OURMED
OUR NATURE OUR FUTURE

Sustainable Water Storage and Distribution in The Mediterranean

Report on Most Suitable NbS at Each Demo for Proper Water Management

VERSION 1.1

Acknowledgment: This project is part of the PRIMA Programme supported by the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 2222.

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DOI: 10.5281/zenodo.11403255

Project Information

Project Title	Sustainable water storage and distribution in the Mediterranean		
Project Acronym	OurMED	Grant Agreement Number	2222
Program	PRIMA Section Management of Water 2022 under Horizon 2020		
Type of Action	Water IA – Innovation Actions		
Start Data	June 1, 2023	Duration	36 months
Project Coordinator	Helmholtz-Zentrum für Umweltforschung (UFZ), Germany		
Consortium	Remote Sensing Solutions GmbH (RSS), Germany Universitat Politècnica de València (UPV), Spain Global Omnium Idrica, SLU (IDRICA), Spain Euro-Mediterranean Information System on know-how in the Water sector (SEMIDE), France La Tour du Valat, (TdV), France Technical University of Crete (TUC), Greece Università di Parma (UNIPR), Italy University of Sassari (UNISS), Italy University of Naples Federico II (UNINA), Italy Royal Society for the Conservation of Nature (RSCN), Jordan Living Planet Morocco (LPM), Morocco AgroInsider (AgroInsider), Portugal Higher School of Engineering of Medjez El Bab (ESIM), Tunisia Boğaziçi University (BU), Turkey		

Document Information

Deliverable Number	D5.1	Deliverable Name	Report on most suitable NbS at each demo for proper water management	
Work Package number	WP5	Work Package Title	Development of tailored Nature-based Solutions	
Due Date	Contractual	May 31, 2024	Actual	May 31, 2024
Version Number	1.1			
Deliverable Type	Report	Dissemination Level	Public	
Authors	Cristina Caramiello, Awais Naeem Sarwar and Salvatore Manfreda			
Reviewer(s)	Amir Rouhani and Seifeddine Jomaa			

Document History

Version	Date	Stage	Reviewed by
1.0	31/03/2024	Cristina Caramiello and Awais Naeem Sarwar	Salvatore Manfreda
1.1	19/04/2024	Draft sent to partners	All

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Acronyms

IUCN	International Union for the Conservation of Nature
EC	European Commision
EbA	Ecosystem based Adaptation
Eco-DRR	Ecosystem based Disaster Risk Reduction
NBS	Nature Based Solutions
GDP	Gross Domestic Product
FAO	Food Agriculture Organization
AI	Aridity Index
DOC	Dissolved Organic Carbon
GVA	Autonomous Community Authority
EPSAR	Public Entity for Water Sanitation
CHJ	Júcar Water Authority
NGO	Non-Governmental Organization
CLC	Corine Land Cover
WWTP	WasteWater Treatment Plant
SUDS	Sustainable Urban Drainage Systems
CW	Constructed Wetland
P.AN.ETAI.K	Regional Development Company of Crete S.A.
TOEB	Local Organization for Land Reclamation of Varipetro
MYHS	Small Hydropower Plant
ARPAS	Environmental Protection Agency of Sardinia
ZVONA	Zone Vulnerated by Nitrates of Agricultural Origin
MBR	Mujib Biosphere Reserve
WWF	World Wildlife Fund

1. Introduction

The European Commission defines nature-based solutions as “solutions that are inspired and supported **by nature**, which are **cost-effective**, simultaneously provide **environmental**, **social** and **economic benefits** and help build **resilience**. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.”. The benefits of NBS to address urban challenges can also be summarised into four broad themes (EC, 2015):

1. **Enhancing sustainable urbanisation:** through nature-based solutions, we can stimulate economic growth, improve the environment, make cities more attractive, and enhance human well-being.
2. **Restoring degraded ecosystems:** the implementation of solutions based on nature can enhance the resilience of ecosystems, enabling them to provide essential ecosystem services and address other societal challenges.
3. **Developing climate change adaptation and mitigation:** nature-based solutions can improve resilience and enhance carbon storage.
4. **Improving risk management and resilience**: the use of nature-based solutions can result in greater benefits than conventional methods and offer synergies in reducing multiple risks.

According to the International Union for the Conservation of Nature (IUCN), the Nature-based Solution can also be defined as “actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits” (IUCN, 2016).

Additional concepts falling under the **NbS umbrella** include: **Natural Solutions** (the role of protected areas in contrasting climate change); **Ecosystem-based Adaptation** (EbA); **Ecosystem-based Disaster Risk Reduction** (Eco-DRR); **Green Infrastructure** (for economic growth and investments, in the urban context); **Natural Infrastructure** (for a sustainable Integrated Water Resource Management); and **Holistic or Regenerative Landscape management** (IUCN, 2020).

In order for an intervention to be deemed as a Nature-based solution, it must address a combination of **societal challenges** in a comprehensive manner. The IUCN (2020) currently refers to **seven** societal challenges: climate change adaptation and mitigation, disaster risk reduction, reversing ecosystem degradation and biodiversity loss, human health, socio-economic development, food security, and water security.

If the societal challenge of ecosystem degradation is being addressed, to differentiate the NbS intervention from a pure conservation action, at least one other societal challenge must be included in the design of the solution (IUCN, 2020).

In general, NbS are deemed as opposed to grey interventions, which are infrastructural and technological solutions to reduce risks from natural hazards.

Although in literature an accurate definition of Nature based Solution is lacking, we can classify NbS into three main components: **green**, **blue** and **hybrid**, and four possible combinations of approaches (**green-blue**, **green-grey, blue-grey** and **green-blue-grey**) within the ecosystem domain (Debele et al., 2019).

The implementation of natural and sustainable measures (green) or the combination of green with grey elements (hybrid) can yield significant co-benefits beyond the reduction of risk (Anderson et al., 2022).

What all NbS have in common is that they seek to maximise the ability of nature to provide ecosystem services that help address a human challenge, such as climate change adaptation, food production or disaster risk reduction (Matthews et al., 2019).

As practical and sustainable tools for improved management of natural and artificial water storage and distribution systems, this report examines the NbS to ensure balanced, high-quality water availability for multiple purposes, including drinking water, irrigation, and natural ecosystem requirements. The characterization of demo sites and the consideration of the stakeholders' requirements in previous Work Package 2 and 3, has led to the identification of NbS for each demo site.

The prioritisation of NbS alongside artificial water infrastructure, such as reservoirs, not only enhances water management but also yields numerous economic, social, and environmental co-benefits at a basin scale.

2. Framework for NBS analysis and selection

2.1 Demo sites description

OurMED project focuses on **eight local** and **one regional demo sites** (Fig. 1) carefully selected because of their water storage and distribution-related challenges (Tab. 1), as shown below:

1. **Bode Catchment (Germany) demo site:** the main water related problems in this area are the **droughts** caused by climate change and consequent impact of **deforestation** on the water quality, in particular related to nutrients loading and **eutrophication** of surface water bodies;
2. **Jucar Basin (Spain) demo site: Albufera Lake**, located on the Mediterranean coast near Valencia within Albufera Natural Park, is fed by streams, rivers, and irrigation channels. It was listed in the RAMSAR Convention's Wetlands of International Importance in 1989 and it is part of the Natura 2000 Network**.** The lake, once burdened by urban and industrial development, served as an inadvertent wastewater treatment facility for four decades. Sanitation efforts began in the early 1990s, initially employing traditional engineering methods. Over time, strategies shifted towards nature-based solutions, though untreated discharges continue, exacerbating water quality issues. Hence, it becomes imperative to increase the number of **water purification** interventions through constructed wetlands.
3. **Agia Region (Crete, Greece) demo site:** the area is characterised by milt temperate climate with dry summers and it's important for its flora and fauna and a significant variety of habitats, such as aquatic and riparian plant communities, that serves as a stopover for migratory birds travelling towards Africa. The site faces challenges such as to provide **equitable water distribution** to mitigate **seawater intrusion** in Crete and requires sustainable and proper water management practises;
4. **Arborea (Italy) demo site:** The site is known for its 10 areas dedicated to conservation and protection, including (three) sites (Stagno di S'Ena Arrubia, Stagni di Corru S'Ittiri, Marceddì, San Giovanni) , which are included in the *"List of wetland of international importance"* as defined by the **Ramsar Convention** which recognizes the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value (The Maristanis project: www.maristanis.org). For these sites the biggest challenge is to improve **water use efficiency** with Precision Agriculture;
5. **Mujib river basin (Jordan) demo site:** the ongoing global warming has a strong impact in particular in territories which already suffer from water scarcity, such as Jordan. Furthermore, an increase in evapotranspiration causes saltwater intrusion in the aquifers and a progressive salinisation of groundwater. In this perspective, the main challenge for this site is the **management of water seasonality** under extreme climate and severe **water scarcity**;
6. **Sebou River Basin (Morocco) demo site:** the Sebou watershed is located in the north-west of Morocco and characterised by mild temperate climate with dry summer. The significance of this demo site is related to protecting biodiversity of 39 recognized

wetlands, including **7 Ramsar sites**, and boasts **2 National parks** within its boundaries. Conserving and restoring biodiversity and maximising water distribution are very crucial for this area.

7. **Medjerda river basin (Tunisia) demo site:** the area is distinguished by its transboundary nature and this makes it a significant centre for the conservation of wetland biodiversity and water dynamics (in this region are present **2 Ramsar sites:** Ghar El Melah lagoon, Ain Dhiab caves, and Reserve Naturelle Djebel Saddine (www.rsis.ramsar.org)). In this context the main concerns are related to **water quantity and quality**, due to the increase in water stress over the past two decades which is attributed to the occurrence of more frequent and **severe floods and droughts**, **water demand increases** as well as the effects of reservoir **siltation**.
8. **Konya Closed Basin (Turkey) demo site:** The decline in groundwater levels caused by climate change and other anthropogenic factors threatens the viability of agriculture in this region. In addition, the decrease in groundwater levels results in the formation of many **sinkholes**. The primary ambition for this area is to improve the current water distribution system and address issues of **water scarcity** and **overexploitation**. The **restoration** of dry **wetlands** is also a crucial objective in this region.
9. **MED Sea Region demo site:** besides being the birthplace of important civilizations and cultures, the Mediterranean basin is also one of the global biodiversity hotspots and a bioclimatic region with unique seasonal and interannual variabilities worldwide. However, over the last decades, it has experienced rapid demographic growth, severe water shortage, increasing anthropogenic pressures and alarming effects of climate change on natural resources, biodiversity, and human wellbeing. This results in intensified water demand through increased irrigation and water consumption, severely threatening socio-economic stability and impacting ecosystem integrity.

Table 1 Major Features of the demo sites. Pop. denotes Population in Millions.

Demo site	Area (km²)	Pop.	Climate	Unique feature	Key problems
Agia, Crete Greece	250	0.07	Mild temperate, dry summer	Important for flora and fauna	Seawater intrusion
Arborea, Italy	854	0.07	Mild temperate, dry summer	10 areas for conservation, 3 Ramsar sites	Water distribution, pollution and energy
Bode, Germany	3300	0.37	Mild temperate and dry winter	Drinking water reservoir, droughts, deforestation	Water quantity, quality deterioration
Jucar, Spain	22200	1	Mild temperate, dry summer	Albufera Natural Park, Ramsar	Sedimentation, Eutrophication
Konya, Turkey	50000	3.2	Mild temperate, dry summer	Restoration of dry wetlands	Overexploitation
Medjerda, Tunisia	23700	2.2	Mild temperate, dry summer	Transboundary, 3 Ramsar sites, 1 Ramsar City	Sedimentation and water distribution
Mujib, Jordan	6600	0.56	Dry and desert	Key Biodiversity for the Dead Sea	Water quality and distribution
Sebou, Morocco	40000	6.2	Mild temperate, dry summer	39 wetlands, 7 Ramsar sites, 2 National parks	Water distribution, biodiversity
MED regional	2000000	480	MED climate	Biodiversity hotspot worldwide	Water scarcity, climate change

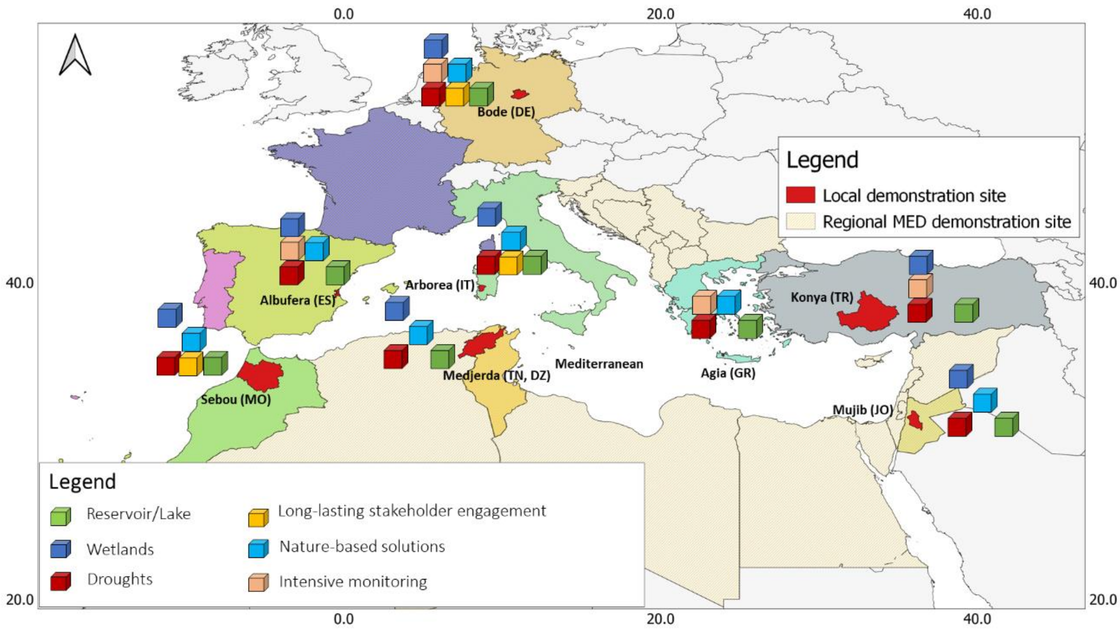

Figure 1 OurMED consortium comprises ten countries encompassing nine demo sites (eight local and the whole MED region), representing diverse water-related ecosystem properties.

2.2 Methodology

Recently, on 27 February 2024, the European Parliament (2024) has approved the **Nature Restoration Law**, the first continent-wide, comprehensive law of its kind which calls for binding targets to restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters.

In Chapter 2 of the law, restoration targets and obligations are detailed, specifically identifying distinct ecosystems for which Member States are required to implement the necessary restoration measures to regenerate habitat types to their optimal conditions. The individuated ecosystems are: **terrestrial, coastal and freshwater ecosystems** (Article 4), **marine ecosystems** (Article 5), **urban ecosystems** (Article 6), **agricultural ecosystems** (Article 9) and **forest ecosystems** (Article 10).

Focusing on coastal, urban, agricultural and forest ecosystems, the presented methodology aims to find tailored Nature based Solutions depending on the examined area.

STEP 1: to define the type of ecosystems

According with Nature Restoration Law **objectives**, we have defined 4 ecosystems:

- **Agricultural ecosystem**: the aim is to **increase biodiversity**, towards a positive trend for grassland butterflies, farmland birds, organic carbon in cropland mineral soils and high-diversity landscape features on agricultural land;
- **Urban and peri-urban ecosystem**: no net loss of green urban space by 2030, and an **increase** in the total area covered **by green urban space by 2040 and 2050**;
- **Forest ecosystem**: achieving an increasing trend for standing and lying deadwood, uneven aged forests, **forest connectivity, abundance of common forest birds and stock of organic carbon**;

- **Marine coastal ecosystem**: **restoring marine habitats** such as seagrass beds or sediment bottoms that deliver significant benefits, including for climate change mitigation, and restoring the habitats of iconic marine species such as dolphins and porpoises, sharks and seabirds.

Agricultural ecosystems:

Agricultural systems, whether semi-natural or modified natural, are human-managed environments designed for the production of food and agricultural commodities. These ecosystems exhibit analogous features in terms of their components, interactions, and functions, thereby constituting a category of agricultural ecosystems referred to as "agro-ecosystems." (Food and Agriculture Organisation of the United Nations & Secretariat of the Convention on Biological Diversity, (1998)).

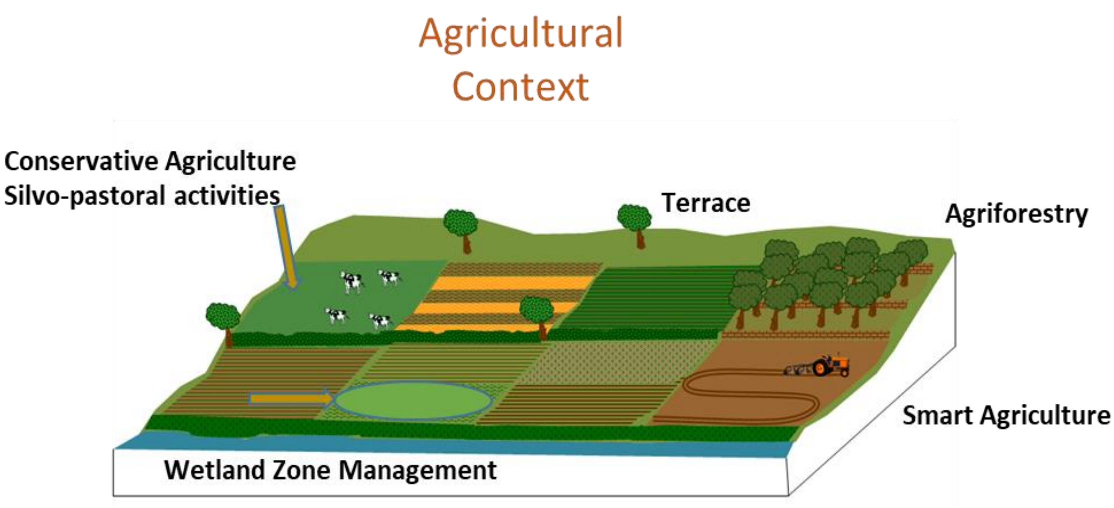

Figure 2 Typologies within the agricultural landscape (Progetto Life-Beware).

Urban and peri-urban ecosystems:

Urban ecosystems are cities and the surrounding, socio-ecological systems where most people live (Maes, et. al. 2016). They are very peculiar ecosystem types: they are almost completely artificial but they include, in different proportions, all other ecosystem types (forests, lakes and rivers and agricultural areas can all be part of urban fringe) and they are strongly influenced by human activities.

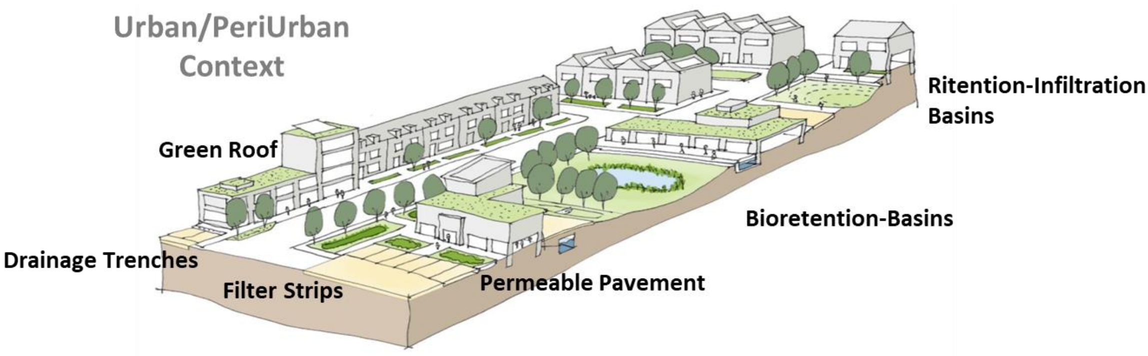

Figure 3 Typologies within the urban landscape (Progetto Life-Beware).

Forest ecosystems:

A forest ecosystem is a dynamic complex of plant, animal and micro-organism communities and their abiotic environment interacting as a functional unit, where trees are a key component of the system. Humans, with their cultural, economic and environmental needs, are an integral part of many forest ecosystems (UN Decade on Ecosystem Restoration 2021-2030).

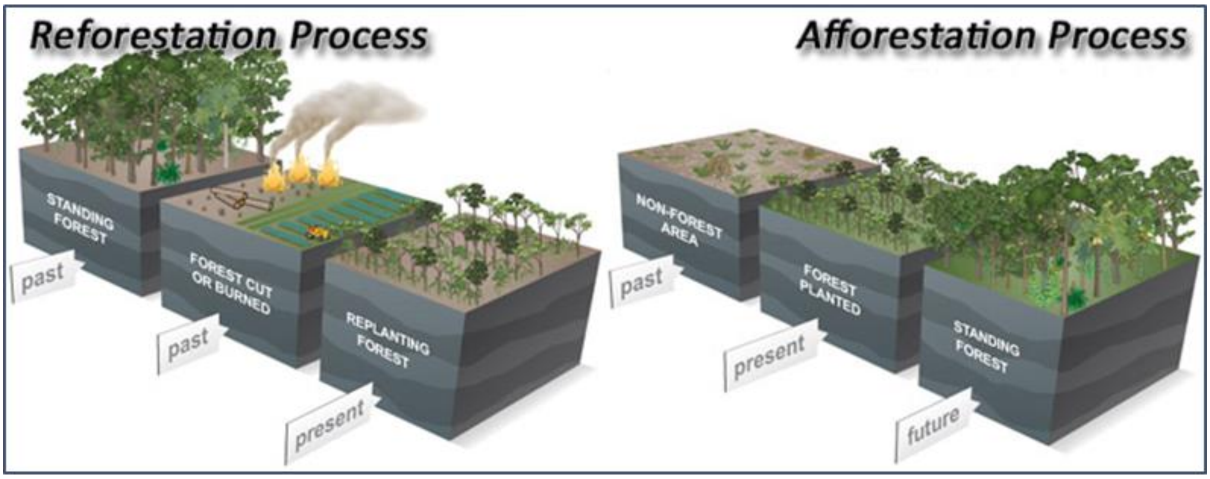

Figure 4 Example Reforestation and Afforestation Process (https://geoengineeringinquiries.blogspot.com/).

Coastal areas/Coastal ecosystems:

Coastal areas are local administrative units (LAUs) that have at least 50 % of their surface area within a distance of 10 km from the coastline. A coastline is defined as the line where land and water surfaces meet (border each other), (Eurostat, Methodological manual for tourism statistics Version 2.1,2013). Due to the existence of several measures (for example, the mean or median tides, high- or low-tides), the European Commission has adopted the harmonised use of the mean high tide (EC, 1999) in order to delineate EU coastlines.

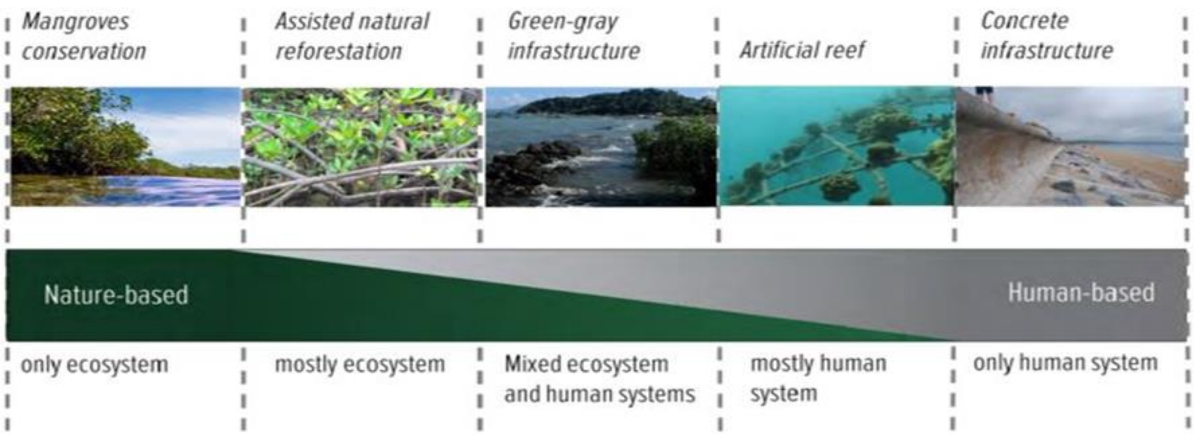

Figure 5 A possible representation of the spectrum of adaptation solutions for coastal protection from nature-based to human-based (Fedele et al., 2019)

After identifying the contexts, the methodology approach is based, **in a first phase**, on the definition of the "load" acting on the generic ecosystem. This load is defined by the **climate** that, **on a basin scale**, characterises the generic demo-site. Various factors or indices widely acknowledged in the scientific literature are employed to identify the climate, as illustrated in the following slides. In this way, the climatic changes taking place in the area under examination are taken into account.

STEP 2: to define the climate conditions that characterise examined area

The FAO (Food and Agriculture Organization) aridity index is a widely used tool for classifying climate based on the ratio of precipitation to potential evapotranspiration. It provides insights into the dryness or moisture of a region (Food and Agriculture Organization [FAO], 1998; Hargreaves & Samani, 1985; Wang, Rich, & Price, 2001; Zomer et al, 2022).

Table 2 Aridity Index (AI) = Precipitation / Potential Evapotranspiration.

Classification	Aridity Index (AI)
Hyper-arid	AI ≤ 0.05
Arid	0.05 < AI < 0.20
Semi-arid	0.20 < AI < 0.50
Dry sub-humid	0.50 < AI < 0.65
Sub-humid	0.65 < AI < 0.80
Humid	0.80 < AI < 1.5
Very humid	1.5 ≤ AI

Arid:

Arid climates are characterised by low precipitation relative to potential evapotranspiration (PET). The FAO aridity index for arid climates typically falls below 0.20.

Semi-Arid:

Semi-arid climates exhibit slightly higher precipitation compared to arid climates, but still, experience water deficits for a significant part of the year. The FAO aridity index for semi-arid climates ranges from 0.20 to 0.50.

Humid:

Humid climates receive abundant precipitation relative to potential evapotranspiration. These regions typically have an aridity index above 0.50.

STEP 3: to define type and characteristics of soil

Soils vary enormously in characteristics, but the size of the particles that make up a soil defines its gardening characteristics:

- Clay: less than 0.002mm
- Silt: 0.002-0.05mm

- Sand: 0.05-2mm
- Stones: bigger than 2mm in size
- Chalky soils also contain calcium carbonate or lime

The dominating particle size gives soil its characteristics and because the tiny clay particles have a huge surface area for a given volume of clay they dominate the other particles:

- Clay soils have over 25 percent clay. Also known as heavy soils, these are potentially fertile as they hold nutrients bound to the clay minerals in the soil. But they also hold a high proportion of water due to the capillary attraction of the tiny spaces between the numerous clay particles. They drain slowly and take longer to warm up in spring than sandy soils. Clay soils are easily compacted when trodden on while wet and they bake hard in summer, often cracking noticeably. These soils often test the gardener to the limits, but when managed properly with cultivation and plant choice, can be very rewarding to work with;
- Sandy soils have a high proportion of sand and little clay. Also known as light soils, these soils drain quickly after rain or watering, are easy to cultivate and work. They warm up more quickly in spring than clay soils. But on the downside, they dry out quickly and are low in plant nutrients, which are quickly washed out by rain. Sandy soils are often very acidic;
- Silt soils, comprised mainly of intermediate sized particles, are fertile, fairly well drained and hold more moisture than sandy soils, but are easily compacted;
- Loams are a mixture of clay, sand and silt that avoid the extremes of clay or sandy soils and are fertile, well-drained and easily worked. They can be clay-loam or sandy-loam depending on their predominant composition and cultivation characteristics;
- Peat soils are mainly organic matter and are usually very fertile and hold much moisture. They are seldom found in gardens;
- Chalky or lime-rich soils may be light or heavy but are largely made up of calcium carbonate and are very alkaline.

Permeable:

The definition of permeability in soil refers to the ability of the soil to transmit water, air, or plant roots through its pores. This property is determined by the soil's structure, texture, cracking, and organic matter content.

Not permeable:

The term "not permeable" refers to a soil's inability to transmit air or water through its pores. This property is influenced by factors such as soil texture, structure, cracking, and the amount of organic matter present. Slow permeability is defined as less than 0.6 inches of water moving through the soil per hour, while moderate permeability allows 0.6 to 6.0 inches of water to pass through in the same time frame. Rapid permeability permits 6 to 20 inches of water to move through the soil per hour.

STEP 4: to define the geomorphology:

Slope is an important factor contributing to geomorphology of the area. It can be broadly classified in 10 classes (FAO,2006 Guidelines for soil description) as shown in Table 3. We reclassify these classes broadly in two categories.

Mild to moderate:

The values ranging from 0 to 15% are reclassified as representing mild to moderate slopes.

Moderate to steep:

Values exceeding 15% are reclassified as moderate to steep slopes.

Table 3 Geomorphology classification in 10 classes. In our methodology values exceeding 15% are reclassified as Moderate to Steep slopes.

Class	Description	Slope [%]
1	Flat	0 – 0.2
2	Level	0.2 – 0.5
3	Nearly level	0.5 – 1.0
4	Very gently sloping	1.0 – 2.0
5	Gently sloping	2 – 5
6	Sloping	5 – 10
7	Strongly sloping	10 – 15
8	Moderately steep	15 – 30
9	Steep	30 – 60
10	Very steep	> 60

STEP 5: Stakeholders

Stakeholder analysis is a crucial component of understanding the complex social and political dynamics in demo sites. It helps to identify and to understand the individuals, groups, or entities that can affect or be affected by a particular project or policy decision.

STEP 6: Socio-Economic conditions:

Assessing socio-economic conditions is crucial for informing project and policy decisions, as these factors significantly influence project outcomes. Various indexes are available for this assessment, with Gross Domestic Product (GDP) being a prominent indicator at a broader scale. GDP represents the overall monetary or market value of all finalized goods and services produced within a country's borders during a specified timeframe.

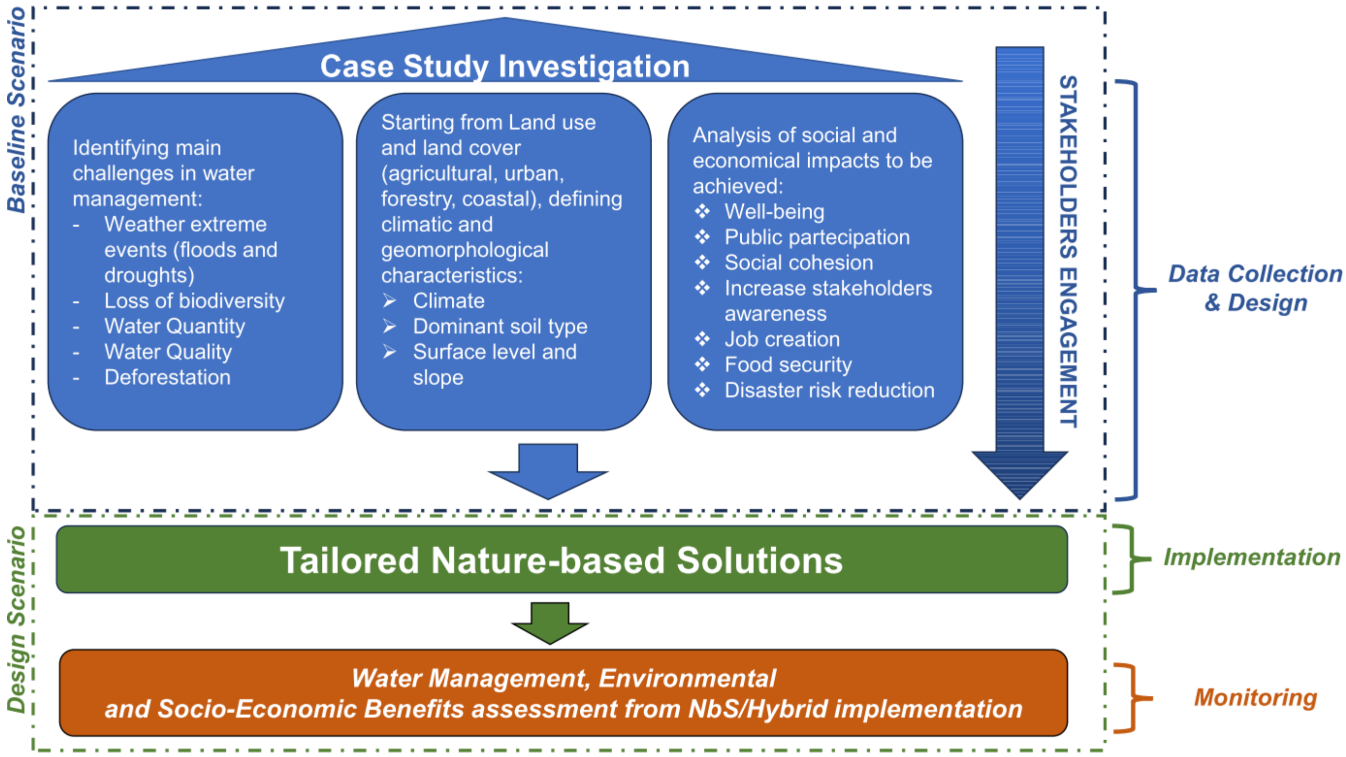

Figure 6 Breakdown structure for NBS assessment.

3. Identification of Nature-based Solutions and proper management options for each demo-site

3.1 Bode (Germany)

Bode River basin is one of the most monitored river basins in central Germany. However, the basin is increasingly exposed to the effects of climate change and prolonged droughts. This results in **severe deforestation** (50% of the Harz Forest was lost in the last few years). Deforestation impacted the **water quality** of the basin. During summer, we are observing frequent discharge with **low-flow conditions** with deteriorated water quality due to reduction in dilution capability.

Population

Urbanisation has made its mark on the catchment, with urban areas covering approximately 6% of the land surface. These urban centres are home to a total population of 370,000 people, underlining the significance of water management strategies that address the needs of both urban and rural communities.

Balancing the demands of growing urban populations with those of rural areas is crucial for sustainable water management within the catchment. Effective strategies must ensure reliable access to clean water for urban residents while also preserving water resources for agricultural, industrial, and ecological purposes. Additionally, measures to mitigate urban runoff and pollution are essential to safeguard water quality throughout the catchment and protect the health of both human and natural communities.

Area

The Bode catchment forms a crucial component of the TERENO Harz/Central German Lowland Observatory, as depicted in Figure 7. Encompassing an area of around 3300 square kilometers, it constitutes a mesoscale catchment nestled within the broader Elbe river basin. Stretching from the Harz Mountains, a gentle mountain range in the southwest, to the Magdeburger Börde area in the northeast, the catchment displays diverse landscapes. With an average water flow of 8.3 m^3/sec at its outlet (Mueller et al. 2016). The catchment itself is diverse, featuring the rugged terrain of the Harz Mountains in the southwest and the flat plains in the northeast. From the towering peak of Brocken, standing at 1142 meters above sea level, to the lowland areas barely 70 meters above sea level, the landscape undergoes significant changes in elevation. These changes result in varied meteorological patterns, land usage, soil compositions, and geological formations throughout the catchment (Zhou et al. 2022). The primary tributaries of the Bode River originate within the Harz Mountains: the Selke River marks its southern boundary, while the Holtemme River flows through the central part of the catchment. These tributaries, alongside the main Bode River itself, begin their journey from the rugged terrain of the Harz. As the Bode catchment stretches northward, it encounters the expansive wetland known as

Grosses Bruch, which sprawls approximately 45 kilometers in an east-west direction, occupying a former glacial valley.

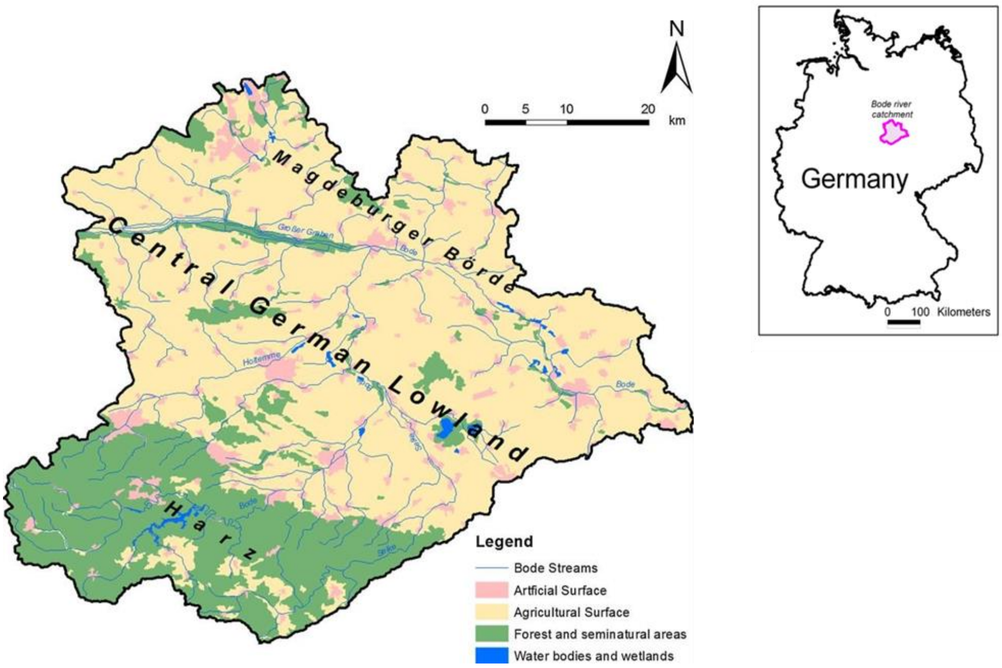

Figure 7 Bode catchment map as part of the Central German Lowland Observatory (TERENO Harz) taken from Wollschläger et al. (2017). Large red labels denote the locations of intensive research sites.

3.1.1 Description (belonging area, soil properties and climate)

The Germany demo site, Bode river basin, is a vast inland area covering 3,300 km2 located in the central Europe area. It is characterized by a mild temperate and dry winter climate. The site is home to a significant drinking water reservoir and faces challenges such as droughts and deforestation. The main objectives of the OurMED project at this site are to improve water quantity and quality, as well as address the deterioration of water bodies.

Figure 8 displays the soil composition across the Bode catchment, revealing distinct patterns influenced by the underlying geology. In regions primarily composed of igneous and metamorphic rocks within the Harz Mountains, soils predominantly consist of Cambisols, with smaller proportions of Leptosols, Luvisols, and Gleysols. Moving towards the northeastern edge of the Harz Mountains, where the terrain transitions into the Central German Lowland, the geological makeup shifts to non-metamorphic sedimentary rocks, often overlaid with loess deposits. Here, the dominant soil types include Luvisols, Leptosols, Cambisols, and Gleysols, reflecting the interplay between geological formations and soil characteristics.

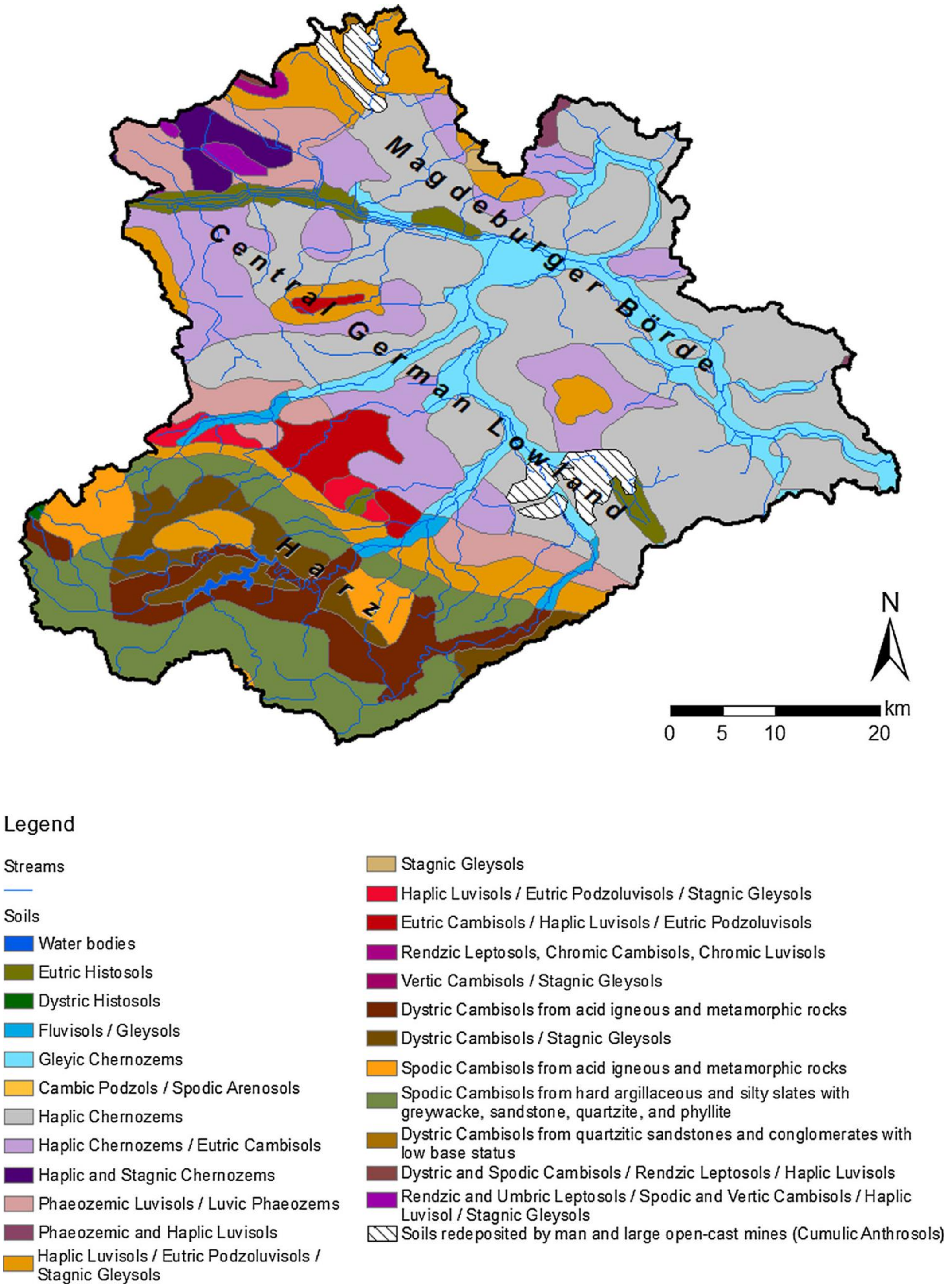

Figure 8 The soil map of the Bode catchment, based on data sourced from the soil map of the Federal Republic of Germany at a scale of 1:1,000,000 (BUEK 1000), provided by the Federal Institute for Geosciences and Natural Resources (BGR) (Wollschläger et al. (2017)).

The distinct zonation observed in the Harz Mountains and the Central German Lowland is mirrored in the land use patterns within the Bode catchment. The mountainous terrain of the Harz, characterised by steep slopes and shallow, less fertile soils, is predominantly covered in forest cover. Agricultural activities are typically confined to the plateau areas due to the challenging topography.

In stark contrast, the fertile Chernozem soils of the Central German Lowland are extensively utilized for agriculture. Approximately 66% of the Bode catchment area is dedicated to agricultural use, while forested and semi natural areas account for 26%. Artificial surfaces, encompassing urban areas, industrial zones, as well as both active and abandoned open-cast mines, constitute 7% of the total catchment area. Water bodies and wetlands make up the remaining 1% of the Bode catchment, underscoring the diverse landscape mosaic present within the region (**Figure 9b**).

Five dominant soil classes are identified based on the United States Department of Agriculture classification system. These classes include sandy, silt loam, silty clay loam, and loam (**Figure 3c**). The lowland area was classified into Classes I-III, representing the dominant loess area (silt loam soils), riverine area (loam soils), and highly sandy area (sandy soils), respectively. Within the mountainous regions, two representative classes were chosen: Class IV, representing mountain pasture areas (silty clay loam soils), and Class V, representing mountain arable areas (sandy soils). This classification approach aimed to capture the varied nitrate-leaching behaviour across different soil-land-use combinations within the Bode catchment.

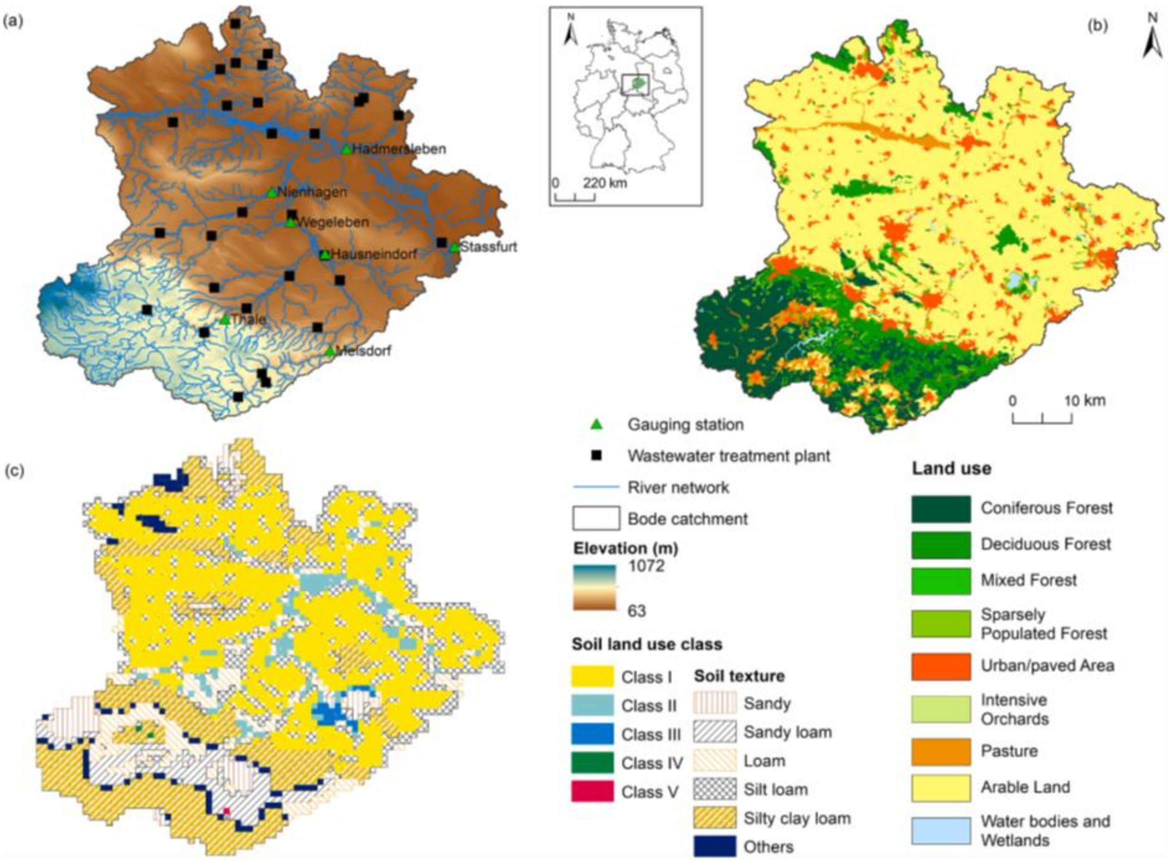

Figure 9 The Bode catchment: (a) geographical location of the gauging stations and wastewater treatment plants, (b) land use types and (c) five dominant soil-landuse (Zhou et al. (2022)).

The significant difference in elevation between the low mountain range of the Harz and the adjacent Central German Lowland regions results in distinct climate patterns. The Harz

Mountains exhibit a cold and moist climate, whereas the Central German Lowland area is notably warmer and drier, leading to a negative climatic water balance in this region. Consequently, the Central German Lowland is highly susceptible to meteorological and agricultural droughts (Wollschläger et al., 2016).

Annual mean precipitation varies significantly, with over 1500 mm recorded at the Brocken and approximately 500 mm in the lowland areas. The mean annual potential evapotranspiration is around 710 mm in the mountainous area and about 810 mm in the lowland areas. Mean annual temperatures range from 5°C at the Brocken to 9.5°C in the lowland areas, with January recording a minimum of -0.6°C (1.2°C) in the mountains and July reaching a maximum of 16.8°C (19.1°C) in the lowlands (Zhou et al., 2022).

The Bode catchment experienced consecutive summer droughts from 2015 to 2018, as indicated by the 3-month standardised precipitation evapotranspiration index (**Figure 10**). These fluctuations underscore the vulnerability of the region to extended periods of dry weather (Jomaa et al., 2020).

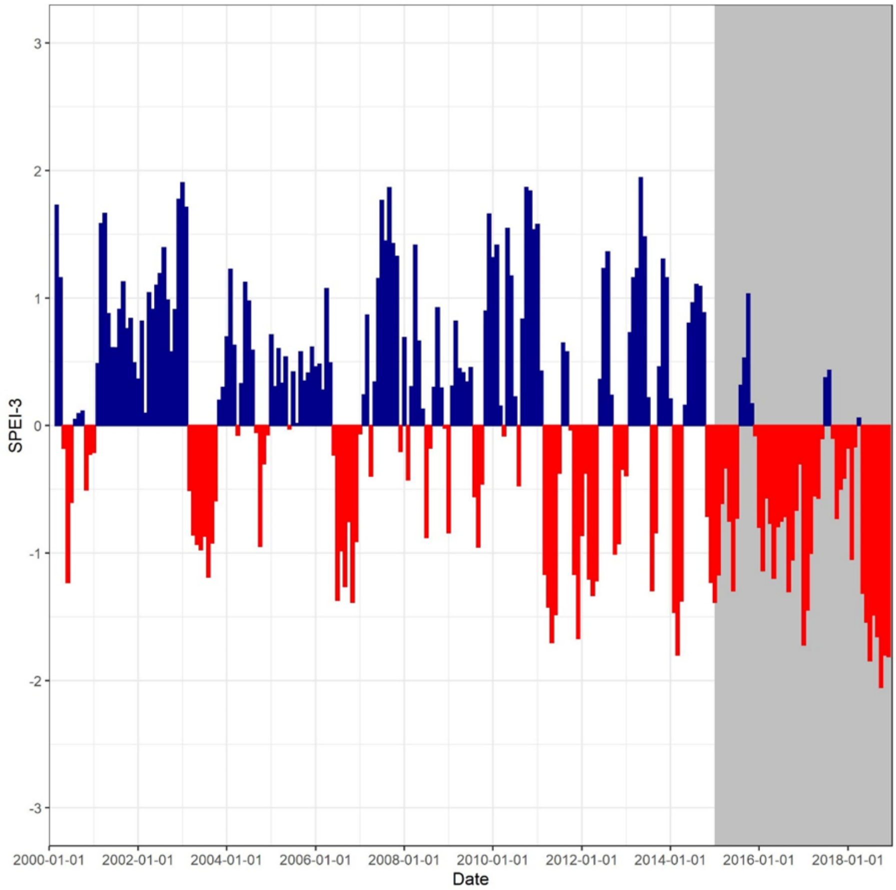

Figure 10 The SPEI values on a 3-month time scale during 2000-2018 at the gauging station Stassfurt (Zhou et al., 2022).

3.1.2 Socio - economic features

The low land area of the Bode is 100% cropped as it is the most fertile soil in Germany. Upstream areas are very important for social activity such as hiking. Rappbode is the largest drinking water reservoir in Germany providing drinking water for more than 1M inhabitants.

Landscape

The landscape of the Bode catchment is primarily shaped by agricultural activities, which occupy almost 70% of the total area. In contrast, the middle mountainous regions of the Harz Mountains are predominantly covered by forests, reflecting their natural state and ecological importance.

Urbanisation has left its mark on the catchment, with urban areas accounting for approximately 6% of the land surface. These urban centers are home to a total population of 370,000 people, highlighting the importance of water management strategies that cater to both urban and rural needs.

Industrial zones and open-pit mining areas each occupy roughly 1% of the land surface, underscoring the presence of human activities that can impact water quality and ecosystem health. Balancing the demands of agriculture, forestry, urban development, and industry within the catchment requires careful planning and integrated water management approaches to ensure sustainable use of the region's resources.

Rappbode Reservoir

The Rappbode Reservoir serves as a vital source of drinking water for over 1 million people in central eastern Germany. With an impressive maximum depth of nearly 90 meters and a voluminous capacity of approximately 100 million cubic meters, it stands as the largest drinking water reservoir in Germany.

The reservoir is fed by three major tributaries: the Bode, Hassel, and Rappbode rivers. Each of these tributaries is individually dammed by smaller pre-dams. However, despite their shared role in supplying water to the reservoir, they contrast starkly in terms of land use characteristics.

The varying land use patterns along these tributaries result in notable differences in nutrient load and dissolved organic carbon (DOC) export. These differences reflect the diverse environmental pressures exerted by agricultural, industrial, and natural landscapes within their respective catchment areas. Understanding and managing these contrasts is essential for maintaining the water quality of the Rappbode Reservoir and ensuring its continued provision of clean drinking water to the region.

Water use

Water plays a vital role in various facets of life within the Bode catchment:

Drinking Water Supply: The Rappbode reservoir serves as a crucial source of drinking water for over a million people, providing an annual supply of about 100 million cubic meters.

Irrigation: Around 10% of farmland in the downstream region of the Bode relies on surface water irrigation during the summer months to sustain agricultural productivity.

Ecosystem Services and Recreation: The downstream portion of the catchment supports diverse ecosystem services and recreational activities such as canoeing, all of which hinge on maintaining minimum flow levels (ecological flow).

3.1.3 Main issues

In recent years, the Bode River basin has grappled with several significant water-related challenges:

- Surface water harvesting in the landscape

– Maintain ecological flow and increase groundwater recharge

– Improve water quality

1. **Prolonged Drought Impact:** Extended periods of drought have afflicted the Bode catchment, leading to severe deforestation and adverse effects on both water quantity and quality. The diminished water availability has necessitated urgent revisions in water management strategies. Moving away from a singular focus on trade-offs, there's a pressing need for a holistic multisectoral approach that considers the diverse needs of all stakeholders.

2. **Increased Nutrient Leaching:** The drought conditions have exacerbated nutrient leaching into the drinking water reservoir and downstream river networks. Reduced forest uptake, limited dilution capacity, and heightened risks of soil erosion have contributed to this issue. Consequently, there's a heightened concern over water quality and the potential impacts on ecosystems and human health.

3. **Shift in Agricultural Practices:** As a response to the water scarcity, farmers are likely to transition towards more irrigated crops, relying on surface water and groundwater sources. This shift places additional strain on already stressed water resources, heightening competition and potential conflicts over water allocation.

Addressing these water-related challenges requires collaborative efforts among various stakeholders, including policymakers, water resource managers, agricultural communities, and environmental advocates. Implementing sustainable water management practices, promoting water conservation measures, and fostering dialogue among stakeholders are essential steps towards mitigating the impacts of drought and ensuring the long-term resilience of the Bode River basin.

3.1.4 Tailored NbS suggested

To improve water management in the Bode River basin, various Nature-based Solutions (NbS) actions can be explored. These include surface water harvesting, utilising floodplains for managed groundwater recharge, diverting streamflow to arable land during peak periods for recharge, assessing the feasibility of different weirs and transversal hydraulic infrastructure to maintain water within the river network, restoring former wetlands for use as natural ponds for nitrogen retention, afforestation, and cooling streamflow temperatures during heatwaves using groundwater and water from the Rappbode reservoir.

The selection of the most appropriate NbS depends on various considerations, such as cost-benefit analysis, public acceptance, the time horizon of proposed solutions' efficiency, and the priority of ecosystem restoration. Another important factor in supporting or rejecting any proposed mitigation measure is evidence of its effectiveness. Typically, hydrological models employing appropriate scenarios are used to test the efficiency of mitigation options. However, these models can only consider a limited number of mitigation scenarios based on specific assumptions.

3.2 Jucar (Spain) - Albufera Natural Park

The Jucar demo site in Spain is located in the coastal region of the West Mediterranean. Spanning an area of 22,200 km2, the site is characterised by a mild temperate climate with dry summers. It is home to the Albufera of Valencia. The Albufera of Valencia, also known as Albufera

Lake, is Spain's demo site for the OurMED project. Located 15 kilometres from the southern end of Valencia along the Mediterranean coast, it's the largest natural lake on the Iberian Peninsula, covering 24 km2 with an average depth of 1.0 m. Surrounded by towns, industries, rice fields, orchards, mixed crops, and a 30 km long, 1 km wide sandbar, it has been significantly shaped by both natural forces and human activities. Originally brackish, centuries of irrigation agriculture transformed it into a freshwater ecosystem, reducing its open water surface from over 30,000 hectares in Roman times to 2,433 hectares today. The lake's water quality declined in the mid-1970s due to untreated sewage and agrochemicals, leading to its unintentional use as a wastewater treatment site. Despite this, it was designated a Natural Park in 1986 and holds special protection status at both community and international levels. Recognized as a Special Protection Area for Birds and listed in the RAMSAR Convention's Wetlands of International Importance, it also features habitats and species protected by the Habitats Directive and is part of the Natura 2000 Network. Managing its water quality and ecological status remains a challenging yet crucial task.

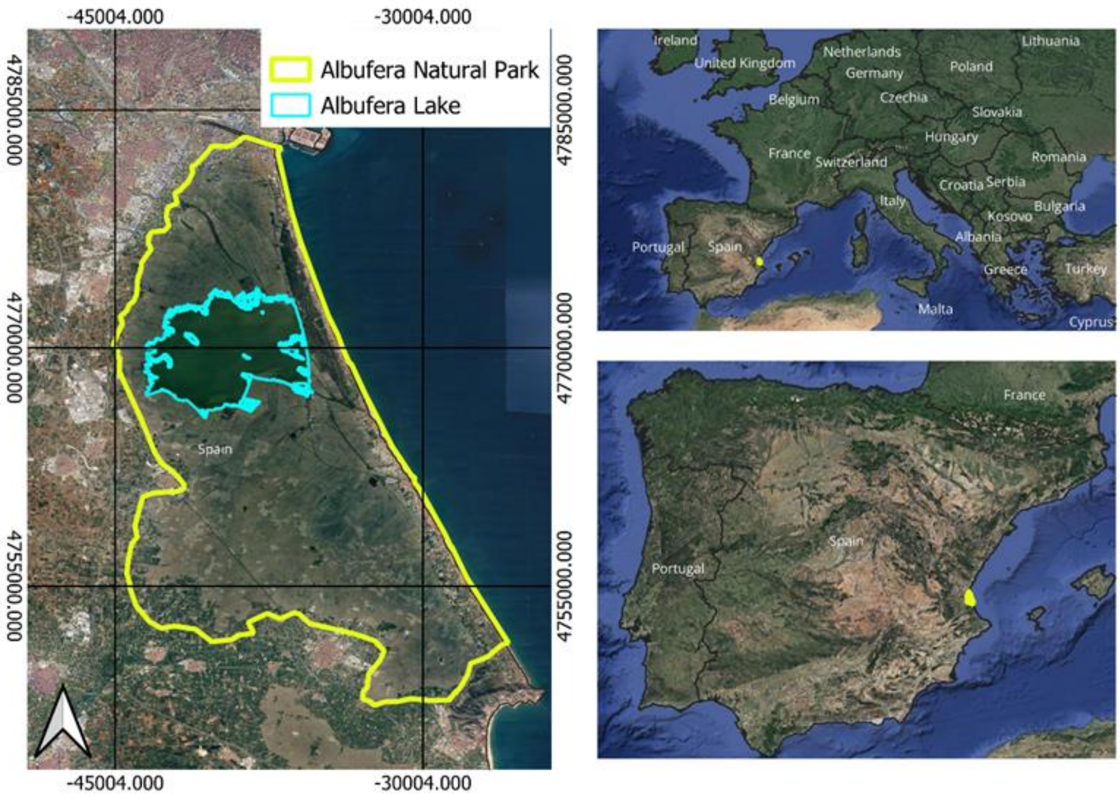

Figure 11 Júcar river basin – Albufera Natural Park and the Albufera Lake.

In the study area, various stakeholders play pivotal roles in water management and environmental conservation. State Actors, including the Autonomous Community Authority (GVA), oversee key environmental decisions. This authority comprises bodies like the Albufera Natural Park Authority and the Public Entity for Water Sanitation (EPSAR). EPSAR is responsible for financing sanitation projects in the region. The Valencia City Council owns the lake and delegates its maintenance to the Oficina Técnica Devesa-Albufera. Additionally, the Júcar Water Authority (CHJ) manages water distribution among users, although not specifically for Albufera

Lake. The Drainage Board regulates water levels in Albufera Lake, controlling gate openings based on rice production and environmental needs.

Market Actors also play significant roles, with various economic activities occurring within the park. These activities include agriculture (fruits, vegetables, rice), food processing (rice), tourism (recreational, dining, birdwatching), and fishing. Some companies in the area support environmental initiatives alongside NGOs, utilising Corporate Social Responsibility for funding. Moreover, innovative products like rice packs are being explored as potential solutions to environmental challenges.

Civil Actors, particularly NGOs, are actively engaged in environmental management and conservation efforts. These organisations collaborate with municipalities, public administrations, and companies on various activities such as educational programs, bird watching, surveys, and water quality monitoring. Successful models like land stewardship have been implemented, effectively linking landowners and managers. Additionally, the Governing Board of the Natural Park serves as a consultative body, convening stakeholders for discussions on diverse issues. This board creates committees like the Scientific Committee, comprising members from universities, research centres, and professionals, to address specific challenges and provide expertise.

3.2.1 Description (belonging area, soil properties and climate)

The Albufera Natural Park in Valencia experiences a Mediterranean climate, characterised by hot, dry summers and mild, wet autumns and winters. Average temperatures range from around 10°C in winter to over 30°C in summer, with an annual precipitation of 457 mm, mainly falling in autumn and winter. Evapotranspiration is high, exceeding 409 mm/year. The agroecosystem trajectory in the region is intricately linked to climate change, with rising sea levels and temperatures expected to increase salinity levels in coastal lake ecosystems like Albufera. Restoration efforts must adapt to these changes.

The Albufera Natural Park sits between the Túria River to the north and the Júcar River to the south, receiving water primarily from ravines like Massanassa (Torrent) and Picassent (Beniparrell). Its main water sources are an extensive network of irrigation ditches and paddies, supplemented by springs known as "ullals". These paddies surrounding the lake are irrigated with its water, showcasing the system's water circulation. Those farther from the lake rely on freshwater from the Túria and Júcar Rivers. Additionally, the lake receives treated effluent from wastewater treatment plants like Pinedo and Albufera Sur. However, small amounts of untreated urban and industrial wastewater still flow into ditches and watercourses that eventually reach the lake. Direct precipitation and urban/agricultural runoff also contribute to the lake's water sources. Figure 12 shows the main water resource infrastructures closest to the lake.

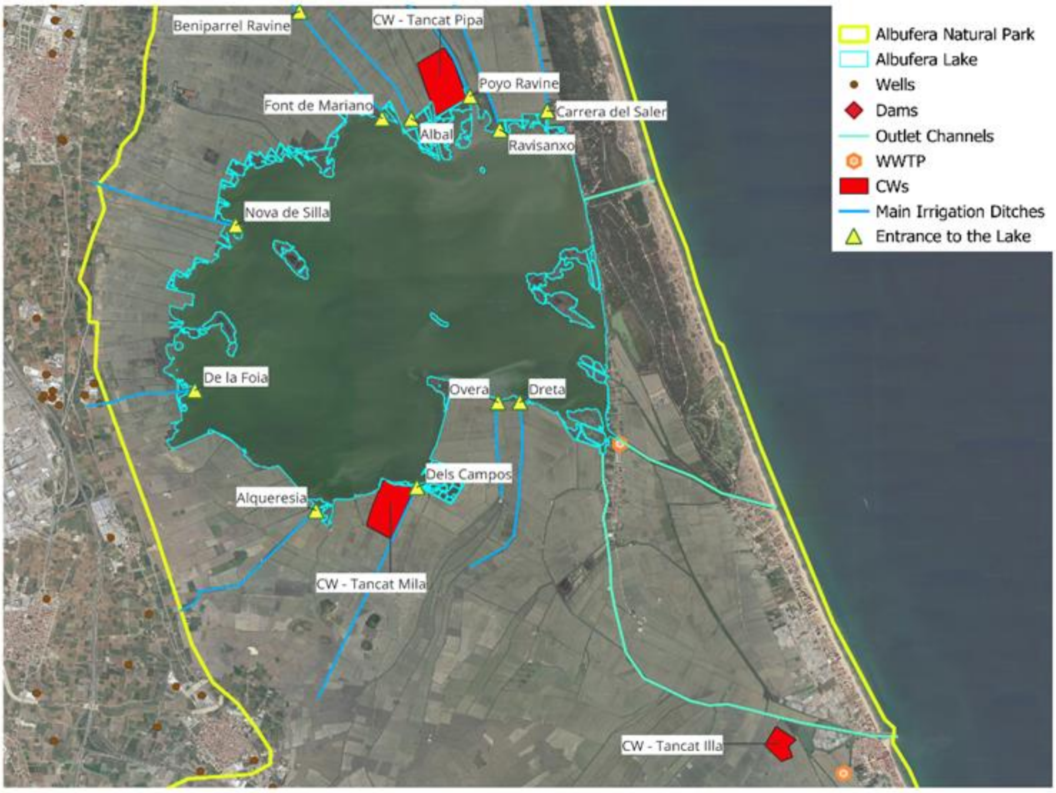

Figure 12 Primary water resource infrastructures closest to the lake.

It is characterised by a diverse array of land uses. According to the CORINE Land Cover (CLC) program, paddy fields dominate over 65% of its expanse, with the lake itself comprising 12% of the total area. Around 8% is designated for orchards, while an additional 3% is dedicated to permanently irrigated land. Urban development occupies roughly 2.5% of the territory, while a mix of crops and coniferous forests each claim 2%. The remaining land is utilised for various agricultural activities, marshlands, tourism, and sports.

3.2.2 Socio - economic features

Some economic activities are developed inside the Natural Park:

1. **Agricultural activities:** fruits (oranges), vegetables and rice. Food processing industry: rice.
2. **Tourism:** recreational, restoration and birdwatching.
3. **Fishing**.

During the last few years, different companies have supported different environmental actions jointly with NGOs. The Corporate Social Responsibility of companies is an opportunity to obtain funds for environmental monitoring and restoration. Also, for educational and environmental awareness.

New market products are being studied to solve environmental problems. In the face of rice straw burning, collecting, and distributing rice packs is seen as a promising management. Rice packs can be used for isolation in small buildings, etc.

Inside the Natural Park, agriculture: mainly rice paddies but also fruits (oranges) and vegetables.

Outside the NP but very close, urban activities: commercial areas and some industry: cars factory (Ford), rice processing.

3.2.3 Main issues

For the Albufera Natural Park demo site, the main issues, followed by the proposed solutions, are presented as follows:

1. **Addressing eutrophication:** Increasing the number of constructed wetlands to improve water quality and enhance the naturalisation of Albufera Park.
2. **Optimisation of reclaimed waters:** Enhancing the utilisation of treated wastewater from major wastewater treatment plants (WWTPs) in the area such as Pinedo, Quart-Benácher, Albufera Sur, and Sueca is imperative to bolster the reliability of irrigation practices.
3. **Integration of reclaimed waters in perellonà:** Implementing reclaimed water systems in perellonà areas can significantly contribute to sustainable irrigation practices.
4. **Water swaps initiatives:** Developing mechanisms for water swaps, wherein regenerated water is utilised for irrigation while providing natural water sources to the lake, can optimise water resource management.
5. **Maintaining high water levels:** sustaining elevated water levels is crucial to mitigate the risk of salinisation resulting from sea intrusion, safeguarding the ecological balance of the region.

3.2.4 Tailored NbS suggested

Since the beginning of the 2010s, three large, constructed wetlands in the Albufera de Valencia Natural Park mimic the natural wetlands in the numerous ecosystem services they provide.

These three wetlands (Tancat de la Pipa 39.369092, -0.346311, Tancat de Milia 39.312004, -0.356310, and Tancat de L'Illa 39.278925, -0.289061), with areas of between 16 and 40 ha,

- contribute to the reduction of the hypertrophic state of the lake when water is introduced directly from the lake;
- act as transition zones between the WWTPs and the Albufera, improving the biological quality of the treated wastewater;
- reduce pollutant inputs from irrigation returns;
- reduce pollutants from urban runoff;
- are a refuge for animal and plant species and contribute to the improvement of phyto and zooplankton biodiversity, macroinvertebrates, etc;
- are used (particularly, Tancat de L'Illa) as water storage for nearby crops.

More recently, since 2019, a stormwater wetland of 1.2 ha (39.351220, -0.403004) connected to the urban drainage network of the town of Silla has been operational. Its objectives are

- To retain pollutants associated with combined sewer overflows;
- To create wetland habitats to increase biodiversity;

- To store water for possible use in irrigation;
- To increase water resources;
- To reduce nitrate concentrations in water.

In all the above cases, productive agricultural land has been converted into wetlands.

In order to reduce urban runoff into the lake, the construction of seven stormwater tanks on the western perimeter of the Natural Park is about to be completed. Regardless of their efficiency in capturing first flushes, urban growth since they were designed 12 years ago suggests that additional systems may be required. Implementing sustainable urban drainage systems (SUDS) in towns can be a compliment. Various types of SUDS have been implemented in various towns in Valencia and have proven to be efficient.

Therefore, the following infrastructures are proposed based on the experience in NbS in the Park and in Valencia.

1. Increase the number of large wetlands (> 15 ha):
   - On the shores of the lake as a transition zone between the rice field and the lake.
   - In areas away from the lake, but within the Natural Park, to renaturalise WWTP effluents before they reach the lake.
2. Increase the number of small wetlands (1-2 ha) to:
   - Capture urban runoff that is not captured by stormwater tanks.
   - Purify water stored in storm tanks to be used for irrigation or as environmental flow.
3. Implement SUDS:
   - Permeable pavements in commercial areas (car parks).
   - Green roofs in industrial buildings.
   - Rain gardens and infiltration/retention basins in the towns around the lake.

Three constructed wetlands between 16 and 40 hectares for treated sewage regeneration and water's lake improvement. A small wetland, 2000 m2 for agricultural and urban runoff control. A huge stormwater basin for urban runoff control.

Albufera lake water quality improvement - Constructed wetlands (CWs) aims to reduce the huge phytoplankton concentrations found in Albufera waters increasing zooplankton communities, reducing nutrients and enhancing transparency.

Treated sewage regeneration from WWTP. CWs improve the biodiversity of treated wastewaters from two nearby WWTPs before being discharged to the lake.

Urban and agricultural runoff control - CWs and stormwaters basins reduce the loads of nutrients and suspended solids from runoff, both urban and agricultural.

L'Albufera Natural Park biodiversity improvement. CWs have been classified as natural reserves inside the Natural Park because of their significant role in biodiversity enhancement (insects, amphibians, fishes, birds, etc.)

3.3 Agia (Crete Greece)

The study area, which lies between 35° 2450N and 35° 3000N and 23° 4950E and 23° 5800E, is located in the central part of the Keritis river basin, only 3.5 km west of the city of Chania. It is characterised by a gentle topography and is mainly drained by the Keritis River, which serves as the main watercourse of the region. Despite the high demand for irrigation water, only 31.0% of the available agricultural land is irrigated (Tsagarakis et al., 2004). TThe study area, which lies between 35o 2450N and 35o 3000N and 23o 4950E and 23o 5800E, is located in the central part of the Keritis river basin, only 3.5 km west of the city of Chania. It is characterised by a gentle topography and is mainly drained by the Keritis River, which serves as the main watercourse of the region. Despite the high demand for irrigation water, only 31.0% of the available agricultural land is irrigated (Tsagarakis et al., 2004). The karst aquifer of Agia, is the most important water reservoir in the region. This water-rich aquifer feeds numerous wells and springs that are distributed throughout the area and serve various purposes, including irrigation and domestic use. The study area and the spatial distribution of the springs are shown in Figure 13.

Various organisations are entrusted with the allocation of water resources based on specific use contexts and contribute significantly to water management. The stakeholders involved in these efforts encompass a wide range of organisations. These include governmental and administrative bodies, including the regional units of Chania and Heraklion of the Region of Crete, the decentralised administration of Crete and the municipalities of Chania and Platanias. In addition, development and economic organisations such as the Development Organization of Crete S.A. and the Regional Development Company of Crete S.A. (P.AN.ETAI.K.) are actively involved. Local organisations and associations such as the Local Organization for Land Reclamation of Varipetro (TOEB of Varipetro) and the Cultural Association of Agyia also play an important role in these efforts. In addition, individual stakeholders, especially farmers who actively use the water in the area, also make an important contribution. Utilities, such as the small hydropower plant (M.Y.H.S.) of Agyia, are an integral part of the joint efforts for effective water management.

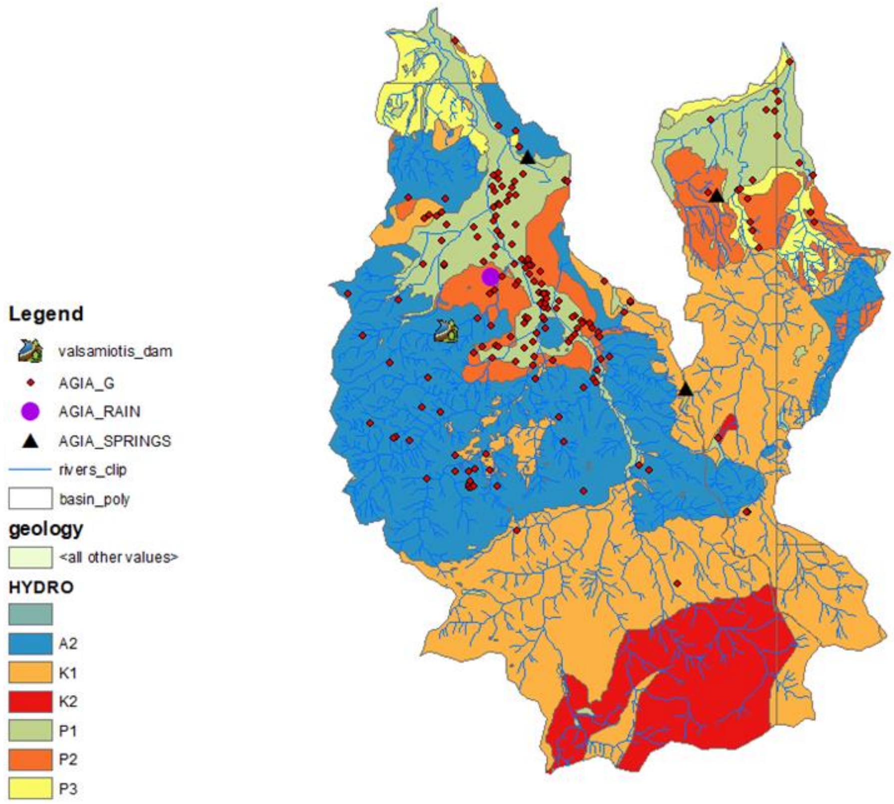

Figure 13 Agia Demo Site, Crete, Greece.

3.3.1 Description (belonging area, soil properties and climate)

The Greek demo site is located in Agia, on the island of Crete. It has a mild temperate climate with dry summers and is important for its rich flora and fauna. The climate of the study area is classified as a sub-humid Mediterranean climate, characterised by humid and relatively cold winters, and dry and warm summers, important for its rich flora and fauna. Winter, which begins in November, brings unstable weather conditions due to frequent alternation between low and high pressure. Most of the rainfall occurs in the winter months, while the dry season extends over six months from May to October. The highest temperatures are generally measured in July, in contrast to the coldest temperatures, which are measured in January and February. Temperatures rarely fall below 0°C. These cyclical fluctuations in the weather patterns illustrate the seasonal dynamics of the region, where fluctuations in temperature and precipitation characterise the climate throughout the year. The site faces challenges such as groundwater overexploitation and requires sustainable and appropriate water management.

The area has variable land use which is mainly non-urban. More specifically, as follows: Natural grassland 23.29%, olive groves 21.13%, sclerophyllous vegetation 19.21%, fruit trees and berry plantations 9.65%, complex cropping patterns 1.29%, mainly agriculture with significant areas of natural vegetation 5.05%, forests (deciduous, coniferous, and mixed forests) 6.90%, transitional forests and shrubs 6.01%, moors and heathlands 2.78%, sparsely vegetated areas 0.26%, non-contiguous urban structures 4.33%.

The predominant geological formations in the Keritis River basin are limestone, alluvium, marl and schists, all of which play a central role in shaping the soil composition in the region. These geological formations exert a significant influence on the terrestrial environment of the catchment. The surface soils in the Keritis catchment are characterised by a texture of loam, sandy loam and clayey loam, demonstrating the direct influence of these formations on the soil structure. In addition, the soil composition in the Keritis watershed has a recognizable presence of heavy metals, primarily due to agricultural activities which are the main economic activity in the region. Copper (Cu), zinc (Zn), lead (Pb) and chromium (Cr) are the main heavy metal components found. The mean, median and range values determined for these metals, as well as their typical and frequently occurring concentrations, provide information on the extent of soil contamination. Copper, for example, has a mean concentration of 30.59 mg/kg, ranging from 10.28 mg/kg to 68.50 mg/kg. Zinc, on the other hand, has an average concentration of 73.2 mg/kg, ranging from 39.75 mg/kg to 139 mg/kg. The average lead content is 18.92 mg/kg and ranges from 11.48 mg/kg to 33.55 mg/kg, while the average chromium concentration is 100.06 mg/kg and varies between 79.73 mg/kg and 162.38 mg/kg. In addition, the pH, calcium carbonate content and organic matter concentration in the Keritis watershed provide important information about the soil characteristics of the region. The observed pH value ranges from acidic to slightly alkaline with an average value of 6.50, which illustrates the different soil conditions in the catchment area. The generally low free calcium carbonate content with a mean value of 1.39 % reflects the geological influences on the mineralogy of the soil. Finally, the variation in organic matter content between 1.30 % and 4.46 % with a mean value of 2.35 % illustrates the dynamics of organic input and soil fertility within the basin (Papafilippaki et al., 2007).

3.3.2 Socio - economic features

The municipality of Agia is a rural settlement in a flat area of 7,912 square kilometres. Agriculture is the most important economic sector in this region, which is characterised by rural landscapes. A large part of the catchment area is used for agricultural activities, with 31.0% of the land being irrigated. Analysis of the Corine Land Cover dataset shows that olive groves and natural vegetation dominate the land use patterns within the basin.

Agriculture and livestock are both components of the Greek economic framework and the socio-economic landscape of the island of Crete, including the study region. These sectors play an important role in sustaining the local economy and rural livelihoods. Due to the fertile soils and favourable climatic conditions, diverse agricultural practices such as olive growing, viticulture, and livestock breeding are practised in the catchment area.

Despite the historical importance of agriculture and livestock farming in the region, significant socio-economic changes have taken place over time. Particularly noteworthy are the abandonment of agricultural land and the depopulation of rural areas, phenomena that have contributed to a significant decline in agricultural and livestock activities in recent years. These adjustments underline the dynamic nature of agricultural practices, which must constantly adapt to evolving socio-economic and environmental dynamics.

At the same time, the growing importance of tourism is becoming a notable economic factor, prompting residents to seek additional sources of income. This change is reflected in the growing presence of tourism-oriented businesses that complement the existing infrastructure facilities.

3.3.3 Main issues

In the Keritis catchment area, the main objective is to preserve the quality of groundwater and contain pollution phenomena in order to ensure the safety and availability of water resources for human consumption. As the catchment serves as a vital source of water for agriculture, industry and households, protecting groundwater from contamination is crucial for sustaining various socio-economic activities and supporting local communities.

However, there are also challenges, particularly at Lake Agia, where sedimentation is a major problem. The accumulation of sediments reduces the surface area of the lake and decreases its active water volume, which ultimately alters the ecological dynamics of the lake's ecosystem. In addition, the extraction of water from Lake Agia for agricultural irrigation purposes, especially during the dry summer months, exacerbates the problem. This water abstraction leads to significant fluctuations in the lake's water level, which can have a negative impact on the ecological balance of this designated Natura 2000 site. These combined factors pose a significant challenge to the ecological integrity and functionality of Lake Agia and require careful management and mitigation strategies to effectively address the issues.

3.3.4 Tailored NbS suggested

The tailored nature-based solutions proposed for the Agia demonstration site are presented and explained with additional detail below.

- Retention and detention basin
- Wetland conservation

Lake of Agia is an artificial lake that was created in the 1920s by the construction of a small dam on the site of a marshland in order to enable the operation of a small hydroelectric power plant for the energy needs of the city of Chania. The wetland lies within the boundaries of the Site of Community Importance “Agia Lake – Platanias – Keritis Stream and Estuary – Fasos Valley” (SCI – GR4340020) of the Natura2000 network and is also listed in the catalogue of important wetlands of Greece of the Natural History Museum of Crete. The lake’s tributaries consist of the karst springs and a surface water stream, a tributary of the Keritis River. The hydroelectric power plant was in operation until 2015 and therefore the management of the lake was specified in the relevant environmental conditions permit decision. This stipulated a minimum flow of 0.3 m^3/sec for the ecological discharge below the dam from November 1 to May 31 and a minimum flow of 0.1 m^3/sec for the rest of the year. The project operator was also required to carry out an environmental remediation study after the power plant was shut down in order to integrate the work into the natural environment and ensure the protection of the area. In 2017, a study was carried out by the Natural History Museum of Crete on the accumulation of suspended matter in the lake. In this study, [IA1] the deepening of the lake was proposed and water level values were estimated to ensure a better functioning of the lake as an ecosystem. Specifically, the following water levels are proposed:

- Minimum water level at 37.7 m, from the beginning of the irrigation period (April 1 to July 10)
- Minimum water level at 37 m for the rest of the months of July to September
- Gradual increase of the water level above 37.5 m, the beginning of October.
- Sustainable agriculture (smart irrigation practices)

Alternative farming practices that reduce erosion include the use of disk harrows or small tines for tinning and direct planting/seeding with hole opening (non-cultivation). This method retains organic matter and protects the soil structure. However, it is only suitable for loam and clay loam soils and is not recommended for sandy soils and compacted soils.

Integrated cropping systems represent a comprehensive approach to crop management. These systems provide satisfactory production of good quality, are economically sustainable and protect the environment. They enhance the positive effects of agricultural practices on the environment while minimising the negative effects without compromising productivity and profitability. These systems are designed for sustainable and optimal use of all resources, including livestock, water, soil, air, machinery, ground relief and wildlife. This is achieved through a combination of good management, the use of natural processes and alternative practices.

- Afforestation
- Maintaining the groundwater and lake water level at the wetland site

Many wetlands such as Agia are hydrologically and ecologically connected to adjacent groundwater bodies, but the degree of interaction can vary greatly. A screening study at the scale of a river basin or regional aquifer will assess the potential for wetland-groundwater interactions. The degree of connectivity is largely determined by a combination of geology, regional hydrology, and topography. Typically, this type of screening study lends itself to a GIS-based approach, possibly with the complementary use of remote sensing tools, to provide an indication of the potential risk to wetlands from regional groundwater abstraction or other forms of use such as artificial recharge with wastewater. Much of the analysis can be done at the desk, although at this level of resolution, it can at best provide “red flags” as to the location of high- risk areas where extensive groundwater exploitation should not be considered without additional studies being conducted to determine the potential impacts to wetlands in the region.

- Measures to extend the natural reedbed area for nutrient filtering and flood protection. Restoration of the riparian zone and phytoremediation help to contain flooding, erosion and the transport of sediments and pollutants. In addition, restoration acts as a natural filtration system, both microbiologically and chemically, retaining nutrients derived from agricultural activities.
- Increasing water availability/improving the condition of aquatic ecosystems.

To ensure comprehensive monitoring of the hydrological system, it is recommended to establish an integrated monitoring system for the inflows and outflows of the aquifer. This system would collect telemetry data during the gradual restructuring of the springs to evaluate the performance of the system and the recovery rate of the aquifer. In addition, annual reports should be prepared detailing aquifer monitoring data and long-term fluctuations in spring discharges, groundwater levels, and abstraction rates. These annual reports serve not only to inform the regional authorities, but also to educate and inform the public about the state of the water resources in the area. (“Research study of the brought matter accumulation at the Agia Lake bed - Final Report”, Natural History Museum of Crete, 2017).

3.4 Arborea (Italy)

The territory of the Arborea demonstration site falls in the central-western part of the island of Sardinia, has approximately the following WGS 84 coordinates: 39°46′21.94″N 8°34′52.64″E and an altitude of approximately 10 m above sea level.

The coastal plain of Arborea, with an extension of about 70 km^2, overlooks the Gulf of Oristano and is an integral part of the vast alluvial plain of Campidano, which extends for about 115 km, in a NW-SE direction, from the Gulf of Cagliari to the Gulf of Oristano and is about 15 km wide.

Between the plain and the Gulf of Oristano, there are transition zones, i.e. wetlands registered by the Ramsar Convention as rich in biodiversity. In particular, the S'Ena Arrubia Pond, the Corru S'Ittiri Marceddì Pond and the San Giovanni Pond belong to the Arborea basin, as shown in the following image.

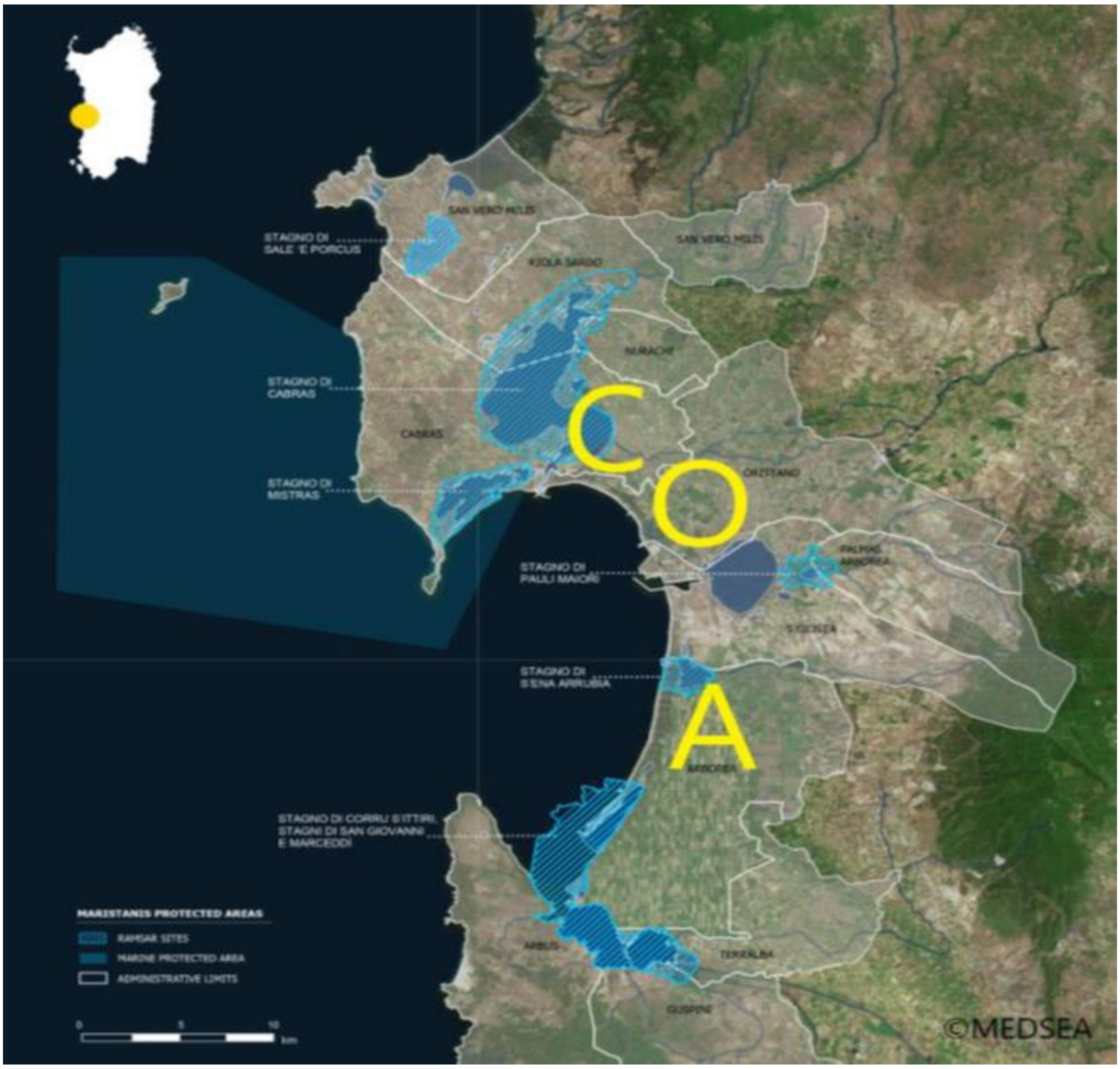

Figure 14 The Gulf of Oristano, with three sites of study: Cabras (C), Oristano (O) and Arborea (A). (Font: MARISTANIS project).

In particular

- S'Ena Arrubia Pond (2,23 km^2)

A freshwater lagoon, the only remaining part of a large complex of marshes and lagoons, converted into an area for agriculture in the 1930s. The vegetation consists of various halophilous plants, submerged species and emergent reeds. This is an important stopping, nesting and wintering area for numerous species of water birds, including the pink flamingo.

- Corru S'Ittiri Pond, San Giovanni and Marceddì Ponds (26,10 km^2)

Three coastal lagoons of variable salinity partially separated from the sea by a system of dunes: that of Corru S'Ittiri is parallel to the sea, while those of Marceddì and San Giovanni are located in succession and perpendicular to the coastline. The vegetation consists of extensive reed beds and halophytic plants. A rich fish fauna can be found in these sites.

Facing the coast and located a few kilometres away from the previous ones, i.e. on the border with the area under examination, is the Pauli Maiori Pond (2,87 km^2) A small low-salinity lagoon surrounded by large reed beds whose only inflow is the drainage of waste water derived from agricultural irrigation. The site is characterised by different types of vegetation typical of weakly brackish freshwater and brackish water. Presence of ornithological species of international zoogeographical value.

The sites, given their international importance from an eco-environmental point of view, are under constant monitoring, of the different environmental components, by the ARPAS Agency (Environmental Protection Agency of Sardinia). The sites, given their international importance from an eco-environmental point of view, are under constant monitoring, of the different environmental components, by the ARPAS Agency (Environmental Protection Agency of Sardinia).

The basin's hydrographic network, made up of riverbeds, at first natural, which later saw their waters regimented by artificial reclamation canals, this plain being, until the beginning of the last century, a marshy area and thus subjected successively to intense environmental reclamation starting roughly in the late 1920s until about 1950.

Among these reclamation channels we note the main ones such as the Flumini Manni (593 km^2), and the Rio Mogoro (381 km^2). The most important tributary of the F. Mannu is the Rio Sitzerri, which originates from the former mining compendium of Montevecchio, and after a course of 24.5 km, flows into the main body about 0.5 km before the S. Giovanni pond. The final deliveries of the canals indicated above, are found in the vicinity of the wetlands indicated above.

Their function is to divert surface-flowing waters in order to prevent flooding phenomena and to manage irrigation for agricultural purposes in the plain area.

Part of the basin afferent to the demo-site area includes the Mount Arci Nature Park. The area of the regional park (270 km^2) is included in the province of Oristano.

Mount Arci, of volcanic origin, is an isolated rock formation located at the northeastern edge of the tectonic trench of the Campidano plain; three peaks, basaltic towers of volcanic origin, belong to it. In ancient history, Mount Arci was a site of mining and mining interest, and was an important piece in the development of trade of the people who inhabited this area of Sardinia since the sixth millennium B.C., because it was rich in obsidian of excellent quality, called the “black gold” of antiquity, which was exported to places far from the region, in the Mediterranean, allowing the local development of an important civilization.

3.4.1 Description (belonging area, soil properties and climate)

The Italy demo site of the OurMED project is located in Arborea, an island in the North MED region. It covers an area of 854 km^2 and experiences a mild temperate climate with dry summers. The site is known for its 10 areas dedicated to conservation and protection, including three Ramsar sites, which are wetlands of international importance. The main objectives of the Italy demo site are to address water distribution issues, pollution, and energy challenges.

The Arborea site has the same geological history as the Campidano Plain. Geologically, the Campidano is a tectonic trench composed of a system of distensive faults that caused the sinking of part of the earth's crust. This tectonic movement is traced back to the middle Pliocene - early Pleistocene geological time interval, approximately 4 to 2 million years ago. Within the trench, subsidence was active for a long period, so that the Miocene Sea penetrated it, as evidenced by numerous outcrops of marine sediments.

The tectonic movement was associated with major effusive events, after which the trench was affected by alluvial sedimentation phenomena that brought a thickness of more than 600 metres of continental and deltaic sediments.

The present morphological structure is the result of fluvial and secondarily aeolian processes that, active throughout the Quaternary period, under climatic conditions different from the present, gave rise to river erosion rips, meanders, river terraces, dejection cones, ponds, wetlands and dune fields. Thus, accumulation and erosion form typical of fluvial and wind dynamics are found. The low, sandy coastline, on the other hand, is the result of the shaping action of the sea. The subsoil is characterised by alternating layers of more or less powerful, sometimes lenticular, pebbly-sandy gravels, clays, silty clays and clayey-silty sands. Locally, peaty layers are also present.

From the hydrogeological point of view, there are two hydrogeological units in the survey area: the multi stratum aquifer in the Oristano plain (classified in the Regional Management Plan of the Hydrographic District according to the criteria dictated by Directive 2000/60/EC as the detrital - alluvial Plio - Quaternary water body of Oristano) and the phreatic sandy aquifer in the Arborea area (also classified according to the Regional Management Plan of the Hydrographic District as the detrital - alluvial Plio - Quaternary water body of Arborea).

The area thus incorporates coastal wetlands, located in the Gulf of Oristano, of international importance and high ecological value, such as the S'Ena Arrubia Pond, the Corru S'Ittiri Marceddì Pond and the San Giovanni Pond, which are protected by the Ramsar Convention as they are characterised by considerable biodiversity. These areas are characterised by high environmental and agricultural pressures, both of which intensify the vulnerability of coastal areas. The coasts of western Sardinia belong to one third of the Mediterranean basin most exposed to natural hazards, mostly due to the very high level of sea waves (Satta et al., 2017).

The mountainous relief of Monte Arci, mentioned above, is an isolated rock formation, located at the north-eastern limit of the tectonic trench of the Campidano plain; it has three peaks, basaltic towers of volcanic origin, which partly fall within the basin of Arborea, it also has important perlite quarries and the Obsidian Museum in the municipality of Pau is interesting. Most of this territory is home to typical floral species, such as holm oaks, cork oaks and Mediterranean maquis plants.

The woods are home to wildlife species such as: wild boar, weasels, martens, foxes, and deer and fallow deer have been reintroduced, but there are also numerous species of birds, such as: wood pigeons, finches, jays and hoopoes, while birds of prey include: goshawks, sparrow hawks, crickets and peregrines. The park is managed by a management consortium that has set up numerous themed trails, creating a hiking network consisting of no less than 200 kilometres of paths and trails of rare beauty.

In the context of the reclamation of the Campidano plain, the regimentation of the Rio Mogoro is of relevance, inserted in the territorial context of Monte Arci, which led in the first half of the last century to the construction of the dam of the same name, useful for the lamination of flood phenomena and the management of agricultural irrigation. The dam including the foundations has a height of 29.80 meters and develops a crest of 345 meters at 67.80 meters above sea level. The plant, owned by the Region of Sardinia, is part of the Regional Multisectoral Water System and is managed by the Sardinian Water Authority. The Rio Mogoro downstream of the dam flows into the San Giovanni pond protected by the Ramsar Convention.

From the geomorphological point of view, the characterization of the territory is as follows:

- in the northern part there is a prevalence of lithologies datable between the Eocene and Holocene;

- in the eastern part, marine deposits of sandstones, Miocene marls, Miocene continental sediments of conglomerates and sandstones with flint beds and tuffitic levels predominate instead;

- in the central part rises the Monte Arci relief, formed during the post-Miocene eruptions, which gave rise to the largest volcanic apparatus in Sardinia, whose lavas consist of ignimbrite spreading of Pliocene rhyolites, rhyodacite, glassy porphyritic dacites and boiling porphyritic dacites and are topped by alkaline and transactional basalts, basaltic andesites, trachytes and phonolites of the Plio-Pleistocene;

- the western slope of the relief is separated from the Quaternary sedimentary plain relief by a morphological step, the plain being composed of Pleistocene aeolian deposits and Holocene alluvium.

These formations can be associated with medium-high permeability laddove we have very low slopes and low permeability where mountainous reliefs insist.

Corresponding to these soils are areas where we have predominantly arable and agricultural crop use, deciduous forests, poplar groves, willow groves, eucalyptus groves, areas of natural pasture and rural built-up areas.

The Sardinian region, in which the Arborea site falls, has a typical Mediterranean climate, with mild, rainy winters and hot, dry summers with evaporation exceeding rainfall from April to September (Niedda and Pirastru, 2013). Average annual precipitation increases with altitude and is lower on the coast (Sardegna ARPAS 2020): for the basin in question, the average amount of precipitation ranges between 600 and 700 mm per year.

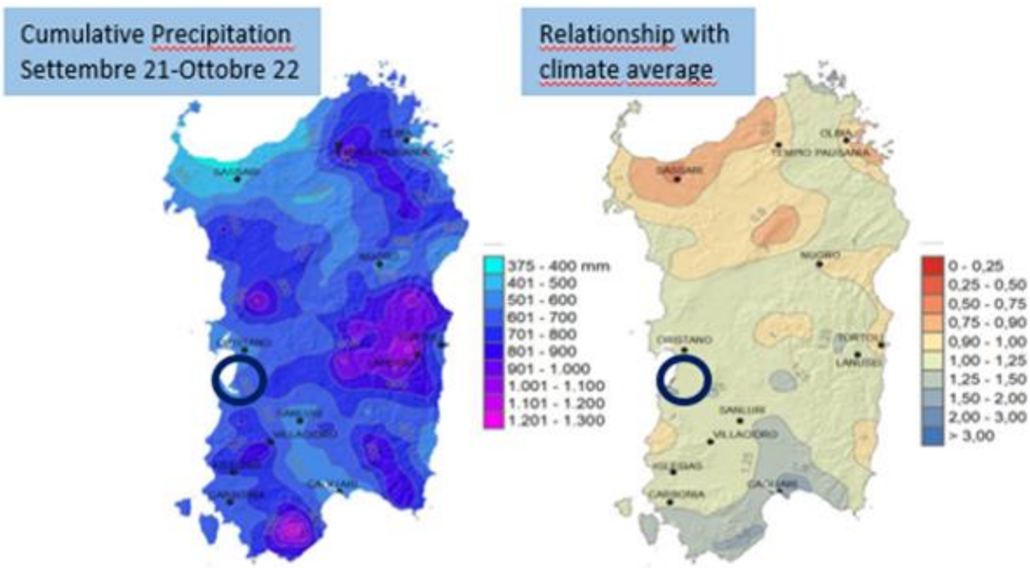

Figure 15 Cumulative precipitation in Sardinia from October 2021 to September 2022 and the relationship between the cumulative and the climatological average (Font: ARPAS).

As far as temperatures are concerned, the measurements of the meteorological stations, managed by the ARPAS Regional Agency, make it possible to identify two precise periods of marked transitions: March-April and September-November, which delimit the two climatic seasons typical of the Mediterranean regions, as well as two periods (July and August, December and February) with substantially constant average temperature.

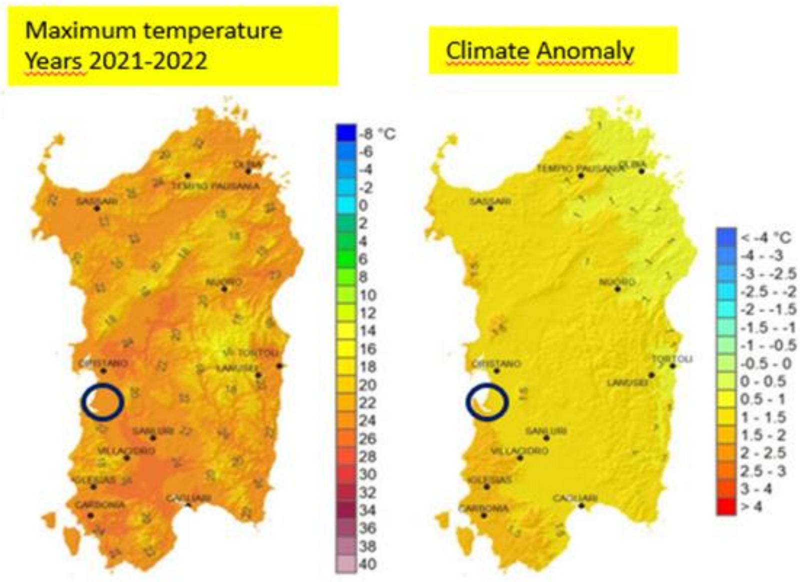

Figure 16 Annual average of maximum temperatures 2021-2022 and anomaly compared to the 1995-2014 average (Font: ARPAS)

For the area in question, the average maximum temperature is around 22 C, and in 2022, there is an increase of 1.5 C compared to previous years.

3.4.2 Socio - economic features

Until 90 years ago, this area was a swamp where no human activity was possible. The land reclamation works in Arborea, which took place both before and after World War II, produced radical changes in the landforms and the sedimentary environment. The interventions consisted mainly in the filling and draining, through a dense and complex network of drainage channels, of the lake and marsh depressions and the installation of large pumping systems. Therefore, almost the entire area is characterised by outcropping sandy surface layers, caused by the wind that flattened the dunes and filled in the marshy depressions. Following land reclamation, today the Arborea plain is the most important agricultural area in Sardinia, mainly dedicated to the dairy industry. The management of the network of canals, the adjoining watercourse pumping system and the irrigation system is entrusted to the Consorzio di Bonifica Oristanese. The area is therefore not affected by the socio-economic dynamics typical of densely urbanised and/or industrialised areas, but has maintained values and characteristics typical of rural areas over time.

Some economic activities are developed inside the Arborea Basins:

- Agricultural activities (cereals, pulses, vegetables, olive groves and vines), Livestock breeding (cattle and sheep)
- Aquaculture
- Handicrafts
- Tourism (bathing activities, hiking)
- Ethnographic museums

The integrated water service related to the management of the water collection, adduction, distribution and purification systems has recently been entrusted to the company Abbanoa S.p.A. It is the sole manager of the Integrated Water Service following the 'in house providing' entrustment that took place with Resolution No. 25/2004 of the Assembly of the Ambit Authority, today the Sardinian Ambit Government Authority due to the regional law reforming the sector (Regional Law No. 4 of 4 February 2015, as amended and supplemented).

This entity interacts with other actors, such as the Sardinian Region's Department of Agriculture, which directs agricultural policies in the area. On the other hand, the dynamics inherent to the use of water and soil resources are also implemented in the acts of the plans and projects of the Regional Agency of the Hydrographic District with particular reference to issues related to defence against flooding events and Water Protection Plan.

Other stakeholders present in the area include the presence of the Cooperativa Produttori Arborea, an important reality of the Sardinian agri-food system consisting of 200 members dedicated to supporting and assisting farms and livestock breeding in the area.

Another reality is the Cooperativa Pescatori di Arborea, an important reference in mussel farming and fishing. Mussel farming of the 'Mytilus galloprovincialis' species is one of the main activities of our company with a production capacity of no less than 86 hectares of mussel farms in the Gulf of Oristano, and a Purification and Dispatch Centre of almost 3,000 square metres.

Other actors acting on the ground to protect flora and fauna are NGOs such as the WWF and the Italian League for the Protection of Birds (LIPU) as a reminder of the close interconnection of habitats in other regions of the Mediterranean and beyond.

The WWF is also very active in the area for the protection of wetland flamingos and is dedicated to the observation of local fauna as well as the organisation of hiking.

3.4.3 Main issues

On the other hand, Sardinia is located in the Mediterranean region, a climate change 'hotspot'. Average temperatures in the region have recently risen to 1.6 °C above pre-industrial levels and are expected to increase by 2-3 °C by 2050. This change will be accompanied by an increase in storm-related rainfall extremes and the likely increase in the frequency and intensity of droughts. A number of nature-based solutions have therefore been proposed to tackle global change; these include the management of wetlands, which act as a buffer against various natural hazards such as floods and droughts, heat waves, sea-level rise and coastal storms. In fact, in this territory intensive agriculture and anThe Gulf of Oristano area has been affected by extreme weather events, especially flash floods following heavy rains, coastal storm surges are frequent during the cold season in the area, and sea levels are projected to rise in the coming decades due to climate change.

In addition to weak governance due to overlapping competences and constraints of different actors, several issues affect these areas: pollution from wastewater treatment plants, former mining activities and agricultural activities (the reclaimed area of Arborea has been declared animal husbandry have become the leading activities. From an environmental and regulatory point of view, according to D.G.R. no. 1/12 of 18/01/2005, implementing the Nitrates Directive 91/676/EEC, a large part of the survey territory is defined at the regional scale as a Zone Vulnerated by Nitrates of Agricultural Origin (ZVNOA) and therefore represents one of the areas with the greatest problems on vulnerability and nitrate pollution of aquifers in Sardinia.

In fact, intensive farming and industrial-type agriculture is practised in this area.

In the Oristano Plain, the consumption of groundwater, emitted through the numerous wells and intended mainly for agricultural uses, is excessive compared to the extent of recharge of the aquifers present (a surface aquifer and a deep multilayer aquifer). This has produced over time a series of phenomena related to overexploitation, which has varied the balance regime between fresh and saltwater. The surface aquifer can be said to be affected by marine intrusion only in the coastal belt, while in the inland areas the salinity peaks are more likely to be attributable to the use of agricultural products and the interactions with the underlying aquifers, which are generally more contaminated. In contrast, the multilayer aquifer, which is subject to more intense pumping regimes, shows clear signs of saline contamination by marine intrusion and upcoming, but it cannot be ruled out that the existence of some degree of communication, especially between the first and second aquifers, may have produced the passage of polluting agricultural products from the first aquifer to those below, a passage that is increasingly reduced as one descends deeper.

Based on the above-mentioned geological, hydrological, hydrogeological setting and use of surface and groundwater for irrigation uses, the following areas can be identified as most at risk for marine intrusion: - Areas bordering the ponds (high salinity water intrusion);- Arborea Reclamation Area (area with higher agro-livestock productivity; problems of marine intrusion, upcoming, short-circuiting of wells);- Coastal strip for a variable width of up to 3.5 km (marine intrusion).

In addition, there are anthropogenic disturbances related to uncontrolled access to the area, as well as the problem of the spread of invasive and alien species. Furthermore, the maximum relative sea level for the Gulf of Oristano is expected to reach levels (based on the IPCC AR5 RCP8.5 scenario) by the year 2100 that could leave some parts of the gulf partially flooded (Antonioli et al., 2017). As far as flooding is concerned, wetlands in this area play a key role in disaster risk reduction, but they also create a conflict between urban areas, fishing and livestock farming, with the famous fishing town of Cabras and the fertile area of Arborea, home to extensive farmland production. Moreover, Sardinians have a long tradition of autonomous governance and environmental awareness, including forest fires in the 14th century (Ivčević et al., 2021).

3.4.4 Tailored NbS suggested

NBS can contribute to the protection of natural processes as a function of the geomorphological and climatic variability of the different environments. The following is a non-exhaustive list of possible solutions to protect biodiversity and water bodies in the basin:

- Retention and detention basin

- Aquifer Recharge
- Wetland conservation
- Riparian zone restoration
- Phytodepuration
- Sustainable agriculture (smart irrigation practices)
- Afforestation/Reforestation
- Dune grass/Seagrass
- Saltmarshes

3.5 Mujib (Jordan)

The Mujib River Basin is located on the eastern slopes of the Rift Valley Region forms semi-arid to arid plateau land, representing 91% of the total area flowing westward from the peripheries of the Jordanian eastern desert, gradually then rapidly accelerating through the eastern highlands to finally discharge in the Dead Sea Basin at the junction joint with Wadi Al Walah Basin in Al Malaqi point located at the heart of the Mujib Biosphere Reserve. The Wadi Al Mujib Basin lies within the larger Mujib and Walah Basin, which covers 6,586.76 Km2 and includes two sub-basins: Wadi Al Mujib Sub-Basin with an area of 4,449 Km2 and Wadi Al Walah Sub-Basin with an area of 2137.76 Km2.

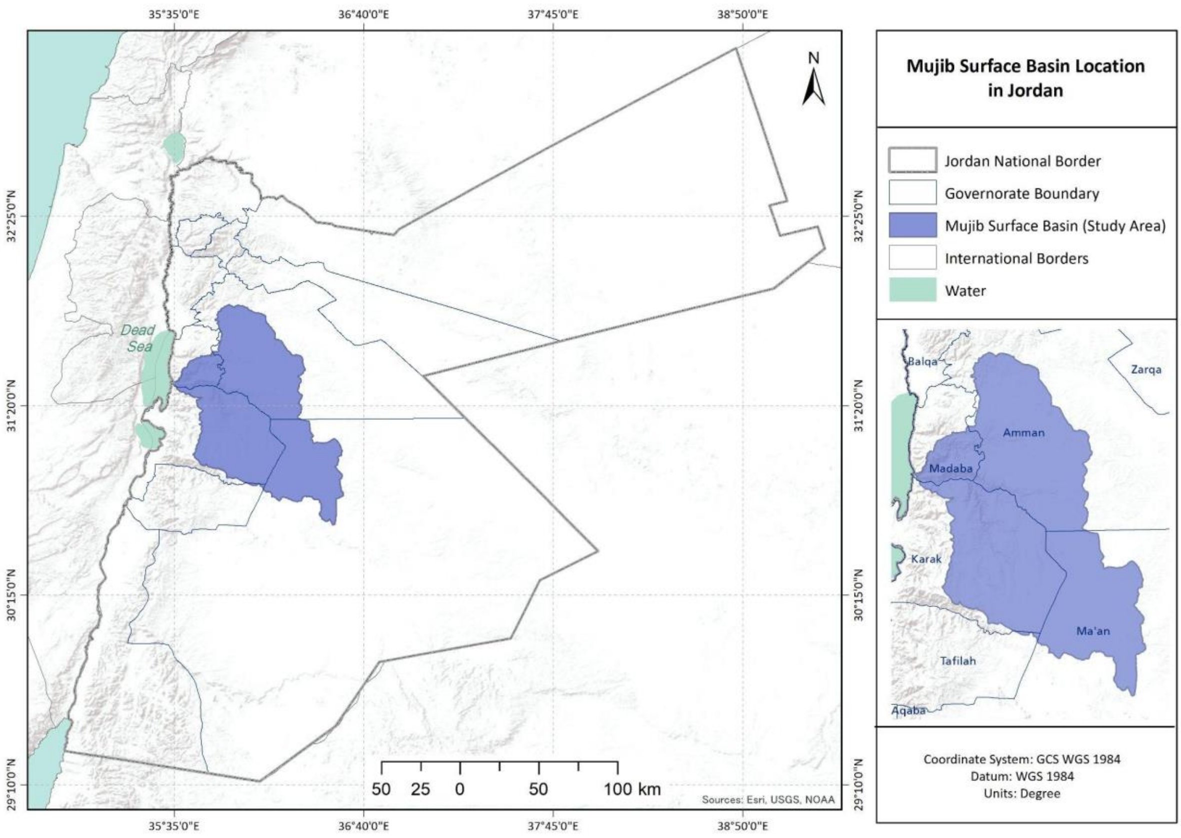

Figure 17 Mujib Surface Basin Location in Jordan.

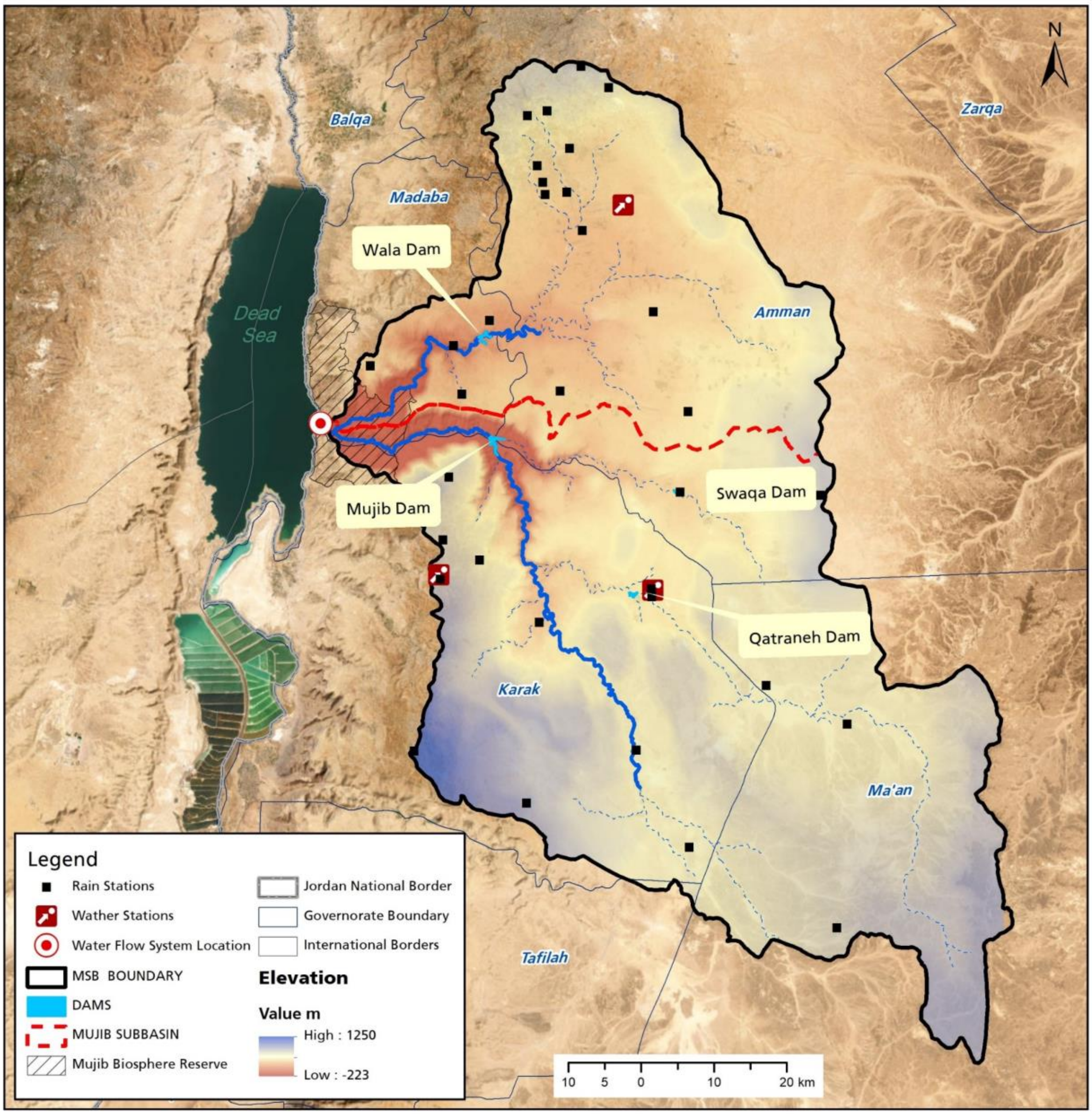

Figure 18 Spatial extend of the Mujib river basin in Jordan.

3.5.1 Description (belonging area, soil properties and climate)

The bulk of soil in the MRB is loamy in texture, ranging from clay loams in the north to sandy loams in the south. In the south, there are gravelly and stony sandy loams. Soil with a limited effective field capacity is common in the basin and has the ability to speed up pollutant transport to the reservoir.

Sandy soil constitutes 0.84% of the basin's land, and located in the southern regions of the basin, while clay soil is characterised by having low permeability and high porosity, surface runoff is higher than other types of soil. It is spread in four main areas: the westernmost part of the basin, the area adjacent to the central area of the basin, and some cadastral spots in the eastern and southern sides of the basin. These areas represent 30.4% of the total area of the basin. Silty soil is the most widespread in the basin, and found in various regions and constitutes 68.8% of the total area of the basin.

The Mujib Basin boasts a diverse climate, predominantly Mediterranean type, with its unique character. It is a land of contrasts, with scorching hot, dry summers and cool to cold, wet winters. The data from the Jordan Meteorological Department reveals a wide range of mean annual rainfall, from less than 50 mm in the southeastern part of the flat area of Ma'an to 350 mm in the northwestern part in the mountains of Karak. The average temperature varies significantly, ranging between (28-32) °C in the summer and (2-5) °C in the winter. The prevailing wind direction adds another layer of complexity, mainly west and northwestern in the summer and southwestern in the winter, with speeds ranging from 2 to 28 km/h.

The MRB derives its ecological importance from the presence of four biogeographic zones and six vegetation covers. This difference makes the region diverse in ecosystem services, especially the area around the water vegetation, which represents 2.6% of the MRB total vegetation type.

The Mujib Biosphere Reserve has been given special ecological importance in the MRB, because it represents the central biodiversity area of the area, especially that associated with the aquatic ecosystem, as most of the natural flow is located within and surrounding the reserve areas.

The Mujib Biosphere Reserve (MBR) formation resulted from water runoff during geological times. This harmonious natural pattern contributed to making the place an unparalleled natural icon at the local and regional levels. It also made it one of the most important national natural and heritage sites that represents a unique geological diversity. The flow of freshwater into the valleys also resulted in a large biodiversity that included very important plants and animals, endangered animal species such as endemic plants, threatened mammals, and rare fish.

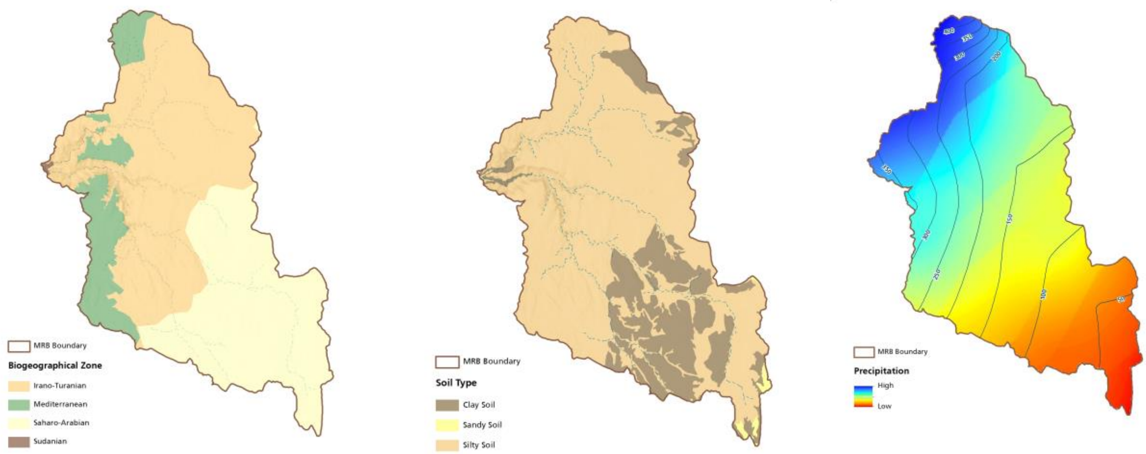

Figure 19 Mujib Classification of Biogeographical Zone, Soil Type and Precipitation.

3.5.2 Socio - economic features

- Agriculture
- Mining

Tourism and operational activities managed by the Mujib Biosphere Reserve (Visitors Center and Tourist Chalets, Al Hidan Adventure Tourism Center).

Employment projects for local community women within the Mujib Biosphere Reserve (silver workshop and leather workshop).

Small projects that include:

- A project to establish a water harvesting pit on the Sudair torrent.
- A project to cultivate pastoral plants, medicinal and aromatic plants.

3.5.3 Main issues

- Water quality and distribution
- Water Shortage
- Climate Change
- Land Degradation
- Loss of Biodiversity

All of these issues are interconnected, but they differ in terms of priority. Therefore, water loss resulting from climate change and mismanagement of water resources is the most important issue, followed by land degradation and loss of biodiversity.

3.5.4 Tailored NbS suggested

NBS can contribute to the protection of natural processes as a function of the geomorphological and climatic variability of the different environments. The following is a non-exhaustive list of possible solutions to protect biodiversity and water bodies in the basin:

- Soil conservation (cover cropping, afforestation and reforestation)
- Climate resilient agriculture (drought resistant crop varieties)
- Smart agriculture practices
- Vegetative cover and restoration

3.6 Sebou (Morocco)

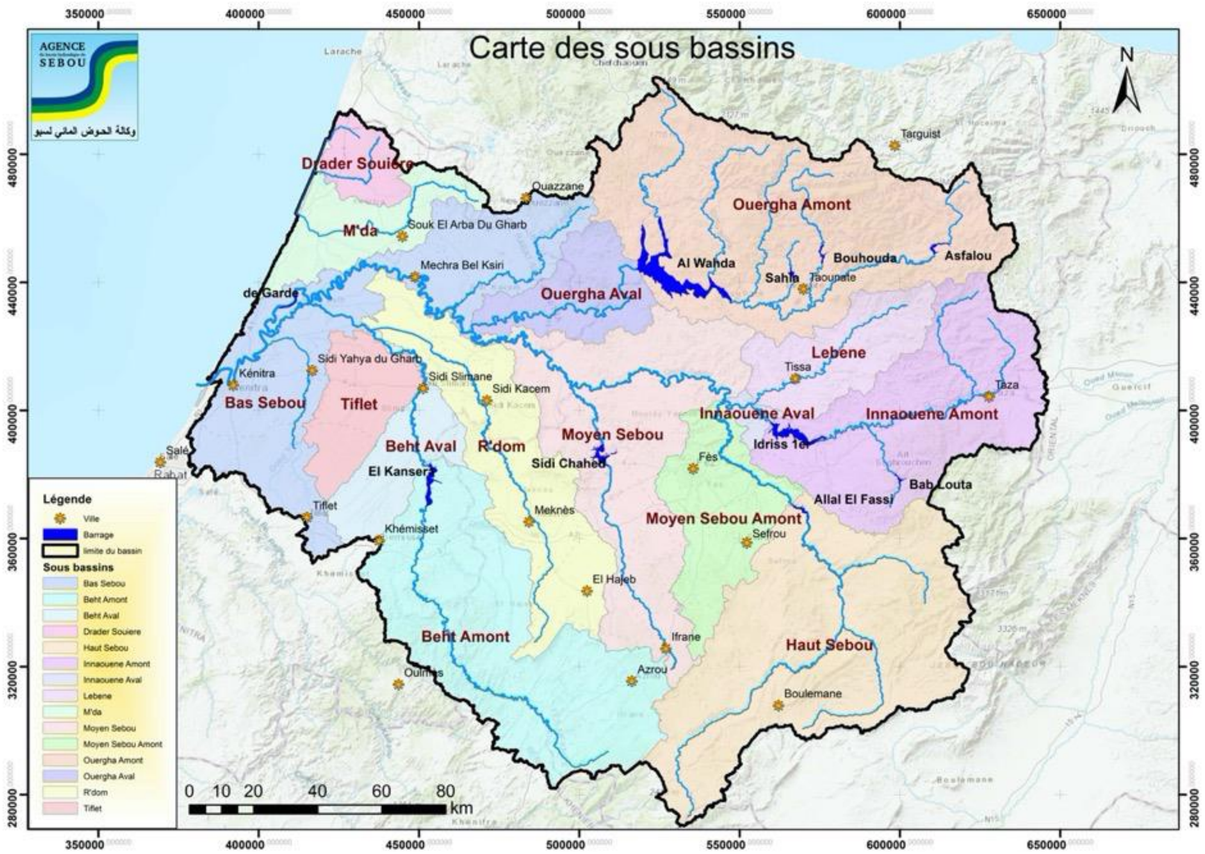

Figure 20 Sebou Demo Site, Morocco.

3.6.1 Description (belonging area, soil properties and climate)

Discover the Morocco demo site, located in the coastal region of Sebou. Covering an expansive area of 40,000 km^2, this site showcases a diverse landscape with a mild temperate climate and dry summers. It is home to 39 wetlands, 7 Ramsar sites, and 2 National parks, making it a critical hub for biodiversity and ecological conservation.

3.6.2 Socio - economic features

The Sebou demonstration site is characterised by a diverse set of socio-economic features:

- **Demographics:** The population of 6.2 million is a blend of various age groups, with a significant portion engaged mainly in agricultural and industrial activities. The community is culturally rich, reflecting a mix of local traditions and modern influences.
- **Economic Activities:** Agriculture is the predominant economic activity, with a focus on both subsistence farming and commercial agriculture. There may also be a growing sector of eco-tourism, leveraging the area's natural beauty and biodiversity.
- **Income Levels:** The region likely has a range of income levels, with disparities possibly existing between rural and urban areas. Income from agriculture and related industries plays a vital role in the local economy.

- **Education and Health Services:** Access to education and healthcare might vary, with more developed facilities in urban centres and limited services in rural areas. Community initiatives could be significant in supplementing these services.
- **Infrastructure:** Infrastructure development could be uneven, with well-developed urban areas and less developed rural regions. Road networks, telecommunications, and access to clean water and sanitation services are key factors.
- **Community Structure:** The community likely features strong local governance, with active participation in community-led initiatives and resource management. Local NGOs and community groups might play a significant role in social development.
- **Land Use:** Land use is diverse, including agricultural lands, possibly some urbanised areas, and natural landscapes like forests or river systems, which are integral to the community's livelihood and culture.
- **Environmental Challenges:** Issues such as water management, soil erosion, and the impacts of climate change on agriculture are significant. These challenges necessitate sustainable approaches like Nature-Based Solutions for long-term environmental and economic sustainability.

3.6.3 Main issues

- Water scarcity
- Groundwater overuse
- Flooding
- Soil erosion
- Loss of biodiversity
- Water pollution
- Climate change impacts

The Sebou River basin is confronted with a decline in water reserves and a high risk of pollution. The threats identified are:

- Overexploitation of groundwater resources for agricultural use
- Pollution of the water resources by solid waste and industrial activities.
- Excessive harvesting of resources, particularly with regard to hunting, poaching of birds and their eggs etc.
- Overexploitation of forests around lakes and overgrazing.

In the long term, this situation will lead to a decrease in water supplies of good quality and will have an irreversible effect on the environment and biodiversity.

3.6.4 Tailored NbS suggested

NBS can contribute to the protection of natural processes as a function of the geomorphological and climatic variability of the different environments. The following is a non-exhaustive list of possible solutions to protect biodiversity and water bodies in the basin:

- Rainwater harvesting (aquifer recharge)
- Vegetative cover and restoration
- Smart agriculture practices
- Ecosystem restoration

3.7 Medjerda (Tunisia)

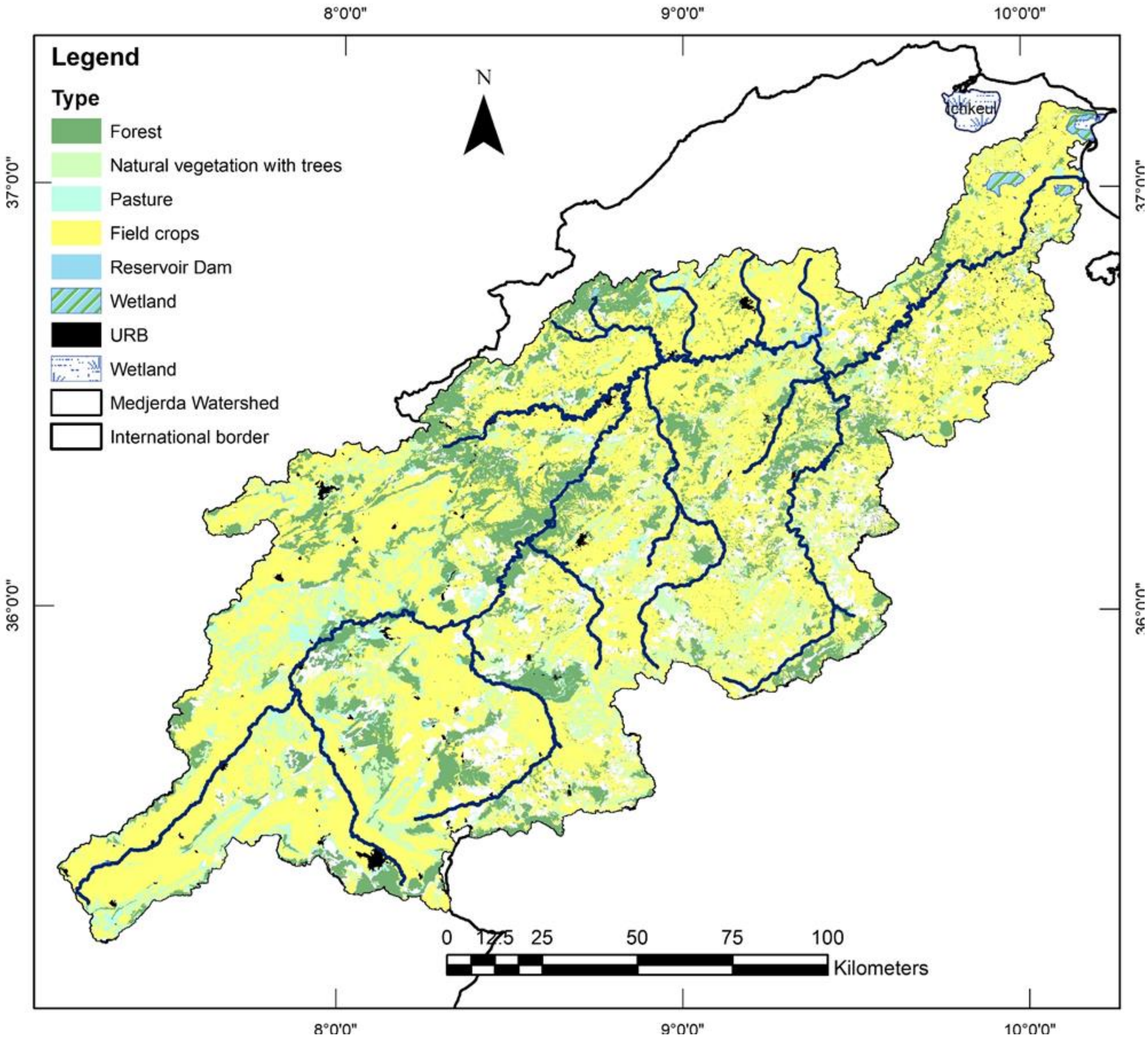

Figure 21 Medjerda Demo Site, Tunisia.

3.7.1 Description (belonging area, soil properties and climate)

The Medjerda river basin is a river in North Africa flowing from northeast Algeria through Tunisia before emptying into the Gulf of Tunis and Lake of Tunis. It covers an area of 23,700 km^2 and experiences a mild temperate climate with dry summers. The site is characterised by its transboundary nature and is home to two Ramsar sites and the first Ramsar City in the North African region Ghar El Melh, making it a hotspot for wetland biodiversity and water dynamics.

3.7.2 Socio - economic features

3.7.3 Main issues

- Sedimentation and water distribution

3.7.4 Tailored NbS suggested

NBS can contribute to the protection of natural processes as a function of the geomorphological and climatic variability of the different environments. The following is a non-exhaustive list of possible solutions to protect biodiversity and water bodies in the basin:

- Vegetative cover and restoration
- Ecosystem restoration (riparian zone restoration)
- Wetland conservation
- Rainwater harvesting (aquifer recharge)

3.8 Konya (Turkey)

With a total size of 49,963 km2, the Konya Closed Basin, located in Central Anatolia, is the biggest endorheic basin in Turkey (Figure 22a). The basin has two significant bodies of water, with Lake Beysehir situated on the western side and tLake Tuz on the northern side. The basin's north and centre are situated at a lower elevation than its west and east (Figure 22b). The site is characterised by a mild temperate climate with dry summers. The main focus of the demo site is to improve the current water distribution system and address issues of water scarcity and overexploitation. The restoration of dry wetlands is also a priority in this region.

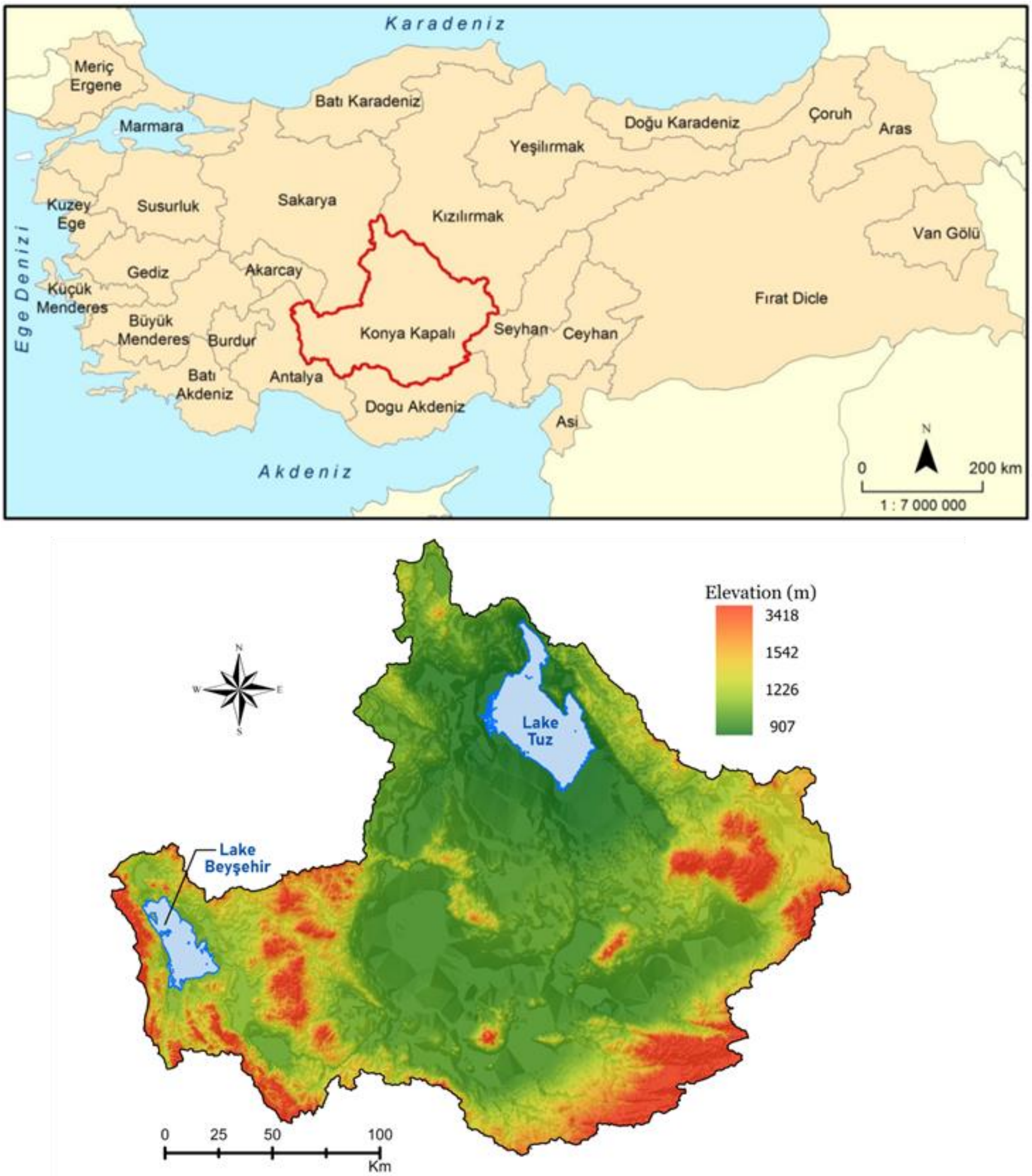

Figure 22 a) Map showing the boundaries of Konya Closed Basin in Turkey, b) Elevation map of the Basin, also showing main water bodies - Lake Tuz and Lake Beyşehir.

3.8.1 Description (belonging area, soil properties and climate)

The basin contains two prominent lakes: Lake Tuz and Lake Beyşehir (Figure 22-b). Lake Tuz is the second largest lake in Turkey and is also considered one of the largest hypersaline lakes globally (Aydoğdu et al., 2014). Lake Beyşehir, located in the western half of the basin, is the largest freshwater lake in Turkey.

Konya Closed Basin is home to an array of different ecosystems and is recognized as one of the 200 significant sites globally identified by the World Wildlife Fund (WWF) due to its abundant biodiversity (Uzun et al., 2011). Beyşehir Lake has great ecological significance. Surrounded by fertile agricultural lands and fed by numerous streams, Beyşehir is a critical haven for biodiversity, with 12 important fish species, 7 of which are critically endangered according to IUCN Red List criteria (Doğa Derneği, 2018). The lake is also in the migratory route of several migratory bird species. Tuz Lake is a vast hypersaline lake, playing a critical role regulating the basin's hydrology. It is home for some halophytic plants, and is also one of the largest flamingo breeding spots in the world (Eken et al., 2006)

The basin experiences seasonal variations in precipitation, with lower rainfall during the summer. The basin is characterised by a semi-arid climate and minimal precipitation, resulting in a scarcity of water and posing issues for water availability. Rainfall occurs mostly in the winter and spring seasons and is limited or zero in the summer.

3.8.2 Socio - economic features

The Basin has historically served as the principal wheat-producing centre of the country. Furthermore, in regard to Tuz Lake in particular, this basin provides 60% of Turkey's total salt output (JMO, 2010). As a result, the local population have a longstanding tradition of engaging in farming, and the industrial output heavily relies on agricultural produce. In recent years, there has been a notable increase in both industrial and agricultural production – mainly as a result of expansion of new irrigation technologies.

A substantial agricultural presence is observed in the region, characterised by the widespread cultivation of wheat, corn, and sugar beets. Fertile soils provide the foundation for a thriving agricultural sector. An additional noteworthy land use element in the area is livestock farming, encompassing the care and maintenance of chickens, sheep, and cattle, and which has a large impact on the regional economy. Alongside agriculture, the basin is distinguished by the existence of urban districts and industrial zones, which demonstrate the expansion and progress of the commercial and residential sectors.

The allocation of water resources in the basin is categorised into five primary sectors: energy, industrial, drinking and domestic utilities, and environmental discharge. Irrigation is the primary sector responsible for water demand, constituting almost 90 percent of the overall water consumption. The demand for drinking water accounts for around four percent of the total, whereas environmental water consumption accounts for 4.86 percent. The industrial and energy sectors contribute modestly to the water demand, with one and 0.14 percent respectively.

The basin does not have a dominant stream. Apart from limited surface water use from Lake Beyşehir and other smaller water bodies, groundwater is mainly used for the water requirements in the basin. However, the overexploitation of groundwater has resulted in a decline in groundwater levels. The shift towards cultivating more water-intensive crops like maize throughout the summer is a contributing factor to the drop. As a result of the imbalance between water demand and availability, there has been a significant growth in both permitted and unregistered wells. The reduction in groundwater levels is a significant factor in the creation of sinkholes, as it leads to land subsidence (Özyurt et al., 2017).

3.8.3 Main issues

One of the most significant problems in the Konya Closed Basin is overexploitation of water resources, causing problems related to water storage, aquifer depletion and reduced resilience to the changing climate. Accelerating depletion of both surface and groundwater resources resulted from the rising demand for water for irrigation. As the basin's primary surface water source, Lake Beysehir is subject to intense demand to supply water for both agricultural and domestic purposes. As a result, the lake's water levels have been significantly below expectations in recent years, and the situation is further complicated by a declining trend in precipitation. Surface water and groundwater depletion levels pose grave dangers. Among the issues in the basin are the production of sinkholes as a result of excessive groundwater use, as well as the depletion of numerous wetland areas that are critical biodiversity hotspots.

3.8.4 Tailored NbS suggested

NBS can contribute to the protection of natural processes as a function of the geomorphological and climatic variability of the different environments. The following is a non-exhaustive list of possible solutions to protect biodiversity and water bodies in the basin:

- Vegetative cover and restoration
- Ecosystem restoration (riparian zone restoration):
- Wetland restoration and conservation
- Rainwater harvesting (aquifer recharge)

3.9 MED Regional

The term Mediterranean is derived from the Latin word mediterraneus, meaning “in the midst of the lands.” This basin has an extension of about 2.9 million km3, maximum depth of 5092 metres and a volume of about 4.2 million km3. Despite its rather small size (it occupies only 0.82% of the entire land surface), due to its peculiar hydrological and geomorphological characteristics, it is considered a biodiversity hot-spot: in fact, it is home to about 7.5% of the world's species. Since different forms of animal and plant life tend to colonise this environment in all its portions, from the most superficial areas down to several kilometres deep below the surface of the seabed, a zonation of the Mediterranean Sea has been carried out.

Is a large body of water with Europe to the north, North Africa to the south and southwest Asia to the eas and extends from the Strait of Gibraltar in the west to the Dardanelles and Suez Canal in the east and is located atom between 35°N and 45°N of latitude and 5°W and 35°E of longitude. It is almost completely enclosed apart from these narrow places. The Strait of Gibraltar to the west is the only outlet into the Atlantic Ocean. Is located, therefore, at the crossroads of three continents: Europe, Africa and Asia. It has an area of about 2.51 million square kilometres. Its width is 3,700 km, maximum depth 5,270 metres, average depth 1,500 metres. Salinity is 39‰, while the oceans average 35‰.

The deepest point is 60 km from the Peloponnese, Greece: it is the Calypso Trench, a name derived from the nymph of the same name. Is inhabited by a total population of about 480,000,000 and is heavily urbanised.

Because of the Mediterranean's size and central location, it borders 21 countries on three continents. Europe has the largest number of nations with coastlines along the Mediterranean Sea with 12.

Figure 23 The Mediterranean Basin A regional Demo Site.

3.9.1 Description (belonging area, soil properties and climate)

The Mediterranean Region is unique in its human society, natural environment and biodiversity, and climate variability. However, it is experiencing rapid population growth, water scarcity, increasing anthropogenic pressures, and rapid climate change. This results in intensified water demand through increased irrigation and water consumption, severely threatening socio-economic stability and ecosystem integrity. In alignment with this challenge and scope of PRIMA objectives on water management, OurMED project was designed to respond to the urgent need for more comprehensive management of water storage and distribution in the Mediterranean region, considering the natural resources and engineered infrastructure over the short and long-term horizons. Besides the local scale demo site, a particular attention was paid to the MED regional scale, where water and environmental policies and directives are considered. The MED Demo Site covers a large area, with a population of approximately 480 million people, and experiences a Mediterranean climate.

Because it is almost landlocked, the Mediterranean has very limited tides and is warmer and saltier than the Atlantic Ocean. This is because evaporation outweighs precipitation and the runoff and circulation of seawater does not occur as easily as it would if they were more connected to the ocean, yet a sufficient amount of water flows into the sea from the Atlantic Ocean, meaning the water level does not fluctuate much.

Geographically, the Mediterranean Sea is divided into two different basins: the Western Basin and the Eastern Basin. The western basin extends from Cape Trafalgar in Spain and Cape Spartel in Africa in the west to Cape Bon in Tunisia in the east. The eastern basin extends from the eastern border of the western basin to the coasts of Syria and Palestine.

Temperatures: The Mediterranean biome has average annual temperatures between 0 and 35 degrees Celsius. Air masses at these latitudes tend to be moisture-poor, promoting desertification. However, the presence of relatively cold adjacent seas or oceans offsets this trend2.

Precipitation: Precipitation is abundant especially in late autumn and early winter. Summers are hot and dry, with the average temperature of the hottest month around 22-28 °C. This type of climate also extends to the coastal belt washed by the Black Sea

In short, the climate of the Mediterranean Basin is characterised by hot summers, mild winters, and seasonal precipitation. It is a unique environment that has influenced the region's history, culture and biodiversity. An analysis of the climatic dynamics occurring in the Mediterranean area that involve areas geographically distant from it is extremely topical. Its importance lies not only in its strictly scientific aspects but also in the practical and social ones: just think of the importance of rainfall in the eastern areas of the basin or the famines that currently plague large areas of the sub-Saharan area caused by persistent periods of drought. What we do know is that the Mediterranean constitutes an important source of atmospheric moisture, and the local characteristics of the water balance profoundly affect the climate of surrounding regions (Peixoto et al., 1982; Ward, 1998). Being able to understand the mechanisms that drive these dynamics is a major challenge as well as necessary; a thorough understanding of the marine and Mediterranean atmosphere and its variability would bring important socio-economic benefits to the nations of this region. Several authors have advanced the hypothesis of a strong connection between the climate of the Mediterranean and the North Atlantic regimes (Wallace and Gutzler, 1989; Hurrel, 1995 1996; Rodo et al., 1997; Eshel and Farrel, 2000) through mechanisms of transporting “dynamic” information. In other words, past and future changes in the climate at the local scale are correlated with the variability of the climate and hydrological cycle at the global scale (Bethoux and Gentili, 1999).

3.9.2 Socio - economic features

The resident population in the Mediterranean coastal states was 246 million in 1960, 380 million in 1990 and is currently 450 million. ‘Blue Plan estimates that this figure will rise to 520-570 million in 2030 and expects it to reach around 600 million in the year 2050 and possibly even 700 million at the end of the 21st century. Population density is highest in coastal regions, particularly in the vicinity of large cities.

The demographic concentration (resident and non-resident population resident) and the concentration of human activities around the Mediterranean basin represents a considerable threat to coastal ecosystems and resources, with impacts in four main areas main:

- on the structure and functioning of natural ecosystems as a consequence of the construction and operation of facilities serving human activities and urban development and associated sectoral;
- on the quality and quantity of natural resources (forests, soils waters, fishing grounds, beaches, etc.) as a result of the growing concentration of population and activities that increases the demand for use and exploitation of these resources and the subsequent disposal of waste;
- on coastal areas as a result of the development of various human activities and associated equipment as well as competition between different users;
- on the natural and man-made landscape as a result of the variation of activities, and the size and scale of related equipment and associated development.

In the future, coastal areas are likely to be exposed to increasing pressures, particularly on habitats, on natural resources (soil, fresh and marine water, energy) and on an increased demand for infrastructure (ports and marinas, transport, facilities for wastewater treatment, etc.). Urbanisation, tourism, agriculture, fisheries, transport and industry are the main sectors inducing a change.

Due to the specific morphology of the Mediterranean basin, there is intense agricultural activity in the limited coastal plains, which are often the result of the reclamation of marshy land.

The role of agriculture in changing the littoral environments of the Mediterranean basin is more indirect than direct and influences mainly on the dynamics of larger areas. In most countries, all types of agricultural practices and land use are considered widespread sources of water pollution and consequently difficult to quantify. Agricultural soils are one of the resources on which development pressures are most intense, in particular on the narrow coastal strip flanked by desert regions on the southern coast.

The main pressures due to agriculture are soil erosion soil and excess nutrients due to the application of an excessive number of fertilisers. Large river basins such as the Rhone and Po basins are subject to agricultural pressures. The first six drainage areas, according to a classification in experimental stage of soil erosion risk and loss of nutrients, are located in peninsular Italy, Sicily and Sardinia, in Greece, Turkey and Spain.

The Mediterranean fishing industry exerts pressure on both the environment and on fish stocks. The overall value of the land is still high compared to the relatively modest tonnage (around 1.3 million tonnes) landed. In recent years there have been relatively minor changes in fishing techniques in the Mediterranean area. The number of fishing vessels increased from 1980 to 1992 with an overall increase of 19.8 %. The fleet of the industrialised EU countries use very advanced technologies and from labour-intensive vessels labour-intensive vessels to more capital-intensive ones, such as capital-intensive vessels, such as larger trawlers and multipurpose vessels. The amount of 'passive' fishing due to lost nets has generally increased.

As far as marine aquaculture is concerned, there has been a great expansion of production in various Mediterranean countries. Its future development will have to be considered in relation with all other existing and planned activities. A careful choice of areas where aquaculture can be implemented, with a precise definition of the environmental load they are able to can withstand, will help minimise nutrient loads on the ecosystem and nutrient loads on the ecosystem and reduce the negative feedback effects negative feedback effects that may eventually damage the productive potential of fish farming activities.

A wide range of industrial activities (from mining to products) is scattered around the Mediterranean basin range of industrial activities (from mining activities to manufacturing), and various 'problem areas' are concentrated mainly in the north-west, due to the presence of heavy industrial complexes and large commercial ports. Discharges and contaminant emissions from this industry pose an environmental threat particularly in problem areas. Industry pressures in the basin mainly include the chemical, petrochemical and metallurgical sectors. Other main industry sectors in the coastal region are waste treatment and solvent regeneration, metal surface treatment, paper, paints, plastics, dyeing and printing, and tanneries.

Inevitably, the Mediterranean has always been a place of trade and therefore of maritime traffic. On the one hand, this favours industrial development, but on the other hand, it creates considerable environmental pressure, especially on coastal environments and in correspondence with ports. Proper planning and management of these areas and related traffic can contribute to the reduction of pollution and to a better integration with the needs of nature.

3.9.3 Main issues

Research shows that average temperatures in the entire Mediterranean region have risen by 1.4 degrees Celsius compared to the pre-industrial era: 0.4 degrees Celsius higher than the global average. Even if we succeed in limiting the global average temperature increase to 2 degrees Celsius (compared to the pre-industrial era), as envisaged by the Paris Agreements, conditions in this region will still lead to a significant reduction in summer rainfall in several areas, by up to 10-30%, exacerbating the general water shortage and, consequently, significantly affecting agricultural productivity, particularly in southern regions.

Coastlines inevitably define a frontier location in the Mediterranean Sea basin and their natural and inevitable interaction with the sea as well as with the diversified hinterland must be protected in the light also of the desertification phenomenon linked to climate change. In particular, the intrusion of sea water into the water-bearing stratum near the coast and the dune systems must be observed.

Salt wedge issues often affect the quality of water and thus its use, especially for agricultural purposes.

The dunes constitute a typical morphological element of the beach-coastal plain system. In addition to constituting environments of great naturalistic and ecological interest (especially in the presence of Mediterranean maquis), they delimit and protect wetlands of great ecological importance: lakes and coastal marshes.

Coastal dune systems, which were quite widespread until recent times, currently survive in a rather limited number of areas, as a result of hydraulic reclamation that led to their dismantling to contribute mainly to urban development. The remaining dune environments are still threatened by serious and advanced degradation mechanisms essentially linked to widespread anthropisation and coastal erosion. The retreat of the shoreline is frequently associated with the demolition of dunes. Dune systems constitute, in fact, at the same time a natural embankment to high waters, a protection for backshore environments and an accumulation of sand that can feed the beach and thus partially counteract the effects of erosion.

Eutrophication is the consequence of high nutrient loads from rivers and/or urban and industrial effluents. In the Mediterranean, eutrophication appears to be limited mainly to specific coastal and open sea areas adjacent to it. Algae blooms, reduced species diversity and oxygen depletion, as well as potential risks to human health related to the ingestion of marine foodstuffs contaminated with pathogens or the development of toxic algae, are some of the problems associated with eutrophication.

Proper management of waterways bordering the Mediterranean and appropriate protection of riparian environments can also be a positive aspect in the management of water resources as well as an important factor in the development of coastal dynamics.

There are several factors that threaten the depletion of biodiversity. Here are the main ones resulting mainly from human activities:

- Natural disasters and the effects of climate change
- Water Scarcity

- The loss of habitat
- The invasion of alien species
- Pollution (plastics and chemical contaminants)
- Fishing and poaching
- Tourism

These are all phenomena that threaten the conservation of biodiversity in the Mediterranean and its delicate balance on which the ecosystem of the mare nostrum rests.

3.9.4 Tailored NbS suggested

NBS can contribute to the protection of natural processes as a function of the geomorphological and climatic variability of the different environments typical of the Mediterranean area, an area to be protected also through projects such as OURMED, as it has always been the cradle of world history and civilization. The following is a non-exhaustive list of possible solutions to protect biodiversity and water bodies in the basin:

– Vegetative cover and restoration
– Ecosystem restoration (riparian zone restoration)
– Wetland conservation
– Rainwater harvesting (aquifer recharge)
– Water scarcity
– Groundwater overuse
– Soil erosion
– Afforestation/Reforestation
– Dune grass/Seagrass
– Saltmarshes.

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