GROUNDWATER RESOURCES

UNESCO

INTERNATIONAL HYDROLOGICAL PROGRAMME

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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

1. Reduction of Land Based Pollution in Priority Coastal Hotspots and Measuring Progress to Impacts  
   **CW, IW**

2. Coastal AQUIFERS  
   Enhancing Sustainability and Climate Resilience in the Coastal Zone  
   **IW, CC**

3. Protecting Marine Biodiversity  
   **BD**

4. Knowledge Management and Programme Coordination  
   **BD, CC, CW, IW**

**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

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

CW, IW
Component 2 –

**Enhancing Sustainability and Climate Resilience in the Coastal Zone**

- **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
Component 3 –

3

Protecting Marine Biodiversity

CP 3.1

Management Support and Expansion of Marine Protected Areas case study - Libya
Component 4 –

CP 4.1 Mediterranean Sea LME Environmental and Climate Regional Support Project

Knowledge Management and Programme Coordination

BD, CC, CW, IW
Coastal Aquifers Enhancing Sustainability and Climate Resilience in the Coastal Zone

2

→ Sub-component:

Assessment and Protection of Coastal Aquifers, SGD, Groundwater Related Ecosystems
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
In all nine participating countries
Albania, Algeria, Bosnia and Herzegovina, Egypt, Lebanon, Libya, Montenegro, Morocco, Tunisia

PARTICIPATING COUNTRIES

- 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

In Albania, Egypt, Lebanon, Montenegro, Morocco, Tunisia
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
Submarine groundwater discharge activities

“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)
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 m³/s, of which a major portion is groundwater. The average annual precipitation in Croatia ranges from 650 mm in eastern Slovenia to 3500 mm or more in Gorski Kotar (Ludwika, 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, Ravné Kotar, and Istarska 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 vicinity of the Šibenik-Naçerica 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 salination to some degree, from changes in sea levels during the last geological period. Apart from salination, 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 southermost 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.

<table>
<thead>
<tr>
<th>Aquifer name</th>
<th>Hydrogeology</th>
<th>Extent (km²)</th>
<th>Salinity</th>
<th>Main uses</th>
<th>Entity responsible for management</th>
<th>Recharge (Mm³/yr)</th>
<th>Abstraction (Mm³/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Istra</td>
<td>Karstic</td>
<td>384.9</td>
<td>Various</td>
<td>Irrigation, livestock and industry. Monitored for water levels, nitroge, salinity, heavy metals, pesticides and industrial organic compounds.</td>
<td>Croatian Waters</td>
<td>Not known</td>
<td>Not known</td>
</tr>
<tr>
<td>Neretva</td>
<td>Karstic</td>
<td>215.8</td>
<td>Local and moderate salinization</td>
<td>Domestic supply, irrigation and livestock. Monitored for water levels and salinity.</td>
<td>Croatian Waters</td>
<td>Not known</td>
<td>Not known</td>
</tr>
<tr>
<td>Ravné Kotar</td>
<td>Karstic</td>
<td>81.9</td>
<td>Local and moderate salinization</td>
<td>Domestic supply, irrigation, livestock and industry. Monitored for nitrogen, salinity, heavy metals, pesticides and industrial organic compounds.</td>
<td>Croatian Waters</td>
<td>Not known</td>
<td>Not known</td>
</tr>
<tr>
<td>Šibenik-Nacarica</td>
<td>Karstic</td>
<td>323.0</td>
<td>Local and moderate salinization</td>
<td>Domestic supply, irrigation, livestock and industry. Monitoring of groundwater levels or quality.</td>
<td>Croatian Waters</td>
<td>Not known</td>
<td>Not known</td>
</tr>
</tbody>
</table>
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

Legend

Coastal aquifers

Type

Wells
Filtering layer
Non-filtering layer
No aquifer

Coastal aquifer names

Adriatic Basin

Levantine Basin

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

very high
high
medium
low
very low

in major groundwater basins
areas with complex hydrogeological structure
areas with local and shallow aquifers

Southern and Central Mediterranean

andrea merla
**Vulnerability mapping of aquifer at selected sites**

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

**Key products**
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.
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.

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 m3/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

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https://en.unesco.org/themes/water-security/hydrology
The coastal seepage and submarine discharges are critical to the water balance and seawater quality in the marine sub-basins and support wetlands and brackish water habitats with biodiversity and fishery nursery areas in the coastal zones. The coastal aquifers are threatened by over-exploitation and consequent seawater intrusion and water and land salinization, thereby adding to the deficit in recharge of the Mediterranean.

In a narrow sense, it is sometimes used to mean only the freshwater component of aquifers outflow. It is that component of SGD from the land that poses the greatest concern for coastal zone managers because this component is most likely to carry pollutants. 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).

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