



# GROUNDWATER RESOURCES

UNESCO

# INTERNATIONAL HYDROLOGICAL PROGRAMME

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**UNESCO IHP**

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United Nations  
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International  
Hydrological  
Programme

# MEDPROGRAMME

## The Mediterranean Programme Enhancing Environmental Security

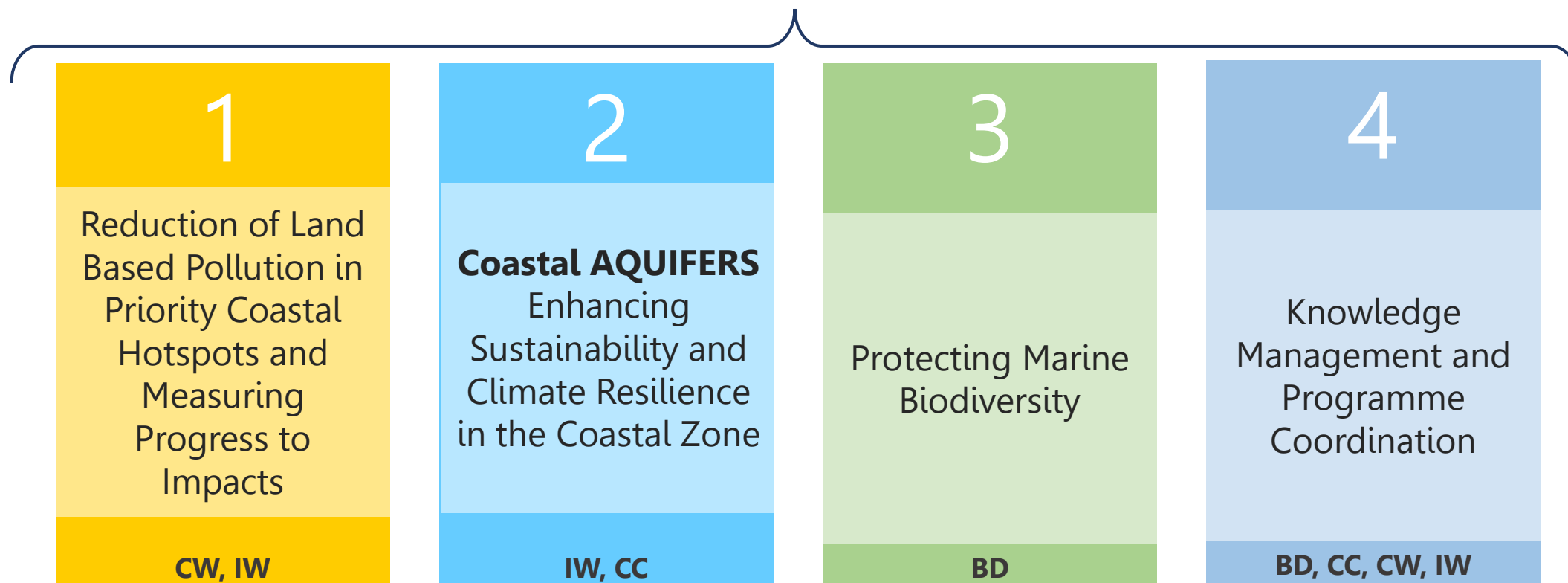


# The MedProgramme project - Structure

*Funded by the GEF, and coordinated by UNEP/MAP.*

The project will be implemented in 9 Mediterranean countries :

Albania, Algeria, Bosnia and Herzegovina, Egypt, Lebanon, Libya, Montenegro, Morocco, Tunisia



**BD:** Biodiversity **CC:** Climate Change **CW:** Chemicals and Waste **IW:** International Waters

# Component 1

1

Reduction of Land  
Based Pollution in  
Priority Coastal  
Hotspots and  
Measuring  
Progress to  
Impacts

CW, IW

**CP 1.1**

Reducing Pollution from Harmful  
Chemicals and Wastes in  
Mediterranean Hotspots and  
Measuring Progress to Impacts

**CP 1.2**

Mediterranean Pollution Hotspots  
Investment Project

**CP 1.3**

Mediterranean Sea Finance for  
Water Systems and Clean Coasts



# Component 2 –

2

Enhancing  
Sustainability and  
Climate Resilience  
in the Coastal Zone

IW, CC

**CP 2.1**

Mediterranean Coastal Zones:  
Coastal Aquifers, Groundwater  
dependent ecosystems, CZM,

**CP 2.2**

Mediterranean Coastal Zones:  
Managing the Water-Food-Energy and  
Ecosystem Nexus

**SCCF**

Enhancing Regional Climate Change  
Adaptation in the Mediterranean  
Marine and Coastal Areas



International  
Hydrological  
Programme



Mediterranean Action Plan  
Barcelona Convention



Mediterranean Action Plan  
Barcelona Convention



United Nations  
Environment Programme



Mediterranean Action Plan  
Barcelona Convention

# Component 3 –

3

**CP 3.1**

Management Support and Expansion of  
Marine Protected Areas case study  
- Libya

Protecting Marine  
Biodiversity

**BD**



Mediterranean Action Plan  
Barcelona Convention





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# Component 4 –

4

**CP 4.1**

Mediterranean Sea LME Environmental  
and Climate Regional Support Project



Mediterranean Action Plan  
Barcelona Convention

Knowledge  
Management and  
Programme  
Coordination

**BD, CC, CW, IW**

2

Coastal Aquifers  
Enhancing  
Sustainability and  
Climate Resilience in  
the Coastal Zone

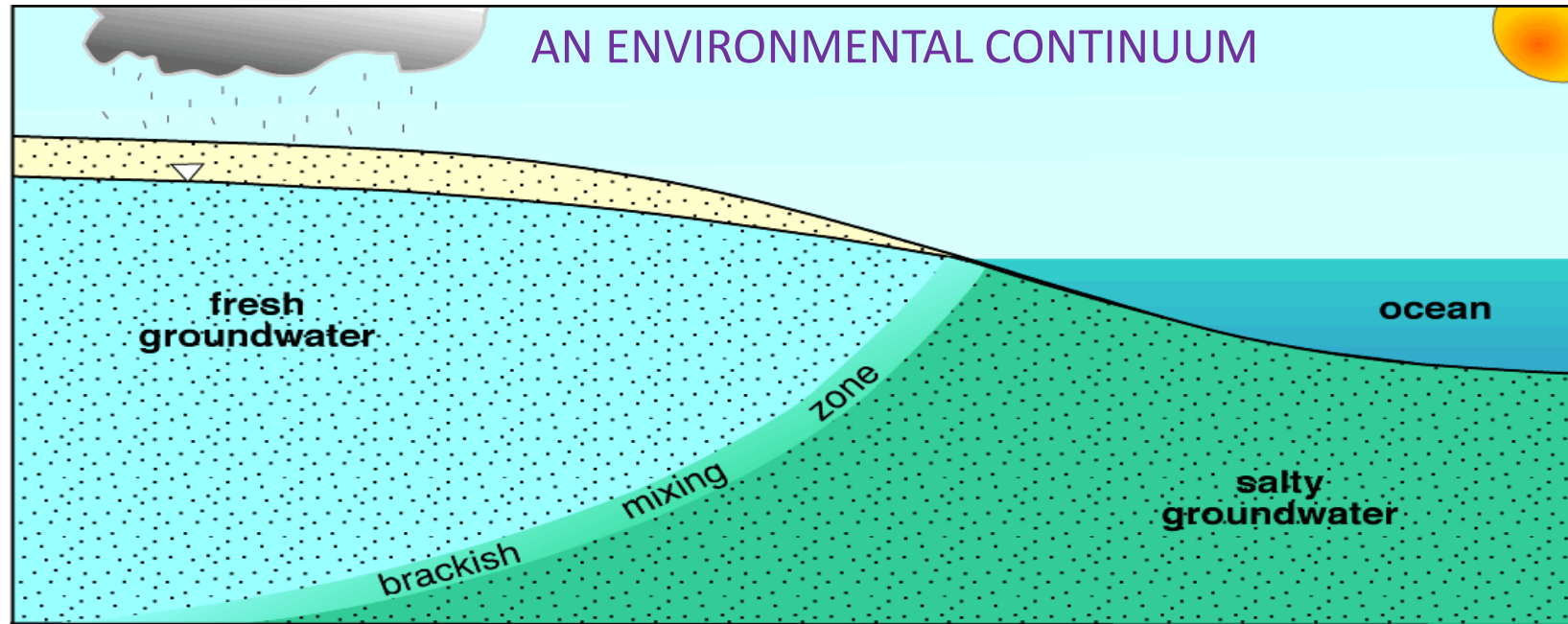
IW, CC

→ **Sub-component:**

**Assessment and Protection of Coastal  
Aquifers, SGD, Groundwater Related  
Ecosystems**



# MEDPROGRAMME



Coastal aquifers contribute to the integrity and functioning of the coastal zone and marine ecosystems, and their degradation contribute to the major transboundary issues affecting the Mediterranean Sea

## Location of the five pilot aquifers



# PARTICIPATING COUNTRIES

## In all nine participating countries

Albania, Algeria, Bosnia and Herzegovina, Egypt, Lebanon, Libya, Montenegro, Morocco, Tunisia

## In Albania, Egypt, Lebanon, Montenegro, Morocco, Tunisia

- Joint regional training modules on conjunctive surface and groundwater management
- National Assessment of Submarine Groundwater Discharges
- Preparation of the Management Plan for the chosen pilot aquifers

## Coastal aquifers sustain **biodiversity and ecosystems**



- Unregulated exploitation
- Decrease of quantity and quality
- Overall lack of management framework



# Description of the Project activities

## IN THE 5 PRIORITY AQUIFERS

1. Development of **coastal aquifer management plans**, including environmental, socio-economic, legal policy aspects
2. Evaluation and mapping of **aquifer vulnerability**,
3. Detailed **assessments of the current state of coastal aquifers dependent ecosystems**,
4. Design of **aquifer monitoring multi-purpose networks and protocols**, and training of responsible personnel

## ALL NINE COUNTRIES



1. Identification of **major submarine groundwater discharge zones** and marine-freshwater interactions
2. Implementation of sub-regional **conjunctive management training modules**



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# Sub-marine groundwater discharge activities

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*“Identification of **major submarine groundwater discharge zones** and marine-freshwater interactions”*

- Creation of an SGD international expert advisory group
- Identification of SGD preferential zones at national level
- Quantification of fluxes and contaminant loads at selected areas (pilot aquifers)



# Key products

## Key features of coastal aquifers

### CROATIA

The coastal aquifers in Croatia are primarily karstic in nature, with significant discharges of fresh groundwater to the Adriatic Sea. The total average annual fresh water runoff in the Adriatic Sea is 886 m<sup>3</sup>/s, of which a major portion is groundwater. The average annual precipitation in Croatia ranges from 650 mm in eastern Slavonia to 3500 mm or more in Gorski Kotar (Lividraga, 3800 mm). The continental part of Croatia is characterized by maximum levels of precipitation in summer and minimum in winter, the transitional area between the continental and the Mediterranean climate is characterized by maximum levels of precipitation in November and minimum levels in February, while the coastal area and the mountainous hinterland (recharge area of coastal aquifers) is characterized by maximum levels of precipitation in winter and minimum levels in summer.



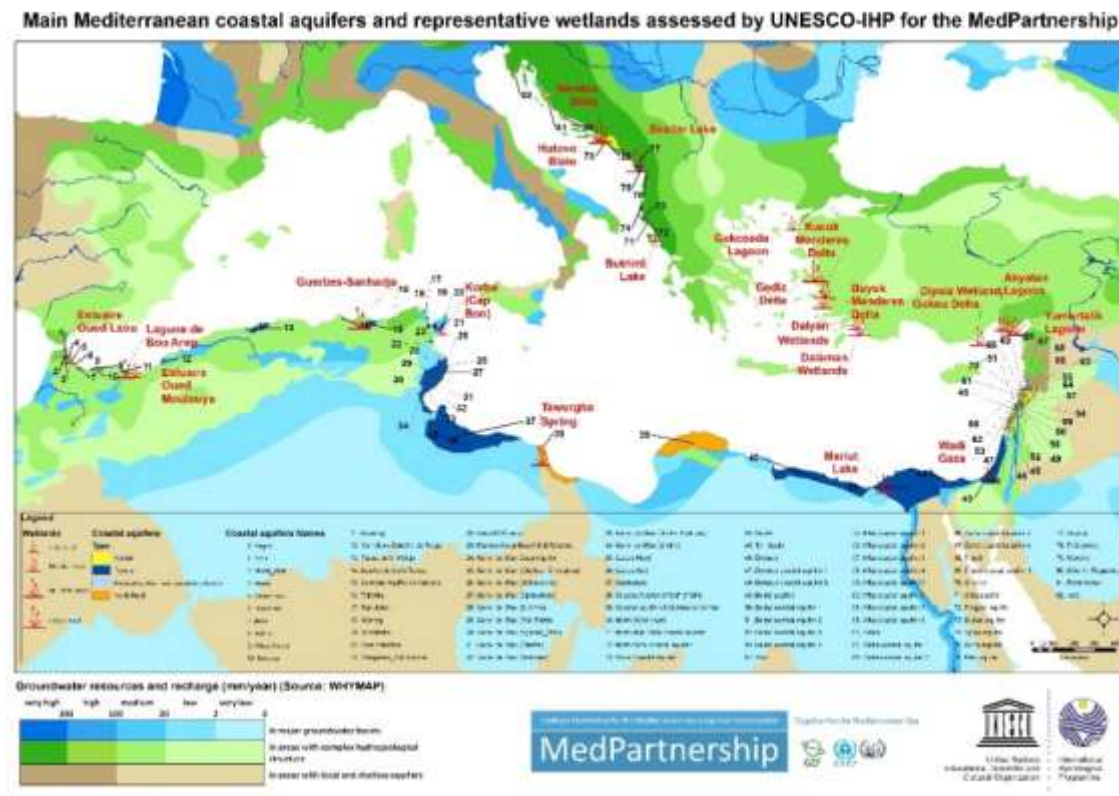
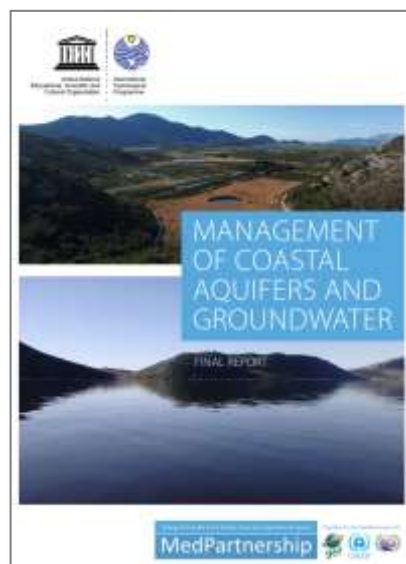
In the Neretva, Ravni Kotari and Istra coastal aquifers, the most important pressure is the intensive use of water for irrigation (mainly by an unknown number of unregistered wells that are pumping water). In the proximity of the Šibenik-Rogožnica coastal aquifer, however, there are fewer suitable areas for agriculture and consequently less pressure on this aquifer from irrigation activities, compared with the other aquifers studied in Croatia.

**Issues of concern:** The greatest pressure on most coastal aquifers is the uncontrolled abstraction of groundwater for irrigation from unregistered wells, which leads to seawater intrusion in many areas. The ever-growing demand for water from the public water supply system further intensifies this problem. Most coastal aquifers are also naturally influenced by salinization to some degree, from changes in sea levels during the last geological period. Apart from salinization, the quality of groundwater in coastal aquifers is also negatively impacted by pollution from the intensive use of fertilizers and pesticides in agriculture as well as the release of untreated wastewaters from numerous settlements. In the southernmost area of the peninsula Istra, in and around Pula, industry and industrial wastewater discharges also exert an important pressure on water quality in the coastal aquifer.

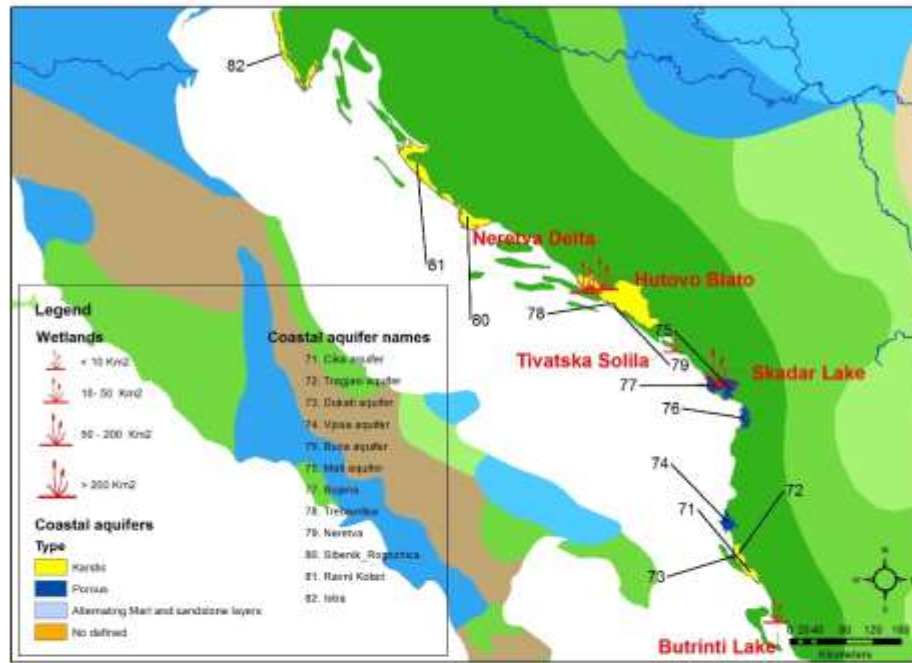
Aquifer name	Hydrogeology	Extent	Salinity	Main uses	Entity responsible for management	Recharge (Mm <sup>3</sup> /yr)	Abstraction (Mm <sup>3</sup> /yr)
Istra	Karstic	584.9 km <sup>2</sup>	Widespread and severe salinization	Irrigation, livestock and industry. Monitored for water levels, nitrogen, salinity, heavy metals, pesticides and industrial organic compounds.	Croatian Waters	Not known	Not known
Neretva	Karstic	215.8 km <sup>2</sup>	Local and moderate salinization	Domestic supply, irrigation and livestock. Monitored for water levels and salinity.	Croatian Waters	Not known	Not known
Ravni Kotari	Karstic	616.9 km <sup>2</sup>	Local and moderate salinization	Domestic supply, irrigation, livestock and industry. Monitored for nitrogen, salinity, heavy metals, pesticides and industrial organic compounds.	Croatian Waters	Not known	Not known
Šibenik-Rogožnica	Karstic	523.3 km <sup>2</sup>	Local and moderate salinization	Domestic supply, irrigation and livestock. No monitoring of groundwater levels or quality.	Croatian Waters	Not known	Not known

## Paste experience: The MedPartnership project

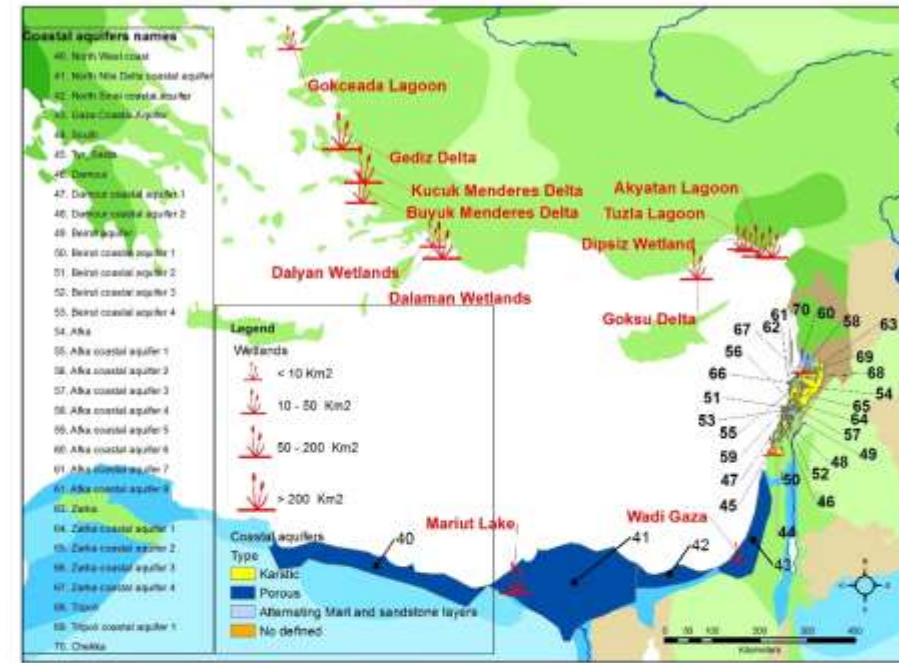
- Pilot demonstrations
- Assessment of groundwater-related ecosystems
- Assessment of the legal, institutional and policy aspects of coastal aquifer management



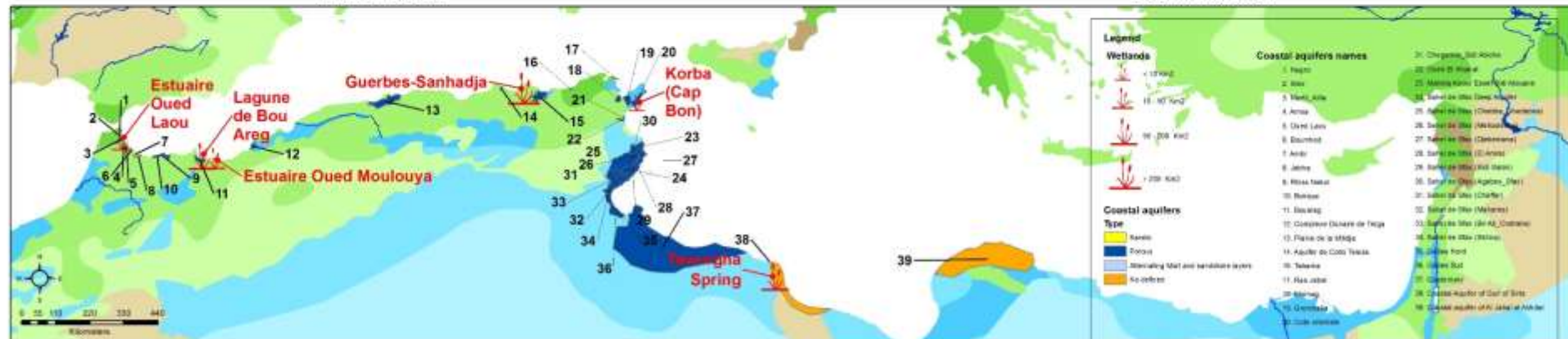
# Main Mediterranean coastal aquifers and representative wetlands assessed by UNESCO-IHP for the MedPartnership



Adriatic Basin

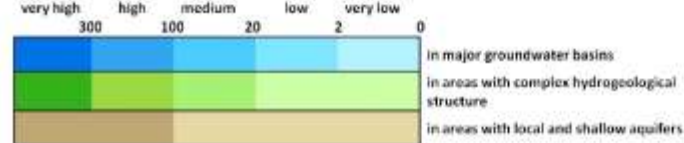


Levantine Basin



Southern and Central Mediterranean

Groundwater resources and recharge (mm/year) (Source: WHYMAP)



Scientific Partnership for the Mediterranean Sea Large Marine Ecosystem

**MedPartnership**

Together for the Mediterranean Sea

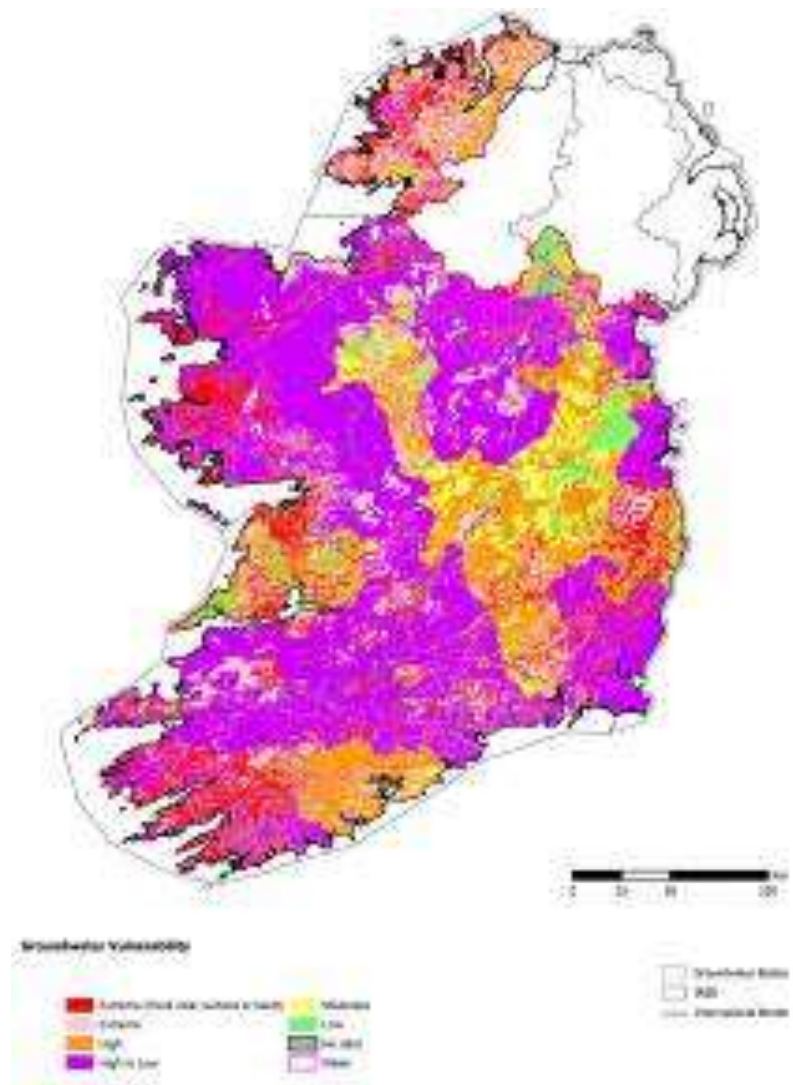
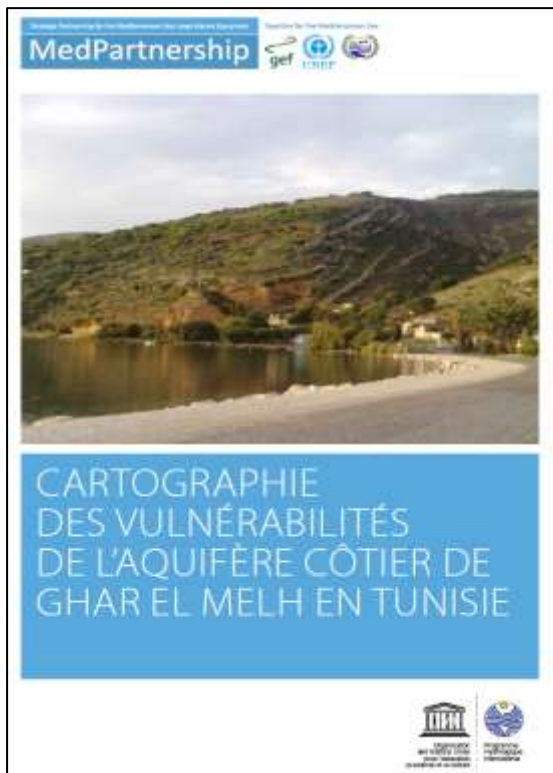




# Key products

## Vulnerability mapping of aquifer at selected sites

Activities	Data collection mapping-GIS information system--training courses--workshops-publication of results
Case studies	<b>Tunisia:</b> Ghar El Melah and Grombalia <b>Croatia:</b> Novljanska Žrnovnica karstic spring, and Pula coastal aquifer
Partners	National Authorities, National Experts, and National Institutions, Tunisia and Croatia, Partners Institutions





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# SUBMARINE GROUNDWATER DISCHARGE (SGD)

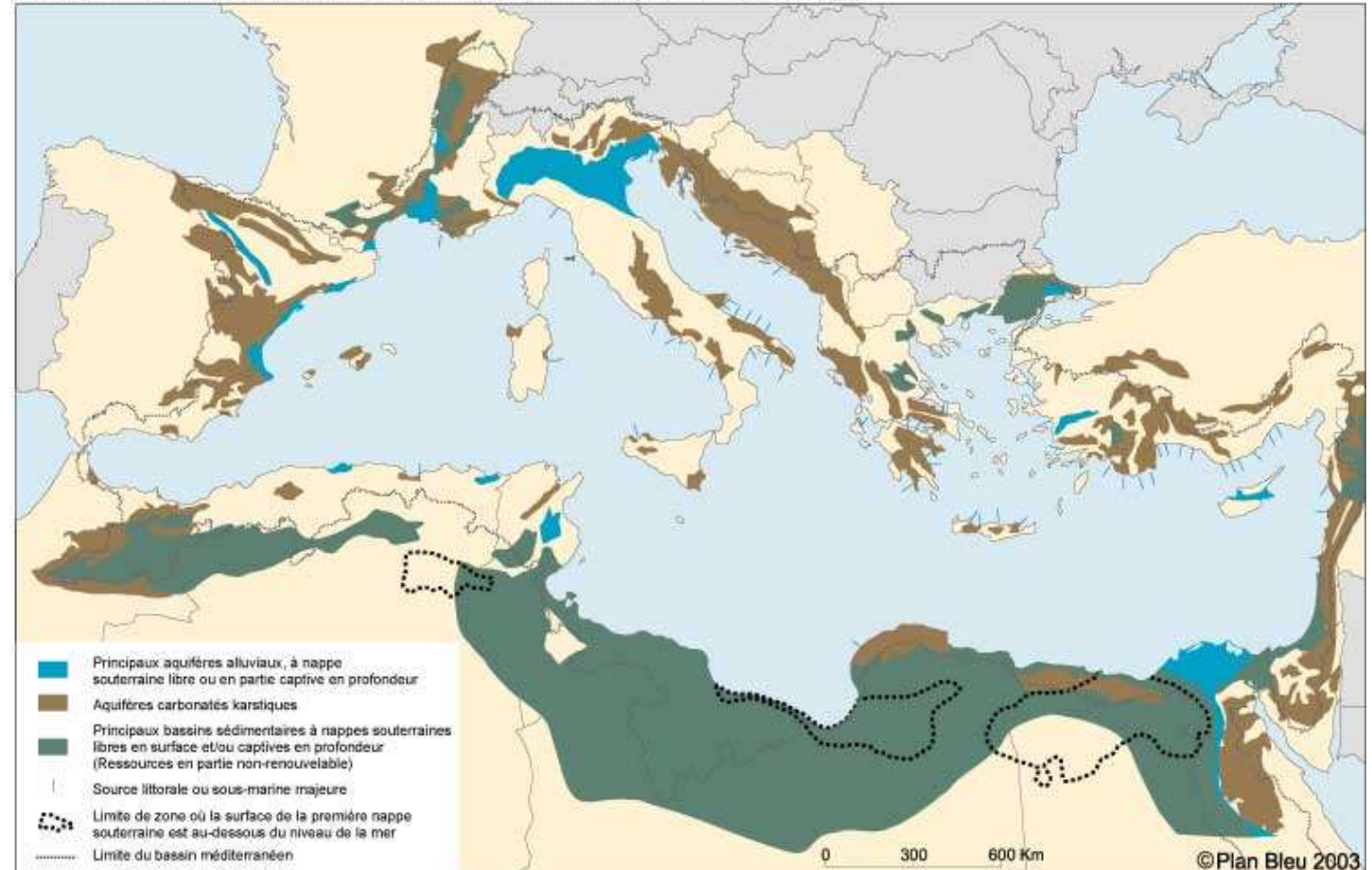
- SGD can be the principal component of freshwater to the coastal zone in areas where surface runoff is small or variable.
- SGD are considered strategic freshwater resources in the arid and semi-arid countries of the Mediterranean region

# SGD

The annual volume of **SGD** for the whole Mediterranean basin ranges from 30 to 500 billion cubic metres, which proves that this process is relevant at large scale

The flux of nutrients associated with this discharge consists of an annual median of three million tonnes of nitrogen, twenty thousand of phosphorous, and three million of silica, which represent a magnitude of inorganic nutrients comparable to that of external sources traditionally considered in marine studies, such as the atmospheric deposition and riverine runoff.

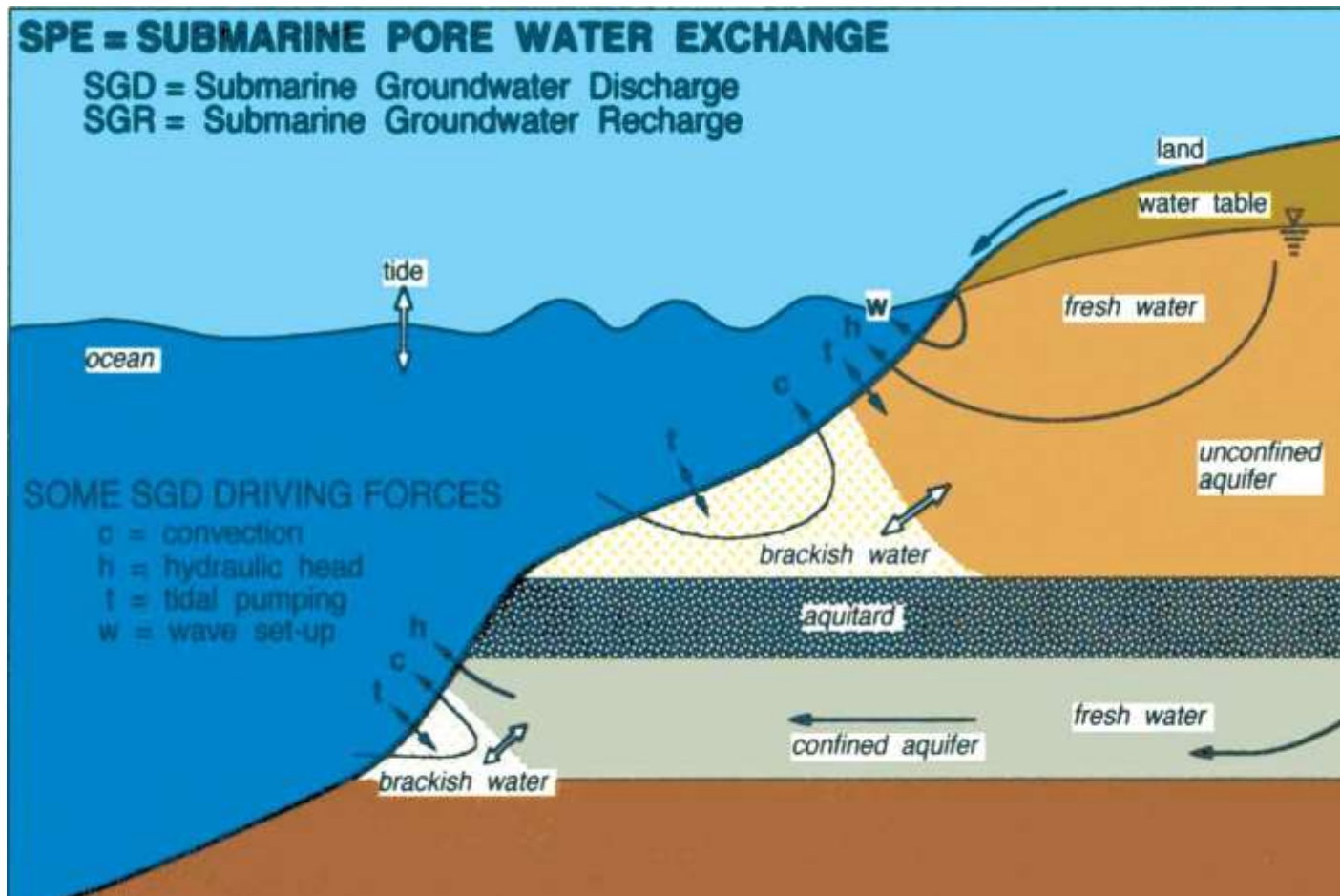
Structures hydrogéologiques et aquifères dans le bassin méditerranéen



**Karst comprises 60% of the shoreline of the Mediterranean and is estimated to contribute 75% of its freshwater input – much of this input are via SGD.**

# SGD

The karstic aquifer substantial submarine discharges presents also large submarine karstic freshwater springs with flows as high as 50 m<sup>3</sup>/sec that are recharged on land.



The seepage inflows are prevalent on the **eastern coast of the Adriatic**, dominated by its karstic aquifer systems, as well as the **eastern and southern Mediterranean coast** with semi-arid and arid conditions and limited precipitation and runoff and limited surface watercourses and discharge points.

The karstic coastal aquifers discharge directly into the sea without previous intervention of rivers or lakes and the functions as flows and storage in karst are directly related to the quantitative status, represented by the discharge flows and the water budgets.

# The UNESCO International Water Conference

## 13-14 May 2019

***“How to leverage intersectorality to the benefit of water security and peace?”***

### **Multi-stakeholders platform for discussion:**

Government representatives, policy-makers, private sector, civil society, academics, international institutions,  
-Opportunities to participate for ESA and UNESCO partners :

- **Panel on Water and Technological Innovation**
- **Panel on Data for Water-related Decision-Making**

**To become a  
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Conference,  
contact us**





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# Thank you

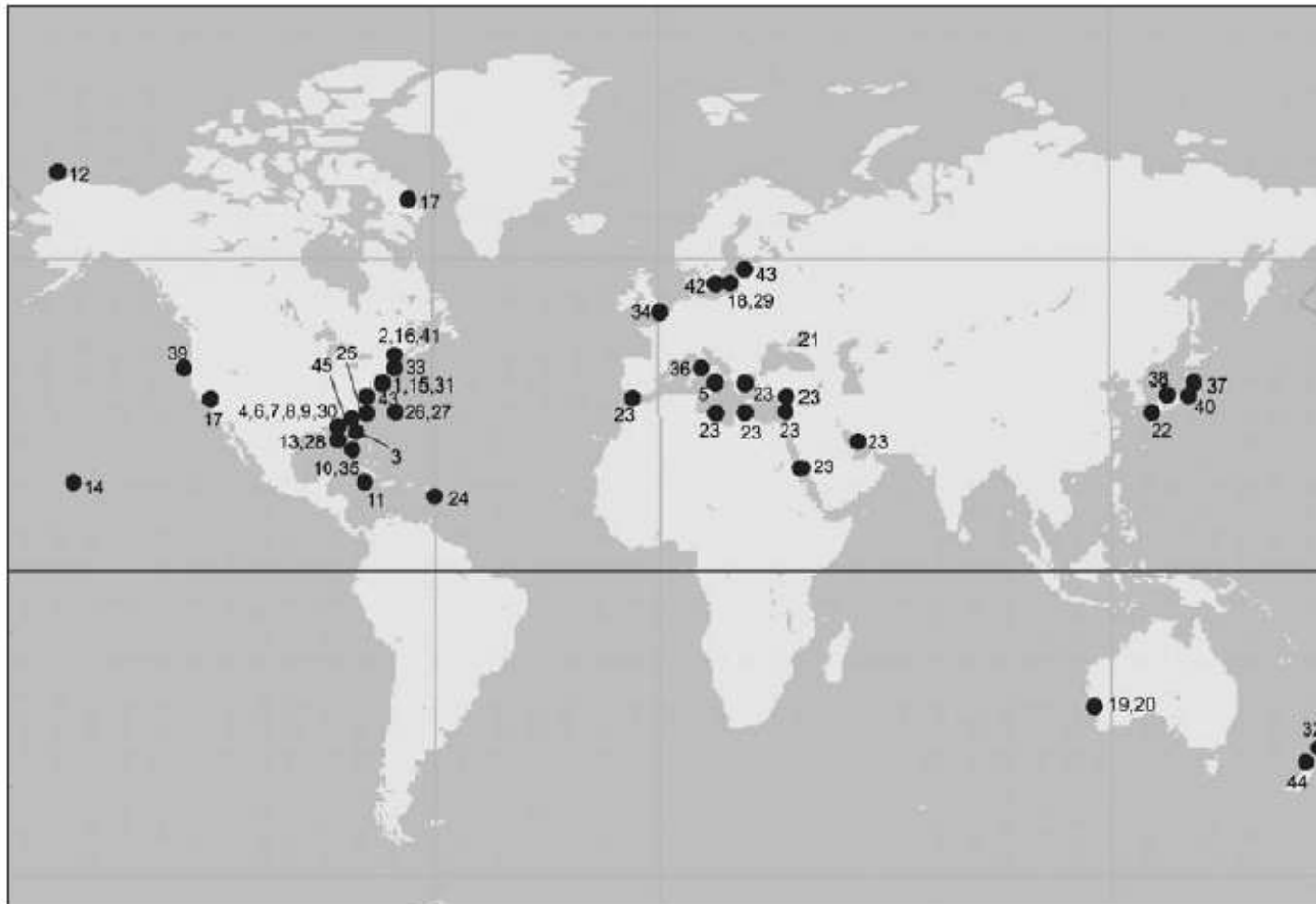
[a.aureli@unesco.org](mailto:a.aureli@unesco.org)

<https://en.unesco.org/themes/water-security/hydrology>



# SGD

Figure 4. Locations of published studies that have reported SGD estimates based on direct measurements. In addition to those noted, depressions called 'Wonky Holes' off the Locations of published studies that have reported SGD estimates based on direct Great Barrier Reef, Australia have recently been attributed to SGD processes. (Stieglitz, T. and Ridd, P.V., *Proceedings, HYDRO 2000*, Perth, November 2000)



As a general rule, the highest freshwater SGD tends to be found closest to shore. In some places, a well defined, seepage face is found, often in the intertidal zone. In other cases, the distribution has often been described as decreasing exponentially from shore and often at a rate so that most of the flow occurs within 100 m or so of the shoreline, but this distance can be quite variable. The geological conditions might be such that substantial flow occurs kilometers offshore, as with the occurrence of springs or seeps. SGD occurring far offshore would be reflected by hydraulic heads in the aquifer at the coast that are significantly greater than mean sea level (with the exception of channelized aquifers, e.g., karst or volcanic terrain).