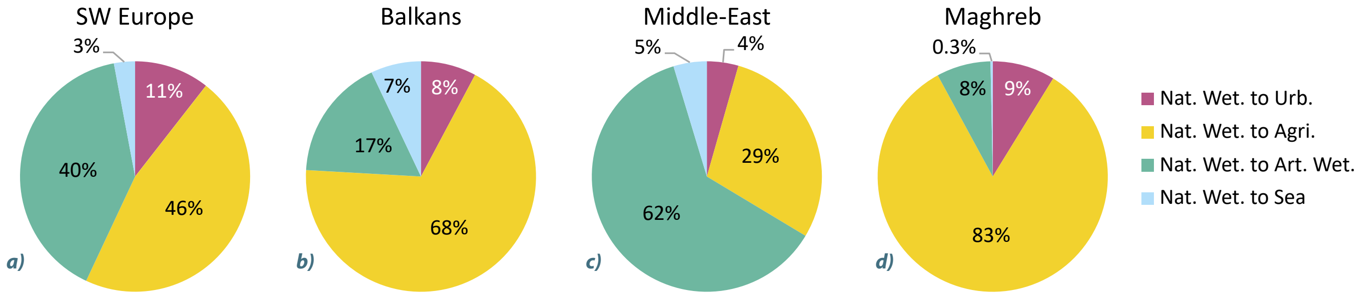

Fig. 2: Conversions of natural wetland habitats from 1990 to 2020 in the four Mediterranean subregions: South-West Europe (a), Balkans (b), Middle East (c), and Maghreb (d).

Coastal and inland wetlands: two different transformation trajectories

Conversion dynamics differ significantly between coastal and inland wetlands (***Fig. 3***). On the coast, 48% of natural wetland losses between 1990 and 2020 were due to transformations into artificial wetlands, compared to just 15% for inland sites. This is linked in particular to the concentration of economic activity in densely populated coastal areas (***Indic. D1***). Inversely, agricultural pressure is predominant for inland sites, driving 80% of losses, compared to 40% in coastal sites. This contrast reflects agricultural intensification in Mediterranean hinterlands, such as the Gharb floodplain in Morocco or around Lake Akşehir in Türkiye.

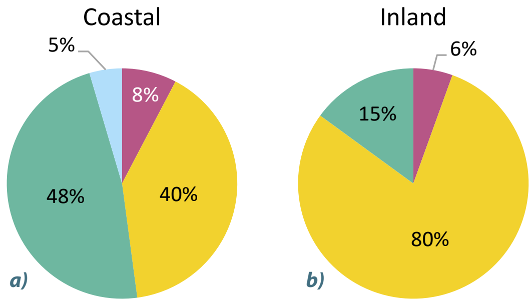

Fig. 3: Conversions of natural wetland habitats from 1990 to 2020 in coastal sites (a) and inland sites (b).

Ramsar designation: a protection against conversion impacts?

Between 1990 and 2020, Ramsar Sites were more resistant to the loss of natural wetland habitats than other sites (3% loss compared to 11%), demonstrating a degree of effectiveness of this designation (***Fig. 4***). The creation of artificial wetlands was also much more limited (+6% compared to +60% in non-Ramsar sites). Urbanisation increased in both cases, with a slightly lower rise in Ramsar Sites (+106% versus +128%). Cultivated land also expanded (+29%), representing the main cause of natural wetland loss (69% of conversions).

These results show that Ramsar status offers relative protection, strengthened by its national and international recognition. However, persistent agricultural and urban pressures underline the limits of a non-binding framework, pointing to the need for stronger measures to preserve the ecological integrity of these sites (***Indic. R1*** & ***Indic. R3***).

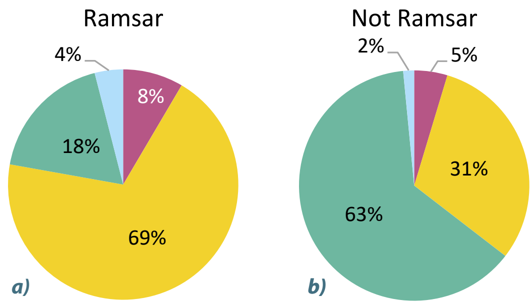

Fig. 4: Conversions of natural wetland habitats from 1990 to 2020 in monitored sites designated as Ramsar (a) and other sites (b).

Agriculture fields and aquaculture ponds, Vlaka (Croatia)
© Image Source/Envato

Annex

Method and reliability

Indic. I2 aims to analyse the conversion of natural wetland habitats into other land use types in order to characterise the impacts of human activities on the extent of Mediterranean wetlands. It falls within the "Impacts" component of the DPSIR framework used by the MWO to assess the socio-ecological dynamics affecting these ecosystems.

The indicator is based on the analysis of land use changes within sites monitored by the MWO. Habitat dynamics are identified through the comparison of land cover maps produced for the annual hydroperiods of 1990 and 2020, derived from time series of Landsat TM and Sentinel-2 satellite imagery. These maps enable the characterisation of habitat composition within each site and the assessment of long-term changes.

Habitat mapping relies on the analysis of multi-temporal satellite imagery. Following pre-processing steps (geometric and radiometric corrections), images are analysed using segmentation and object-based classification methods, allowing the delineation of homogeneous spatial units and their assignment to land cover classes. The classification system is based on a hybrid approach combining CORINE Land Cover classes with wetland habitats defined under the Ramsar Convention. This approach enables a refined distinction between different types of wetlands and the main land use categories likely to drive their transformation.

For the purposes of the indicator, land cover classes are grouped into six functional categories: (1) Built-up areas; (2) Agricultural lands; (3) Natural dry-lands; (4) Natural wetlands; (5) Artificial wetlands; and (6) Sea. Land cover maps produced for the two hydroperiods are then overlaid using a Geographic Information System tools in order to identify transitions between classes and generate conversion matrices. These matrices make it possible to quantify the areas of natural wetland habitats converted into other land uses and to identify the main trajectories of habitat change.

The reliability of the indicator is considered to be moderate to good. The mapping outputs are based on well-established and scientifically validated remote sensing methods and achieve an overall accuracy exceeding 88%, based on field validation data. However, the sample of sites monitored by the MWO is not statistically representative of all Mediterranean wetlands. The results should therefore be interpreted as robust indications of conversion dynamics within the monitored sites, rather than as a comprehensive assessment at the scale of the entire Mediterranean Basin.

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Data

Indic. I2 relies exclusively on data from the MWO site monitoring database. Since 2010, this database has compiled spatial information produced within the Mediterranean wetlands monitoring programme. It includes land use and land cover maps developed for monitored sites, derived from satellite image analysis and harmonised using a common classification system adapted to wetland ecosystems. These data make it possible to characterise habitat composition within each site and to analyse land use changes over several decades.

The database covers several hundred sites across MedWet countries and includes a wide range of wetland types (coastal, inland and artificial). It currently represents one of the main regional sources of spatial information for monitoring habitat dynamics in Mediterranean wetlands

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Barbus meridionalis
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Indicator
I3
Trend

IMPACTS

Alteration of river ecological continuity

Major Mediterranean rivers are fragmented along 95% of their length, despite an apparently good connectivity of all rivers.

This degradation is mainly driven by road network density (47%) and water abstraction (39%)..

The overall connectivity remains relatively high, but major river axes are under pressure

The ecological continuity of rivers is essential to ensure sediment transport, the free movement of species and the maintenance of key ecosystem processes. This indicator assesses the level of river connectivity by distinguishing between free-flowing stretches, stretches with reduced connectivity, and heavily impacted stretches. In the Mediterranean context, characterised by strong climatic and hydrological diversity, this indicator highlights the risks faced by aquatic ecosystems and helps guide restoration priorities.

Across the Basin, of the 2.16 million km of rivers assessed, 92% remain free-flowing, 3% show reduced connectivity and 5% are heavily impacted. While small watercourses are mostly in good ecological condition in terms of connectivity, the main rivers, critical to catchment-scale hydrological structure (such as the Nile, Rhône, Ebro and Po, for example), show a high level of fragmentation, including in their major tributaries forming the secondary networks (***Fig. 1***).

Sub-regional trends and main pressures

River connectivity in the Mediterranean is mainly affected by road network density (47%) and water abstraction (39%), well ahead of other pressures such as longitudinal fragmentation (6%), urbanisation (5%), flow alteration (2%) or sediment trapping (1%).

In South-Western Europe, fragmentation is particularly severe in the main rivers, due to a long history of hydraulic infrastructure development for irrigation and drinking water supply. Today, transport infrastructure density is the main pressure on river connectivity, intensified by high agricultural demand for water (***Fig. 2***).

In the Balkans, although 85% of the network remains free-flowing, major rivers are increasingly affected. This recent trend is largely linked to the proliferation of hydroelectric infrastructures, sometimes small in scale but cumulatively very harmful to the ecological continuity. The development of such infrastructure, often lacking basin-wide coordination, threatens rivers that until now have ranked among the best preserved in Europe.

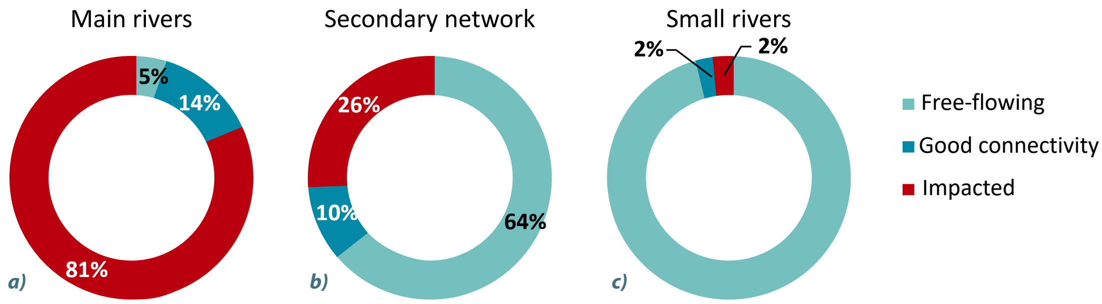

Fig. 1: Degree of river fragmentation in the Mediterranean (%), assessed using the Connectivity Status Index for main rivers (a), the secondary network (b), and small rivers (c).

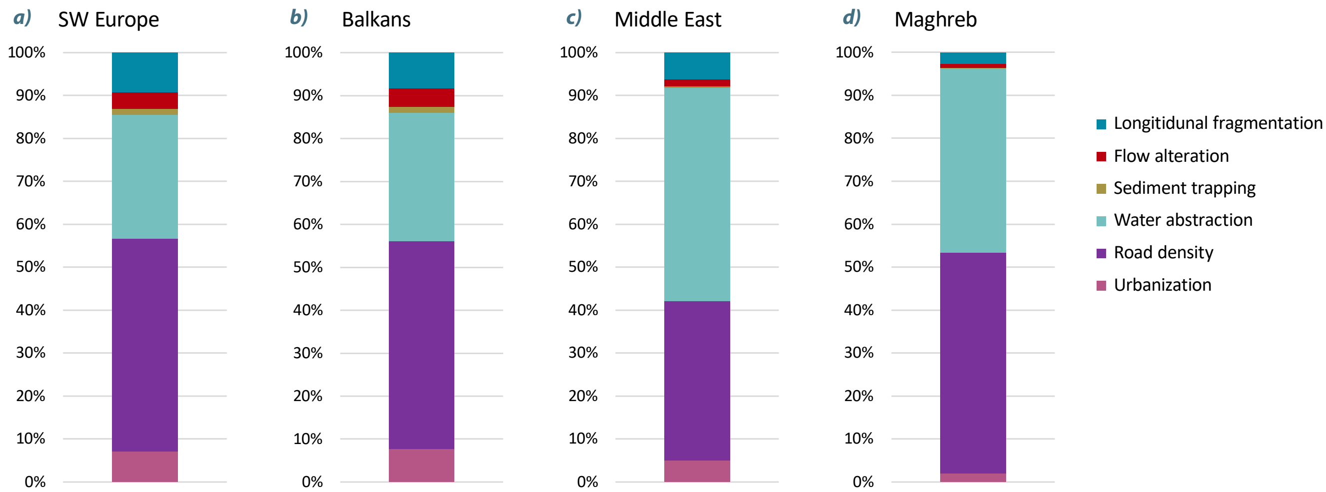

Fig. 2: Main pressures on Mediterranean rivers: South-Western Europe (a), Balkans (b), Middle East (c), and Maghreb (d).

In the Middle East and the Maghreb, the arid climate explains the dominance of intermittent rivers and wadis. The natural intermittence of flows is a structuring feature of these ecosystems, which are adapted to such hydrological regimes. However, intense pressure from water abstraction and development, in response to limited water availability, significantly weakens small rivers, despite their apparently good connectivity.

Impacts on floodplains and coastal wetlands

Fragmentation of river continuity has major consequences for floodplain and coastal wetlands across the Mediterranean region. The disruption of hydrological connectivity first affects the natural supply of water to floodplains and associated wetland areas, reducing the frequency and volume of inflows needed to sustain these habitats.

This leads to the gradual drying out of alluvial wetlands (***Indic. I1***), a decline in species-specific biodiversity, and a loss of ecosystem functions such as carbon storage, water purification and flood regulation. Secondly, the reduction of sediment transport due to the presence of dams and hydraulic structures (***Indic. P2***) results in accelerated erosion in deltas and coastal zones. Coastal wetlands that rely on regular sediment inputs, including lagoons, coastal marshes and estuaries, face growing instability. This is particularly critical in a Mediterranean region already highly exposed to SLR (***Indic. P5***) and soil salinisation.

In the arid and semi-arid areas of the Basin, mainly in the Maghreb and the Middle East, rivers play a crucial role during flash flood events. The loss of river continuity can lead to the disappearance of temporary wetlands, which are essential for many migratory species and for the livelihoods of local communities.

In summary, river fragmentation directly increases the vulnerability of Mediterranean wetlands by altering both their hydrological dynamics and their ecological functioning.

Napoleon bridge, Soča river (Slovenia)
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Annex

Method and reliability

Indic. I3 falls under the "Impacts" component of the DPSIR framework adopted by the MWO. It aims to assess the degree of disruption of river ecological continuity by analysing the intensity of anthropogenic pressures that may interfere with the movement of water, sediments, organic matter and living organisms within river networks.

The analysis is based on the Connectivity Status Index (CSI), a spatially explicit indicator used to assess river connectivity at the scale of individual river reaches. This index integrates multiple dimensions of fluvial connectivity (longitudinal, lateral, vertical and temporal) and combines different pressure factors likely to affect ecological processes. On this basis, each river reach is classified into one of three connectivity states: free-flowing, good connectivity, impacted.

The methodology relies on a global hydrographic network derived from the HydroSHEDS database, segmented into reaches located between successive confluences. Each reach constitutes the unit of analysis for which several pressure indicators are calculated, reflecting the main anthropogenic alterations affecting river connectivity. These pressures include longitudinal fragmentation associated with dams and other hydraulic infrastructure, flow regime alteration resulting from regulation, sediment trapping in reservoirs, water abstraction, as well as the intensity of infrastructure and urban development within floodplains.

These variables are integrated into a weighted multi-criteria model to produce a connectivity score ranging from 0 to 100%. Reaches with high connectivity (CSI ≥ 95%) are considered to be close to natural ecological functioning, while lower values indicate increasing levels of disruption to fluvial continuity.

Within the framework of ***Indic. I3***, connectivity values have been aggregated at the scale of the Mediterranean Basin to distinguish between free-flowing reaches, those with reduced connectivity, and those that are heavily impacted. The analysis has also been structured according to river order, allowing differentiation between major rivers structuring the hydrographic network, secondary rivers, and smaller watercourses, including headwater streams.

The overall reliability of the indicator is considered good for identifying national and regional trends. The approach relies on globally harmonised hydrological and environmental datasets and on a scientifically validated methodology. However, uncertainties remain at local (catchment) scale, particularly due to the absence or incomplete coverage of small hydraulic structures in global datasets. Small dams, weirs and diversions, which are often numerous in certain basins, may therefore lead to an underestimation of the actual level of fragmentation at local scale. Despite these limitations, the indicator provides a robust tool for analysing regional gradients of river connectivity alteration and identifying priority areas for conservation and restoration of Mediterranean river systems.

Data

The indicator primarily relies on the global dataset on river connectivity developed as part of the Free-Flowing Rivers study. This dataset is based on a global hydrographic network derived from the HydroSHEDS database, constructed from high-resolution topographic data and organised into river reaches corresponding to segments between successive confluences.

The attributes used to characterise anthropogenic pressures on river reaches combine hydrological, geometric and environmental information derived from multiple international datasets. These include global inventories of dams and reservoirs, land use and urbanisation datasets, global road network data, as well as hydrological models describing flow regimes and water abstraction. These variables are integrated into a multi-criteria assessment model to assign a connectivity score to each river reach. The results are then aggregated to produce synthetic metrics at the scale of the Mediterranean Basin.

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Emys orbicularis
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Indicator
R1
Trend

RESPONSES

Wetlands protection

Although 36% of Mediterranean wetland habitats lie within protected areas, only 7% benefit from a high level of protection.

The Ramsar network includes 414 sites across the Mediterranean, yet 161 key wetlands for waterbirds remain undesignated.

Protected areas: a central yet incomplete tool for wetland conservation in the Mediterranean

The designation of protected areas remains one of the main levers for conserving Mediterranean wetlands. By providing refuges for biodiversity, limiting anthropogenic pressures, and safeguarding essential ecological functions, these delimited areas play a key role in preserving wetland ecosystems and the services they provide.

A cross-analysis of up-to-date data on the spatial distribution of wetland habitats in MedWet countries (***Indic. S1***) and the coverage of protected areas (according to IUCN classification) highlights the significant yet partial role of these mechanisms. As shown in ***Fig. 1***, approximately 36% of identified wetland habitats in the Mediterranean are located within protected areas, and 31% benefit from legally binding protection. However, only 7% fall under high protection categories (IUCN I to IV). These proportions remain fairly consistent across different wetland types (coastal, inland, etc.) but hide important geographical disparities.

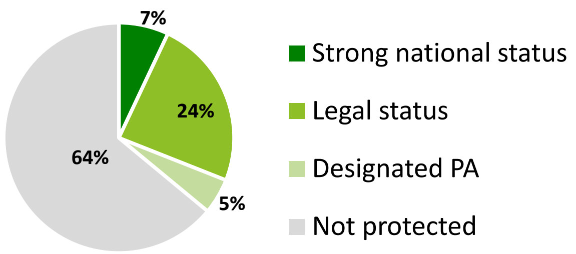

Fig. 1: Protection levels of wetland habitats across MedWet countries.

While countries in South-West Europe or the Balkans have dense protected area networks covering a large share of their wetlands, others, such as Algeria, Egypt, Syria or Türkiye, still show major gaps.

In addition, the designation of protected areas is strategic for targeting the most critical wetlands. Over the past twenty years, the proportion of Key Biodiversity Areas (KBAs) for freshwater that benefit from a protection status and/or Other Effective Area-Based Conservation Measures (OECMs) has significantly increased in most Mediterranean countries. However, such spatial analyses remain limited, as data are often heterogeneous and rarely updated in a coordinated way, which can lead to an overestimation of actual protection. Finally, the surface area of protected zones does not necessarily reflect their real effectiveness in ensuring the long-term conservation of wetlands (***Indic. R3***).

Wetlands of International Importance gaining recognition

Since the creation of the Ramsar Convention in 1971, 414 sites have been designated in MedWet countries, covering over 70,000 km^2 (***Fig. 2***). In recent years, Mediterranean wetlands have gained visibility and recognition through inclusion in the Ramsar List. Since 2010, 17 countries have expanded their national designations, with Tunisia, France and Morocco standing out for their commitment, designating 22, 14 and 14 new sites respectively. A total of 85 new sites have been listed over the past 15 years, representing a nearly 10 000 km^2 increase. These additions include 41 inland sites, 23 coastal sites and 21 human-made wetlands.

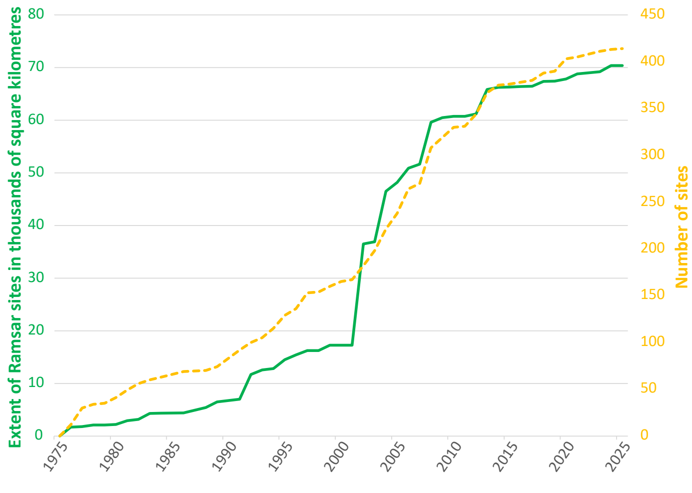

Fig. 2: Cumulative surface area of Ramsar Sites in Mediterranean Contracting Parties

Strengthening and expanding wetland protection

The identification of Wetlands of International Importance is based on rigorous criteria that help guide long-term conservation and management. Despite a significant number of Ramsar site listings, a large share of wetlands of interest, particularly for waterbirds, remains undesignated (***Fig. 3***). By cross-referencing waterbird monitoring data with three Ramsar designation criteria, 161 additional sites have been identified as eligible across most Mediterranean countries (mainly in the Middle East and South-West Europe), with 51% of these located in coastal zones. Expanding the Ramsar network would help address current gaps and support international objectives for wetland and ecosystem protection.

Although Ramsar sites represent only 7% of Mediterranean wetlands monitored for wintering waterbirds, they alone host nearly half of the populations. These sites show significantly higher species richness and abundance compared to undesignated wetlands. Approximately 35% of their surface area corresponds to wetland habitats, underscoring both their ecological value and the potential for restoring degraded ecosystems.

Currently, 43% of Ramsar Site areas have regulatory protection status, including 12% with strong national protection. However, 76 sites remain without any formal protection, including 44 in Algeria and 22 in Morocco. Some of these are nevertheless included within areas benefiting from OECMs. These figures show notable progress, while highlighting the need for strengthened measures, particularly in the Maghreb.

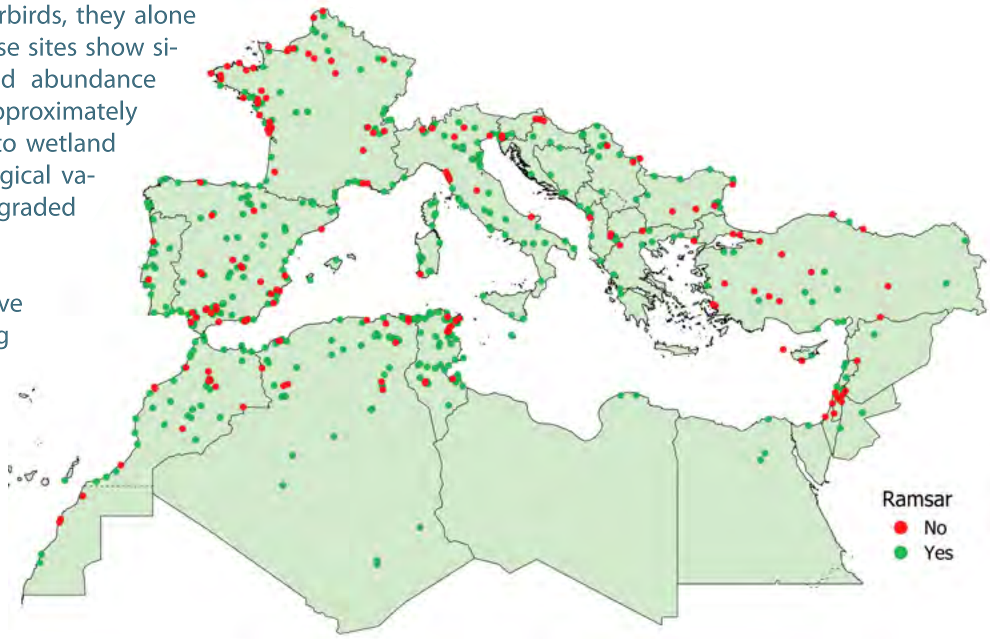

Fig. 3: Mediterranean wetlands important for waterbirds (based on 3 Ramsar criteria), with designation status.

Crnojevića River (Montenegro)
© Jasmina K.

Annex

Method and reliability

Indic. R1 falls within the "Responses" component of the DPSIR framework adopted by the MWO. It aims to characterise the level of protection of Mediterranean wetlands by analysing both the extent and spatial distribution of protection measures implemented across the Basin. The indicator is based on two complementary approaches: assessing the proportion of wetland habitats located within protected areas, and analysing the coverage of the network of Wetlands of International Importance designated under the Ramsar Convention.

The estimation of wetland protection levels relies on a spatial analysis combining the harmonised mapping of Mediterranean wetland habitats developed under ***Indic. S1*** with international databases on protected areas. Using Geographic Information System tools, wetland habitat polygons are intersected with protected area boundaries in order to identify surfaces falling within protection schemes. This approach allows for the estimation of the proportion of wetland habitats benefiting from a protection status, whether internationally recognised or established through national legislation. Protection levels are further differentiated according to the management categories defined by the International Union for Conservation of Nature (IUCN). Particular attention is given to protected areas associated with stricter conservation measures, with sites classified under categories Ia, Ib, II, III and IV considered as having a high level of protection.

The indicator also includes an analysis of the Ramsar Sites network. This component aims to characterise both the development and coverage of the Mediterranean network, as well as to identify potential gaps in the designation of Sites of International Importance. These gaps are identified by comparing existing Ramsar Sites with wetlands recognised as important for wintering waterbirds. Such sites are identified using data from international waterbird monitoring programmes and by applying several ecological criteria used for Ramsar designation. This approach makes it possible to highlight wetlands that are likely to meet the designation criteria but have not yet been designated.

The reliability of the indicator is considered to be good for characterising the overall level of wetland protection at the Mediterranean scale. It is based on recognised international spatial datasets and standardised geospatial analysis methods. However, its interpretation requires caution. The spatial data used may be incomplete, heterogeneous and not synchronised in terms of updates across countries and sources. Moreover, the analyses are based on a single reference point in time and do not allow for the direct assessment of temporal trends. A decrease in the total extent of wetlands may therefore lead to an apparent increase in the proportion of protected areas without reflecting an actual improvement in conservation status. Finally, the diversity of protected area types included in the analysis (whether regulatory, contractual or based on land tenure arrangements) covers national, regional and global designations with varying levels of management, monitoring and effectiveness. As such, the designation of a protected area does not necessarily guarantee active management or effective conservation outcomes on the ground.

Data

The analysis is based on the regional database of Mediterranean wetland extent developed under ***Indic. S1***. This database results from a process of compilation, harmonisation and refinement of national wetland inventories at the Mediterranean scale, providing a consistent and comparable representation of the spatial extent of natural and artificial wetland habitats.

Data on protected areas are derived from the World Database on Protected Areas (WDPA), available through the Protected Planet platform, which compiles official information on protected area boundaries and management categories worldwide. Information on Ramsar Sites is sourced from the Ramsar Sites Information Service (RSIS), the official database listing Wetlands of International Importance designated by the Contracting Parties. The identification of wetlands important for waterbirds is based on data from the International Waterbird Census (IWC), coordinated by Wetlands International, which provides information on the abundance and distribution of wintering waterbird populations across wetland sites globally.

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Azraq (Jordan)
© Young L.

Indicator
R2
Trend

RESPONSES

Wetlands restoration

In the northern Mediterranean countries, nearly 88,000 km² of lost wetland habitats could be restored with low effort, enabling rapid and cost-effective ecological recovery.

A survey conducted in 24 MedWet countries has already identified 224 priority wetland sites for restoration, covering nearly 4,000 km².

Mapping priority areas for restoration actions

Using a spatial approach that combines hydrological, topographic, climatic and land-use data, an assessment of wetland restoration potential was carried out across the northern Mediterranean countries, from Portugal to Türkiye. It allows to accurately identify historically wetland areas that have been lost and to assess their potential for restoration. Of the 442,000 km^2 potentially restorable wetland habitats, around 88,000 km^2 (20%) could be recovered with relatively low effort, in areas where conditions are most favourable for rapid and low-cost rehabilitation. In a context of intense environmental pressure, these results provide a concrete basis for initiating ambitious and targeted restoration actions.

This fine-scale spatial analysis enables countries to prioritise actions on the most accessible and functional areas (***Fig. 1***). Restoring these ecosystems would quickly reactivate key ecosystem services such as carbon storage, flood regulation and improved water quality. When integrated into national wetland, biodiversity, climate and land-use strategies, this data helps strengthen the consistency and effectiveness of public policies.

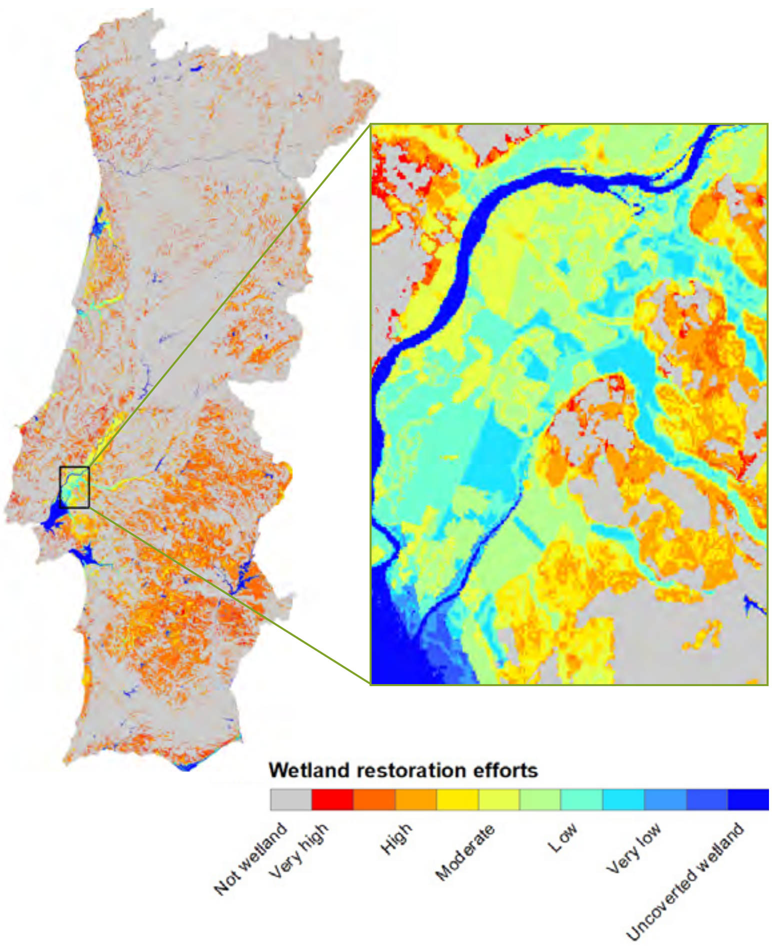

Fig. 1: Example of national-scale mapping (Portugal) of potentially restorable wetlands, including an estimate of the effort required to rehabilitate lost wetland habitats.

Restoration remains limited, despite many identified sites

A survey conducted among wetland experts in 24 Mediterranean countries identified 224 priority wetland sites for restoration, representing nearly 4,000 km². These sites are severely degraded due to urban expansion, tourism development, agricultural intensification and insufficient management. These pressures have led to habitat destruction, altered hydrological regimes and a high disruption of wildlife, undermining the ecological functioning of these areas.

Although 24% of the identified sites benefit from protection status and/or international designation, mainly under the Ramsar Convention or the Natura 2000 network, this recognition often remains symbolic. In most cases, conservation measures are only partially implemented, which limits their effectiveness against ongoing degradation.

The study also highlights the importance of natural coastal wetlands, which represent two-thirds of all identified sites. The most affected habitats include coastal marshes, lagoons and temporary ponds. Despite the ecological urgency, effective restoration remains extremely limited: less than 1% of sites have been restored to date.

A policy framework under construction

La restauration des zones humides en Méditerranée reWetland restoration in the Mediterranean is underpinned by an evolving legal and policy framework, notably at the European level. Instruments such as the Water Framework Directive, and the Habitats, Birds and Floods Directives, require Member States to achieve or restore good ecological status in aquatic ecosystems. This ambition was significantly reinforced in 2024 with the adoption of the Nature Restoration Law, which sets legally binding targets: the restoration of 20% of degraded natural habitats by 2030 and 100% by 2050. Each Member State must develop a national restoration plan, including for wetlands ecosystems.

Wetlands are also integrated into other frameworks such as national climate strategies, Nationally Determined Contributions (NDCs), the EU Climate Adaptation Strategy, and the LULUCF regulation (Land Use, Land-Use Change and Forestry).

At the global level, the Ramsar Convention remains the primary instrument for wetland conservation and restoration. Other frameworks, such as the UN Decade on Ecosystem Restoration and the Kunming-Montreal Global Biodiversity Framework, have established ambitious targets for 2030. These commitments are supported by additional mechanisms, including the Protocol on Integrated Coastal Zone Management (Barcelona Convention) and the Sustainable Development Goals. However, most of these instruments remain non-binding, and the term "restoration" still lacks a harmonised legal definition at the global level.

Successful wetland restoration case studies in the Mediterranean

Several flagship projects across the Mediterranean demonstrate the multiple benefits of wetland restoration as Nature-based Solutions. In Spain, in the Albufera de Valencia Natural Park, the rehabilitation of wetland habitats has significantly improved water quality, restored bird communities and revived a local economy based on sustainable farming and ecotourism. In France, parts of the former Camargue salt pans have been reconnected to natural hydrological flows, enhancing the resilience of the ecosystem to sea-level rise and coastal erosion.

Further east in the region, additional examples confirm the relevance of such initiatives. In Montenegro, the Tivat Solila Nature Reserve, formerly a hunting area and dump site, was restored as a coastal wetland through strong community engagement and has since been designated a Ramsar Site. In Italy, within the Venice Lagoon, the creation of 2.2 km² of wetland habitat allows for the storage of up to 1.8 million m³ of water, playing a key role in flood regulation and risk mitigation.

These cases clearly illustrate the vital role that restored wetlands can play for biodiversity, climate adaptation and local communities.

Albufera de Valencia (Spain)
© Retamosastock/Envato

Annex

Method and reliability

Indic. R2 falls under the "Responses" component of the DPSIR framework adopted by the MWO. It aims to characterise wetland restoration dynamics across the Mediterranean Basin, as well as the opportunities available to accelerate restoration efforts. The indicator combines two complementary approaches: the large-scale spatial assessment of wetland restoration potential and the identification of priority restoration sites based on regional initiatives and expert-based surveys.

The assessment of restoration potential relies on a spatial modelling approach based on Earth Observation data. This method consists of identifying areas historically favourable to wetland occurrence by combining several biophysical variables, including topographic, hydrological and climatic factors. These inputs are used to generate maps of Potential Wetland Areas (PWA), which represent the likelihood of wetland presence independently of current land use. By intersecting these maps with Land Use / Land Cover (LULC) datasets, it becomes possible to identify wetland habitats that may have been lost and to assess their potential for recovery. The identified areas can then be classified according to different levels of restoration effort, providing a basis for prioritising interventions at various territorial scales.

In addition to this spatial approach, the indicator draws on the results of a regional survey aimed at identifying degraded wetlands that could be subject to restoration actions. This survey was conducted among experts, site managers and stakeholders involved in wetland conservation across several Mediterranean countries. It provides valuable insight into priority sites, the main drivers of degradation and ongoing restoration dynamics in the region.

The reliability of the indicator is considered good for analysing restoration opportunities at the Mediterranean scale. The spatial approaches used rely on harmonised global environmental datasets and robust modelling methods, enabling a consistent large-scale assessment. However, the results should be interpreted with caution. Restoration potential maps are based on biophysical criteria and do not systematically account for local constraints such as land ownership, infrastructure or planning policies. In addition, these results are currently available only for the northern Mediterranean countries, from Portugal to Türkiye. This partial geographical coverage limits the ability of ***Indic. R2*** to comprehensively identify potentially restorable wetlands across all MedWet countries using this method. Furthermore, expert-based surveys rely on voluntary contributions and may be subject to biases related to the availability and geographical distribution of respondents. Despite these limitations, the indicator provides a valuable basis for identifying restoration opportunities and supporting policy development for wetland conservation.

Data

The analysis relies on several complementary data sources. The assessment of restoration potential is based on spatial modelling outputs derived from global environmental datasets, including Digital Elevation Models from the Copernicus Digital Elevation Model (COP-DEM90), climatic variables from the WorldClim database, and LULC maps from international datasets such as CORINE Land Cover. These datasets are combined to identify potential wetland areas and potentially restorable wetlands at different geographical scales.

Information on priority restoration sites is derived from a regional survey conducted by WWF Spain among experts and stakeholders involved in wetland conservation across several Mediterranean countries. This survey enabled the identification of more than 200 sites suitable for ecological restoration and provided insight into the main pressures affecting these ecosystems.

The integration of these sources makes it possible to combine a forward-looking spatial approach with expert knowledge of sites, thereby characterising wetland restoration opportunities across the Mediterranean Basin.

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Field visit, Oristano (Italy)
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Indicator
R3
Trend

RESPONSES

Wetlands management

In 2023, only 47% of Mediterranean Ramsar Sites had a management plan, and 33% had effectively implemented it.

Wetland Contracts offer concrete levers to help fill this gap and strengthen management on the ground.

Ramsar Sites: designated, but not always managed

Beyond their protected status (***Indic. R1***), the long-term sustainability of Mediterranean wetlands and their biodiversity largely depends on the quality and effective implementation of management actions. Designation mechanisms provide useful, sometimes legally binding, frameworks, but they are not sufficient on their own to ensure the conservation of habitats or the resilience of species under growing pressures, particularly those linked to climate change.

Ramsar Sites clearly illustrate this limitation. In the Maghreb, for example, wintering populations of threatened waterbird species are significantly larger in sites with a management plan that is actively implemented. These instruments are therefore essential to translate formal commitments into concrete actions. However, in 2024, only 47% of Mediterranean Ramsar Sites had a management plan, and just 33% had actually implemented it (***Fig. 1***). Of the 85 sites designated since 2010, 34 have an implemented plan, 10 are under development, 5 have an inactive plan, and 36 have declared none. The Maghreb sub-region, despite having a large number of sites compared to the Middle East and the Balkans, shows particularly low rates of management plans development and implementation.

Another instructive example concerns management actions targeting wetland habitats within the Natura 2000 network: they enable waterbird communities to adapt to global warming twice faster than other types of intervention. Measures focusing on natural habitats are therefore more effective than species-specific actions, and play a key role in helping species communities adapt to the effects of climate change.

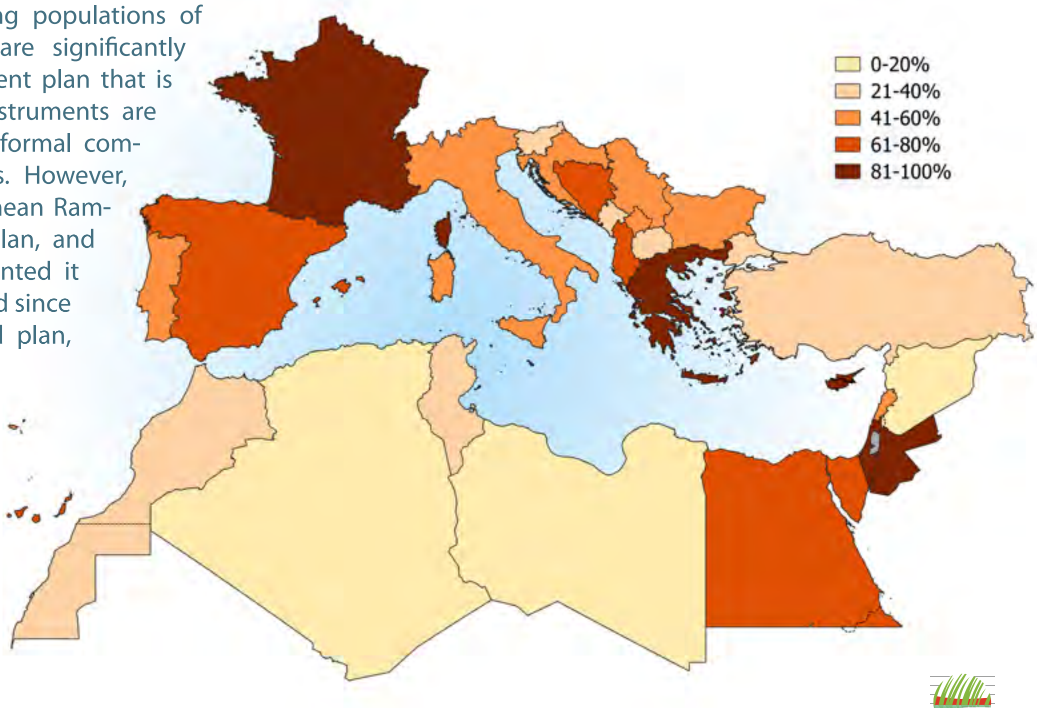

Fig. 1: Level of development and effective implementation of management plans in Mediterranean Ramsar sites in 2024 (%).

MWO

A participatory approach: Wetland Contracts

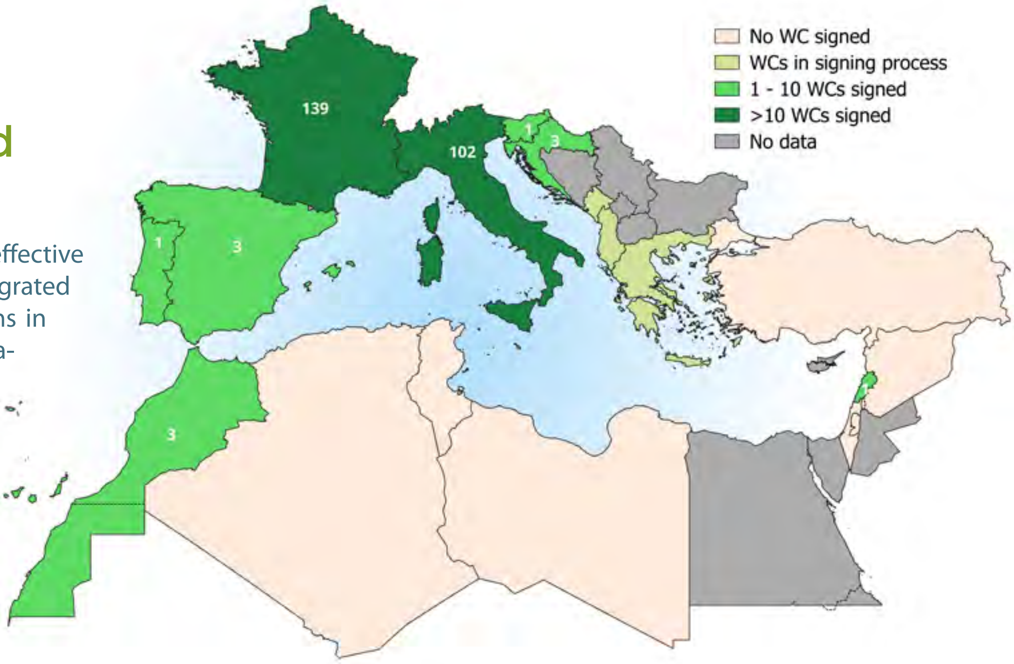

Fig. 2: Wetland Contracts in Mediterranean countries and their level of implementation.

Wetland Contracts are particularly effective tools for the sustainable and integrated management of wetland ecosystems in the Mediterranean. Based on voluntary agreements between public and private stakeholders, they foster a shared long-term vision for the preservation and sustainable use of wetlands through a participatory and collaborative process. By actively involving local actors, these contracts enhance coordination and improve the effectiveness of actions on the ground.

They are supported by a clear legal framework and a strategic action plan that define objectives, concrete commitments, roles, responsibilities and actions. This approach promotes inclusive governance tailored to local contexts, while integrating existing legal frameworks and environmental assessment tools. The objective is to reconcile local development, public participation and wetland conservation.

Initially developed in the context of River Contracts, mainly in France and Italy, these mechanisms have gradually expanded to other types of wetlands such as lakes, lagoons and even aquifers. A first inventory carried out in 2024-2025 identified several dozen contracts already in force, some of them covering Ramsar Sites, as well as many under negotiation across countries of South-West Europe and the Balkans (***Fig. 2***). This regional dynamic is now extending to the Maghreb and the Middle East, with emerging initiatives particularly in Morocco and Lebanon.

This expansion demonstrates the relevance and transferability of these participatory governance models, offering concrete solutions for wetland conservation across the Mediterranean Basin.

Aligning water and wetland management

Indicator SDG 6.5.1 assesses the extent to which Integrated Water Resources Management (IWRM) is being implemented, based on the existence and implementation of relevant policy, legal frameworks and monitoring programs. In 2023, although many countries reported advanced levels of implementation, particularly France and Spain, significant disparities remain, especially in the Balkans and the Middle East (***Indic. R4***). A more coherent and operational implementation of IWRM could significantly enhance wetland management, provided these ecosystems are explicitly included in its scope. By structuring governance around intersectoral coordination (***Indic. R5***), local stakeholder engagement and a catchment-based approach, IWRM offers a key lever to promote effective management of wetland ecosystems in the Mediterranean.

Cabo de Gata, Nijar (Spain)
© Carrera A.

Annex

Method and reliability

Indic. R3 falls under the "Responses" component of the DPSIR framework adopted by the MWO. It aims to assess the level of effective implementation of wetland management mechanisms across the Mediterranean Basin. The indicator evaluates the extent to which existing management tools translate conservation commitments into operational actions on the ground, while also structuring coordination among the various stakeholders involved in wetland management.

The analysis is primarily based on assessing the degree of development and implementation of management plans for Mediterranean Ramsar Sites. Management plans are one of the main instruments recommended by the Convention on Wetlands to ensure the conservation and wise use of wetlands. The metric consists of compiling, for all Ramsar Sites across MedWet countries, the reported status of their management plans. Sites are classified into four categories: (i) sites with no declared plan; (ii) sites with a plan under development; (iii) sites with an existing but not implemented plan; and (iv) sites with a management plan effectively implemented. This typology makes it possible to distinguish between formal site designation and actual management implementation, and to better assess countries' capacity to translate international commitments into operational frameworks.

In addition, the indicator considers the development of participatory and local governance tools such as Wetland Contracts. These mechanisms are based on voluntary agreements between public authorities, local governments, civil society organisations and local users, aimed at establishing a shared vision and an action plan for the sustainable management of wetlands. They help integrate ecological, socio-economic and territorial issues within a framework of dialogue and strategic planning at the local or river basin scale.

The analysis also takes into account the articulation between wetland management and integrated water resources management frameworks. This perspective allows for an assessment of how water policies and intersectoral coordination mechanisms contribute to structuring management actions and enhancing the coherence of public policies related to wetland ecosystems.

The reliability of the indicator is considered good in terms of capturing institutional arrangements and governance dynamics related to wetland management at the Mediterranean scale. The analysis is based on recognised institutional databases and information derived from international reporting mechanisms. The analytical categories used enable consistent comparisons between countries and provide insight into the operational status of management instruments. However, some limitations must be acknowledged. The existence of a management plan or governance mechanism does not necessarily guarantee its ecological effectiveness or the actual level of implementation. In addition, the availability and updating of information may vary across countries. Finally, the analysis of management plans focuses primarily on Ramsar Sites. Wetlands outside this network may also be subject to management measures, which could lead to an underestimation of the overall level of wetland management in some countries.

Data

The analysis draws on several complementary data sources relating to wetlands management in the Mediterranean. Information on Ramsar Sites and the status of their management plans is mainly derived from the Ramsar Sites Information Service (RSIS), the official database listing Wetlands of International Importance designated by Contracting Parties. These data are complemented by national reports submitted by countries as part of the Convention's monitoring framework.

Data on Wetland Contracts and similar participatory governance mechanisms are sourced from Euro-Mediterranean cooperation projects dedicated to biodiversity protection and integrated ecosystem management, including initiatives developed under the Interreg MED and Interreg Euro-MED programmes, such as the WE GO COOP project (improving WEtland GOvernance through a COmmunity Of Practice). These sources provide an overview of existing initiatives and their level of implementation across different countries in the Mediterranean Basin.

Together, these datasets allow for the documentation of both formal site-based management instruments and innovative territorial approaches aimed at strengthening coordination and collective action around wetlands.

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Indicator

R4

Trend

RESPONSES

Sustainable use of water resources

Water Use Efficiency (WUE) remains low in the Mediterranean, particularly in agriculture, although modern irrigation and sustainable farming practices could reduce annual water consumption by 35%.

Only 20% of treated wastewater is currently reused in the Mediterranean, despite its strong potential.

Towards more efficient water resource management

The Water Use Efficiency (WUE) index, developed by the FAO as part of the Sustainable Development Goals (SDGs), helps assess progress in water savings relative to demand. While some countries show high efficiency thanks to effective domestic water management (Malta, Cyprus) or industrial sectors (France, Israel), most countries record very low levels of efficiency (***Fig. 1***).

Agriculture, the largest consumer of water in the Mediterranean (***Indic. P2***), continues to show the lowest efficiency levels, despite slight improvements in recent years (***Fig. 2***). Countries such as Libya, Morocco, Syria, Tunisia and Türkiye, among the most affected by severe water stress, show WUE values below the global average (0.7 USD/m^3).

Yet solutions exist. Modern irrigation, combined with sustainable farming practices, could reduce agricultural water use by 35% annually across the Mediterranean. Many countries are gradually replacing surface irrigation with more efficient localised systems. The European Union has also introduced a specific regulatory framework (EU 2020/741), in effect since 2023, to support the reuse of wastewater in agriculture.

However, this transition has not always resulted in real water savings, due to the expansion of irrigated areas and the shift to more water-intensive crops, such as corn and avocados, counterbalancing gains in efficiency.

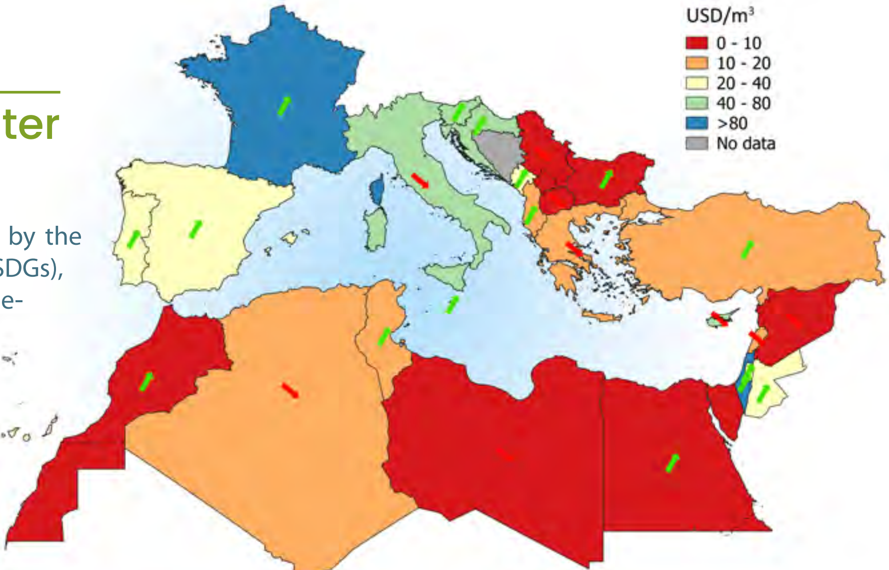

Fig. 1: WUE index (USD/m^3) in 2021, with arrows showing the change since 2010.

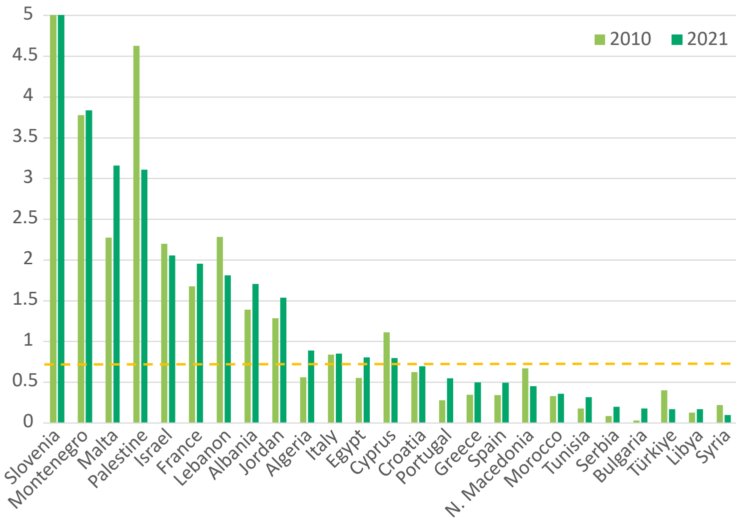

Fig. 2: Changes in WUE (USD/m^3) between 2010 and 2021 in the agricultural sector in Mediterranean countries (Slovenia: 13 in 2010 and 9.1 in 2021).

Non-conventional water resources: a solution for sustainable water management?

As water resources become increasingly scarce, non-conventional solutions such as the reuse of treated wastewater and the desalination of seawater or brackish water are attracting growing interest across the Mediterranean countries.

Nonetheless, 80% of wastewater in the region is still discharged without being reused. Yet reuse of treated domestic or industrial wastewater for agricultural, urban or industrial use is an effective way of reducing pressure on freshwater sources, improving discharge quality and securing water supplies for human uses. In the Mediterranean, reuse is mostly dedicated to crop irrigation and is supported by regulations in around two-thirds of countries. In Israel, Jordan and Tunisia, it accounts for more than 96% of collected wastewater volumes.

Desalination is also expanding rapidly. In the Maghreb and the Middle East, capacity could reach 30 to 40 million m^3/day by 2040, thirteen times more than in 2014. Countries such as Algeria, Egypt, Spain, Israel and Italy are leading large-scale implementation. However, this solution presents significant challenges: high investment costs, substantial energy use, and major environmental impacts, particularly in coastal zones, where discharges of saline brine and chemical additives can cause long-lasting degradation of marine ecosystems. Relying solely on technological solutions can, in some cases, shift pressure from freshwater systems to marine environments, without addressing the structural causes of water stress.

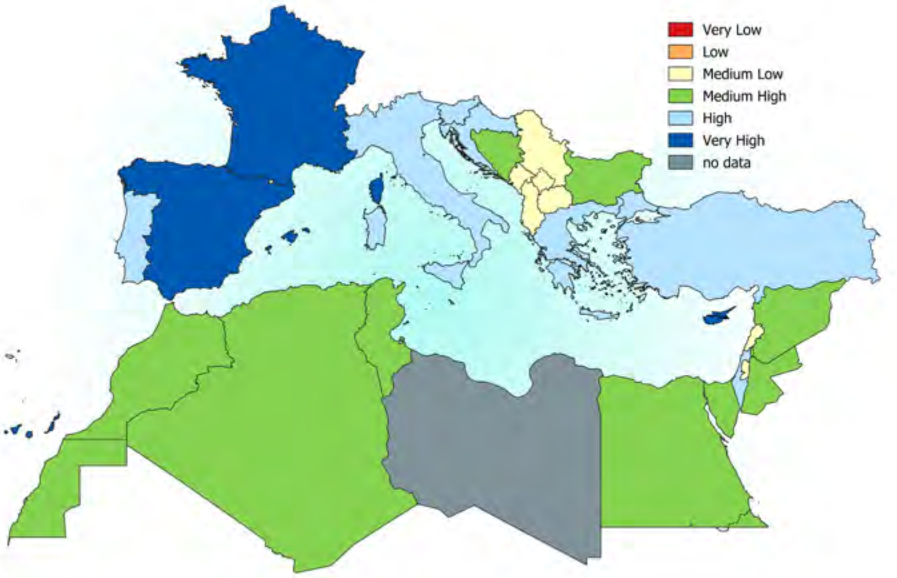

Fig. 3: Degree of IWRM implementation in Mediterranean countries, based on SDG indicator 6.5.1 (2023).

Integrated water resources management to sustainably meet growing demand

The increase in the number and capacity of dams (***Indic. P2***), land use changes (***Indic. P1*** & ***Indic. I2***), and water pollution (***Indic. P3***) are having major impacts on downstream ecosystems, reducing the services they provide. Hydraulic infrastructure, often associated with agriculture, energy or water supply, disrupts the ecological connectivity of rivers (***Indic. I3***). These pressures weaken natural wetlands, which rely on freshwater inflows and may dry out or disappear entirely (***Indic. I1***).

In this context, Integrated Water Resources Management (IWRM) represents a sustainable approach. It promotes coordinated management of water, lands and related resources, aiming to balance socio-economic development with the preservation of ecosystems. Monitored as part of the SDGs, its implementation is based on four pillars: policy, institutions, management tools and financing. While most Mediterranean countries have included IWRM in their strategies (***Fig. 3***), progress remains uneven, particularly in the Maghreb and the Middle East, where institutional coordination is still limited (***Indic. D3***). Transboundary cooperation is also essential: more than 60% of surface waters in the southern and eastern Mediterranean are shared between countries, and all states in the region have at least one transboundary aquifer.

Wastewater treatment plant, Mataró (Spain)
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Annex

Method and reliability

Indic. R4 falls within the "Responses" component of the DPSIR framework adopted by the MWO. It aims to assess progress made towards the sustainable use of water resources across the Mediterranean Basin, by analysing both the efficiency of water use and the development of solutions designed to reduce pressure on water resources.

The analysis is primarily based on the Water Use Efficiency (WUE) index, which is also used to monitor the Sustainable Development Goal (SDG) 6.4 on sustainable water use. This index measures the economic value generated per unit of water used and provides an indication of the capacity of national economies to generate value while limiting the intensity of their water consumption. It is expressed in USD/m^3 and is calculated as the ratio between the gross value added generated by the main economic sectors and the volume of water withdrawn by these sectors. The index distinguishes three main sectors of use: agriculture, industry and services, the latter including domestic uses. This sectoral approach makes it possible to compare efficiency levels across different types of economic activity and to identify potential areas for improving water use optimisation.

In the Mediterranean context, particular attention is given to the agricultural sector, which represents the largest user of water across the basin. Water use efficiency in this sector is generally lower than in industry and services, reflecting both the strong reliance on irrigation and the structural importance of agriculture in many national economies.

The indicator also incorporates elements related to the development of alternative water management solutions aimed at diversifying water supply sources and reducing pressure on natural resources. These include, in particular, the reuse of treated wastewater and the desalination of seawater and brackish water, both of which are expanding rapidly in several Mediterranean countries facing increasing water stress.

The reliability of the indicator is considered moderate to good for analysing trends at the Mediterranean scale. The WUE index is based on internationally harmonised economic and hydrological statistics developed within the SDGs monitoring framework, ensuring a certain degree of comparability across countries and over time. However, several limitations must be acknowledged. Estimates rely on national statistics whose availability, accuracy and update frequency may vary between countries. In addition, the indicator primarily reflects the economic efficiency of water use and does not directly capture the full range of environmental dimensions associated with water sustainability, particularly the ecological impacts related to water abstraction, hydraulic infrastructure, or technological solutions implemented to secure water supply.

Data

The analysis is mainly based on data related to the WUE index derived from the SDG indicator 6.4.1 and compiled by the FAO in the FAOSTAT database. This indicator combines information on water withdrawals by economic sector and on the gross value added generated by these sectors, based on national statistics harmonised at the international level.

Data on treated wastewater reuse are drawn from institutional reports and international databases on water and sanitation, particularly those produced by the FAO and the World Bank. These sources provide estimates of the proportion of treated wastewater that is effectively reused across Mediterranean countries.

Information on desalination is based on international analyses and databases documenting the evolution of desalination capacity and its geographical distribution across Mediterranean countries, particularly in the Maghreb and Middle East sub-regions where this technology is rapidly expanding.

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Wetlands conference, Oristano (Italy)
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Indicator
R5
Trend

RESPONSES

Political commitment to wetlands and levers for action

Political commitment to wetlands varies significantly across Mediterranean sub-regions, with clear discrepancies between declared intentions and real implementation.

Strengthening intersectoral governance, institutional capacities and regional cooperation is a priority to turn commitments into tangible actions.

This composite indicator is based on a set of institutional variables describing the mechanisms established by Mediterranean countries to protect and sustainably manage their wetlands. It assesses key elements such as the existence of intersectoral wetland committees, river basin authorities, national biodiversity and/or wetland strategies, and the integration of wetlands into broader development programmes. Each variable has been rated according to its level of formalisation and real implementation, allowing for the calculation of a standardised overall score for each country (***Fig. 1***). The resulting indicator reflects the degree of political and institutional engagement and provides a comparative basis for analysing regional dynamics and identifying areas requiring reinforcement.

Unequal political commitment dynamics across the Mediterranean basin

The assessment reveals a pronounced disparity in political commitments to wetlands across sub-regions. While some countries have well-developed and coordinated policy frameworks, others struggle to translate international commitments into national policies (***Indic. D3***).

In South-West Europe, countries' engagement is underpinned by stable institutions and integrated policy approaches, particularly for the management of water resources (***Indic. R4***). Most of these countries have operational basin authorities, intersectoral coordination committees and national or local action plans for wetlands conservation.

These mechanisms are usually supported by consistent legal frameworks and reinforced by obligations from EU directives, such as the Water Framework Directive and the Birds and Habitats Directives. The interaction between local, national and European levels is well established, facilitating the practical application of international commitments (particularly within the Ramsar Convention framework).

In the Balkans, recent efforts to strengthen environmental policy are notable, driven largely by accession or alignment processes with the European Union. Water management institutions have been established and wetlands are gradually being recognised in national strategies. However, intersectoral coordination is often incomplete and implementation mechanisms suffer from a lack of both human and financial resources. Planning efforts remain largely theoretical, and water, agricultural and spatial policies continue to operate in silos.

The situation in the Middle East is more diverse. Some countries, such as Türkiye and Cyprus, have relatively advanced administrative structures and have adopted strategies that include wetlands among conservation priorities. In other countries in the sub-region, policies remain incomplete or unevenly implemented. Conflicts, political instability and resource scarcity limit institutional capacity to manage wetlands effectively. The absence or weakness of intersectoral committees, fragmented ministerial responsibilities and lack of implementation monitoring hinder the full integration of wetlands into policy.

In the Maghreb, countries are demonstrating growing political will to take actions in favour of wetlands, with national strategies being developed and wetlands increasingly included among environmental priorities.

However, implementation is often disadvantaged by poor institutional coordination, the absence of dedicated structures and persistent funding challenges. Tunisia stands out with a more structured approach and sustained dynamic, but elsewhere wetlands remain largely marginal in sectoral policy frameworks.

Overall, formal commitments, such as ratification of international conventions, national planning and the establishment of technical bodies, are present in most Mediterranean countries. However, the extent to which these are put into practice varies widely depending on political context, institutional capacity (***Indic. D3***), and the degree to which wetlands are prioritised in national policies.

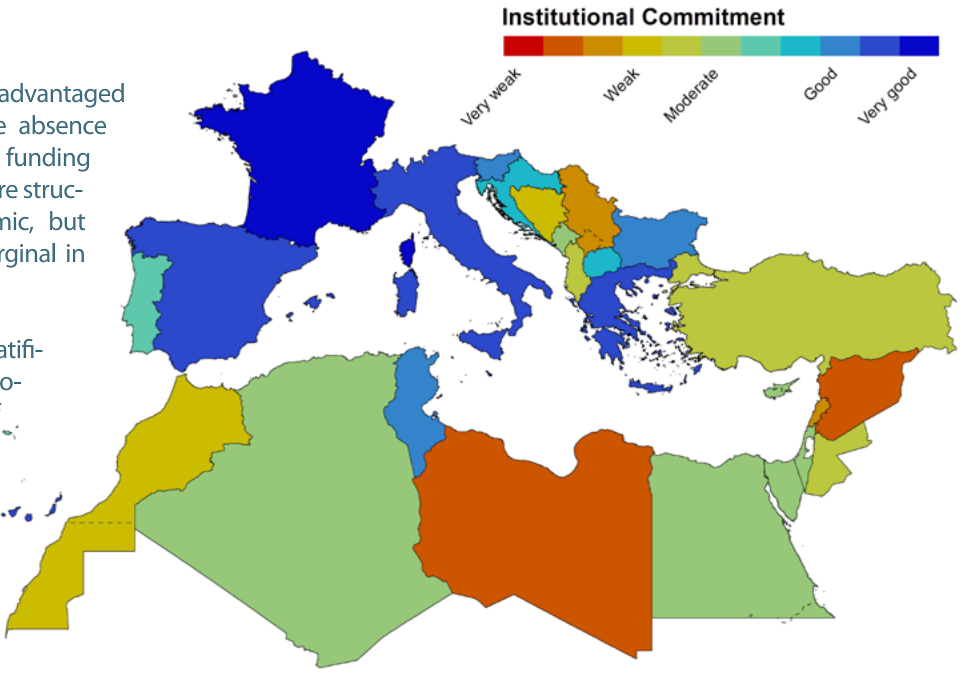

Fig. 1: Institutional engagement levels in favour of wetlands across Mediterranean countries in 2023.

Strengthening political engagement: levers and paths for action

A number of levers can be activated to reinforce political commitment to wetlands across the Mediterranean basin.

A first key lever lies in strengthening intersectoral governance. Creating or reactivating national wetland committees that bring together all relevant ministries (environment, water, agriculture, planning, tourism, culture, health, education, research, interior, etc.) is essential to break down institutional silos and establish an integrated approach.

Developing operational national action plans, complemented by clear timelines, measurable objectives and dedicated budget lines, is a second decisive lever. While many countries have overarching strategies in place, they often lack proper monitoring tools and sustainable funding mechanisms.

Enhancing the technical capacities of public administrations is also crucial, especially in planning, monitoring and evaluation, and integrating climate-related concerns.

A third lever is the mobilisation of financial resources. This involves ensuring a minimum level of national public funding for wetland-related policies, as well as leveraging international and private funding (environmental funds, bilateral or multilateral cooperation, private foundations, etc.) to support both national and local projects.

Finally, regional cooperation remains a powerful driver of strengthened political engagement. Knowledge exchange among Mediterranean countries, data sharing, participation in technical or scientific networks, and the development of transboundary projects all help to disseminate good practices, build institutional capacity, and harmonise approaches.

By promoting institutional consistency, enhancing technical and financial capacity, and fostering cooperation, these levers together can contribute to raising the level of ambition in Mediterranean wetlands policy.

Floodplain wetland, Nile (Egypt)
© EwaStudio/Envato

Annex

Method and reliability

Indic. R5 falls within the "Responses" component of the DPSIR framework adopted by the MWO. It aims to assess the level of political and institutional commitment of Mediterranean countries to the conservation and sustainable management of wetlands. The indicator seeks to evaluate the extent to which countries have established governance, planning and coordination mechanisms capable of supporting effective public policies for these ecosystems.

This composite indicator is based on a set of institutional variables describing the main national mechanisms related to wetlands management. The variables considered include, in particular, the existence of competent water management authorities, the presence of national or intersectoral committees dedicated to wetlands, the development of national biodiversity plans and/or wetland-specific strategies, and the integration of wetlands into broader environmental planning or development frameworks. They also capture elements reflecting the implementation of public policies, such as the proportion of wetland habitats covered by protected areas and their level of protection, as well as the level of wastewater treatment.

Each variable was assessed according to its level of formalisation and effective implementation at the national level, and then converted into numerical values on a standardised scale from 1 to 10 in order to enable comparisons between countries. The resulting values were subsequently harmonised on a common scale and aggregated using a simple arithmetic mean, without weighting, to produce a synthetic score reflecting the overall level of institutional commitment of each Mediterranean country.

The indicator thus provides a comparative overview of political and institutional dynamics across the Mediterranean Basin, highlighting regional disparities and identifying potential areas for improvement in wetland governance.

The reliability of ***Indic. R5*** is considered moderate to good, as it primarily relies on the analysis of formal institutional measures and national strategic frameworks. However, several limitations should be acknowledged. The formal existence of a mechanism does not necessarily guarantee its effective functioning or operational efficiency. In addition, the availability and accuracy of information may vary across countries, particularly in contexts of institutional instability or limited public data. Finally, the indicator measures levels of political and institutional commitment rather than the ecological outcomes of implemented policies.

Data

The data used to build ***Indic. R5*** are primarily drawn from international databases and institutional sources related to water governance, biodiversity conservation and wetland management. Information on national institutional mechanisms (such as the existence of water management authorities, intersectoral coordination mechanisms, or national strategies for wetlands or biodiversity) is mainly derived from national reports submitted under the Ramsar Convention, as well as from national strategies, including National Biodiversity Strategies and Action Plans (NBSAPs). Data on protected areas are sourced from the World Database on Protected Areas (WDPA), accessible through the Protected Planet platform, while information on Key Biodiversity Areas (KBAs) is derived from the global database provided by BirdLife International. Statistics on wastewater collection, treatment and reuse are drawn from FAO's AQUASTAT database, the United Nations global database on Sustainable Development Goal (SDG) indicators, and the World Bank's World Development Indicators.

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