Acronym: ***MEDISS***
*Reporting period: 0****1/08/2019 - 28/02/2023***
Project closing date: ***31/07/2022 (extended 28 February 2023)***

Mediterranean Integrated System for Water Supply «MEDISS»

Agreement No: A_B.4.1_0249

WP3 ACTIVITIES

Report on WP3_3.4 - Final Technical Report (Baseline data, GIS set up and implementation, Monitoring plan, Monitoring in field and results benefits and critical issue, opportunities, capitalisations and transferability of results)

edited by Enas

This document has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Programme. The contents of this document are the sole responsibility of Enas and can under no circumstances be regarded as reflecting the position of the European Union or the Programme management structures

Sommario

Chapter1

INTRODUCTION

PP01 ENAS coordinates the activities of the WP3 and it is supported by a technical Board of Experts (BoE), established at the beginning of the project. BoE is composed by chair (APP Monther Hind engineer), 2 experts from PP02 on socio-economic analysis and 2 experts per area with relevant expertise on water supply, pedology (soil science) and agronomy.
BoE tasks in WP3 are: preparation of a Data Collection Plan (DCP) in order to guarantee the collection of relevant site data; data collection of each sites; set up the MEDISS monitoring database, comprehensive of water, soil and agricultural data; constant monitoring of water, soil and crops data during plants operating phase and set up of contingency strategies if deviations occur; elaboration of up-scaling proposals; elaboration of the final technical report.

Aims of WP3
WP3 is a technical WP that embraces the whole project and it is aimed to:

- collecting relevant and consistent baseline data in the 4 MEDISS areas;
- analyzing and organizing data in a comprehensive database;
- provide target values and tools for monitoring;
- evaluate MEDISS impact on water, soils and crops during and after pilot tests;
- identify up-scaling opportunities and elaborate solid proposal for future funding.

During MEDISS data on water supply, water quality, soil composition and crops are collected in each area, were analyzed and organized. Also, a socio-economical analysis and legislation and policies analysis is carried out in each area to provide baseline data on water-related issues. These baselines surveys provide technical directions for pilot initiatives set-up (WP4), and represent reference values to monitor and evaluate their impact. In the final year, while MEDISS pilots will be operative, specific analyses of water, soils and crops will carry out with regularity and resulting data compared with reference and target values to check effectiveness.

This final report represents the deliverable envisaged in point 3.4.4 of the main contract by responsibility of PP1_Enas partner.
The structure of the report contains the main elements of the point 3.2.2. "Baseline data" and point 3.2.1 “Data base design and set up”, of the points 3.4.1, 3.4.2, 3.4.3 "Water, soil and crop monitoring" and the consequent results of the activities scheduled and carried out on the water, soil and crop components before and after the installation of the plant pilot in the 4 test areas: Italy, Jordan, Palestine and Tunisia (see section monitoring plan).
A specific section adrdresses capitalization and transferability of results at MED level, referring to up-scaling proposals.

WP3 Activity 3.2.1 Database design and set-up

The MEDISS Data collection Plan (DCP) is a management tool of the project. Information sharing is a necessary step when contingency strategies and deviations occur. Moreover the elaboration of up-scaling proposal and the final technical report are helped by the MEDISS data collection tool.
The Guideline (in annex 1) of this report proposed a model of database collection also to realize the Geographical Information System (GIS) for the 4 pilot areas. The DCP was elaborated evaluating the local beneficiaries and target groups as well as the data needs to elaborate a MEDISS database (WP3 activities 3.2.1 and 3.2.2) .
ENAS coordinates the activities of BoE and supervises the monitoring and evaluation of activities while pilots are operative, referring to database (WP3) and providing feedback (including strategy/contingency plans if is necessary).

The Data Collection Plan (DCP) and GIS are the core of the data base that must be implemented along the project life with the results of the monitoring activities on test sites (pilots).
The preliminary data collection proposed was organized in sections (points) where each partner will indicated the main characteristics of pilots area. Descriptive and detailed information on existing data are requests, as well as georeferencing data and reference literature etc. The main aim of the guidelines is to collects comparative information for every pilot area.

State of the art of data implementation

ENAS GIS experts developed a MEDISS-GIS project using the open-source QGIS platform for water and soil data collection on the four pilot sites.

The ENAS's QGIS project allows user-friendly loading and updating sampling points thanks to the possibility of inserting high-resolution web images and filling the specific forms containing both general and detailed information.

The QGIS project is developed to be constantly adapted and customised to individual pilot site needs.

Enas' technicians have created a webspace or "cloud" to facilitate the sharing of information between partners.

This cloud in addition to sharing the hydrogeological, pedological and agronimc and enviriomental data allowed each MEDISS partner to download and load the biggest size data as high-resolution images or video, hardly share by e-mail.

Into the cloud, there are shared specific guidelines for software use and data insertion (in the previus paragraf), plus two video tutorials(realized by Enas to help other partners). Finally, Enas' technicians organised online session training to better understand the upload and to save the data in the Qgis project. Access to the "cloud" is reserved only for Mediss partners via username and password.

Thanks to the contribution of each partner, inside Qgis there are uploaded the datasets of water/wastewater and soil, originated by lab analysis and onsite recording in order to create the "MEDISS geodatabase" which can be implemented during the experimentations (Fig.1-5). By clicking on each sampling point it is possible to view all the information and photos relating to the position and the results of the analyzes, finally it is possible to process thematic maps as layouts.

The monitoring results, chemical and physical data from the two groundwater control piezometers (Station Pz1 and Station Pz2), realized in September 2020 in the Italian pilot site, (Arborea, Sardinia) is loaded on Qgis. The monthly water monitoring started in January 2021 to date.

For the soil, the previous data dating back to 2019 collected by LAORE (one of the associated partners of the Mediss project in Italy) relating to the sampling points included in the areas chosen for the experimentation were uploaded. The new soil samplings by Enas and LAORE (ammonium sulphate post-treatment) were carried out in September 2022.

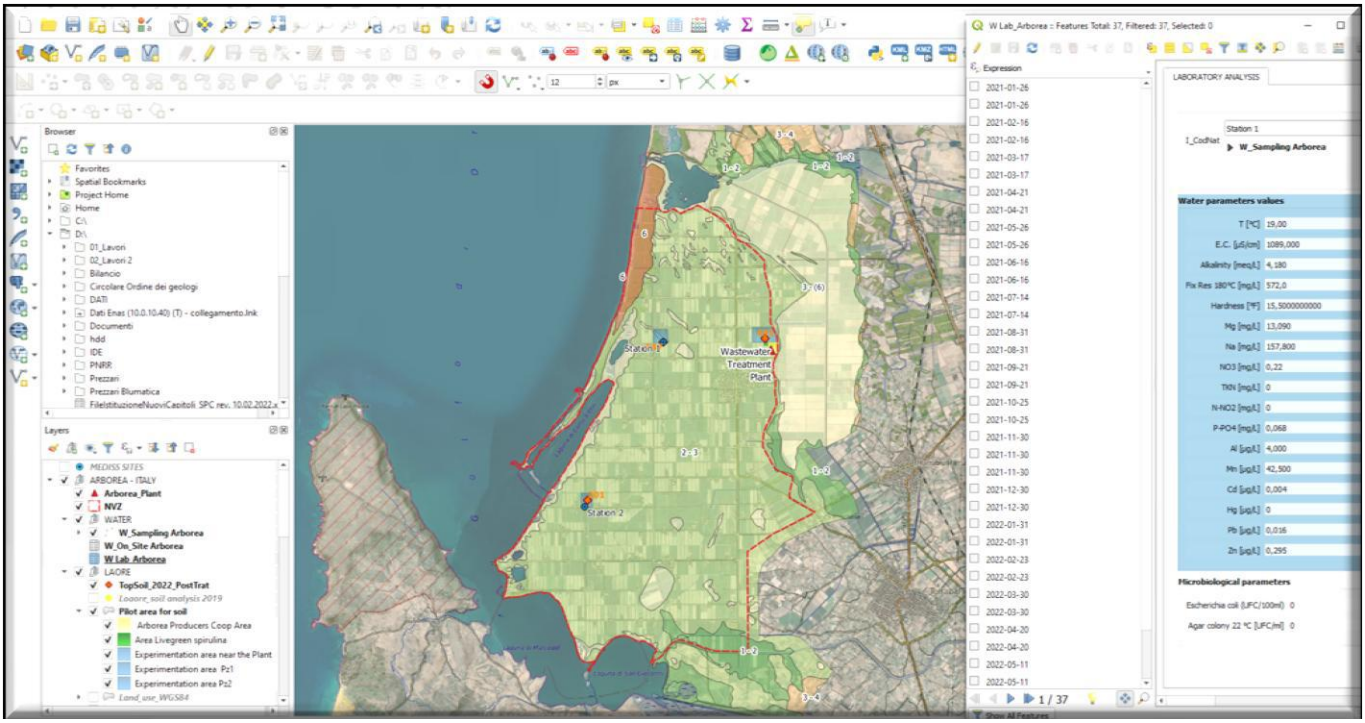


Fig.1: Arborea, pilot site in Italy –water and soil sampling points - water and soil dataset - soil classification.

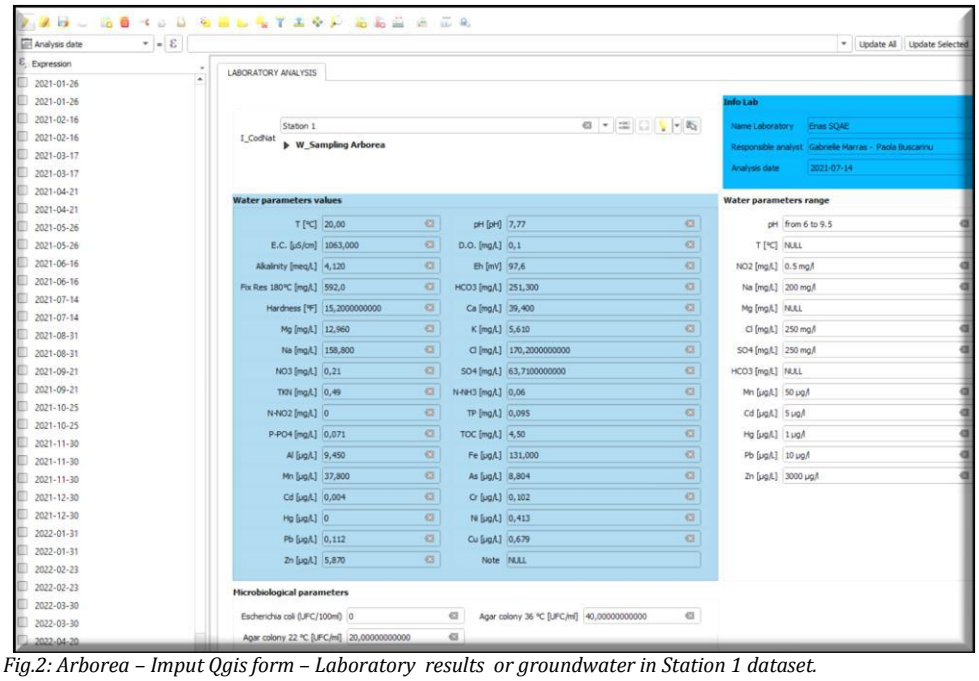


Fig.2: Arborea – Imput Qgis form – Laboratory results or groundwater in Station 1 dataset.

For Bechima, the pilot site in Tunisia chemical data there's been loaded wastewater out of the treatment plant used for irrigation of agricultural fields as well as the soil analysis results during the different irrigation steps. Particularly, we can display the four pilot areas which have different irrigation times. In these areas collected the samples from different deep for soil analysis made by Ira Company.

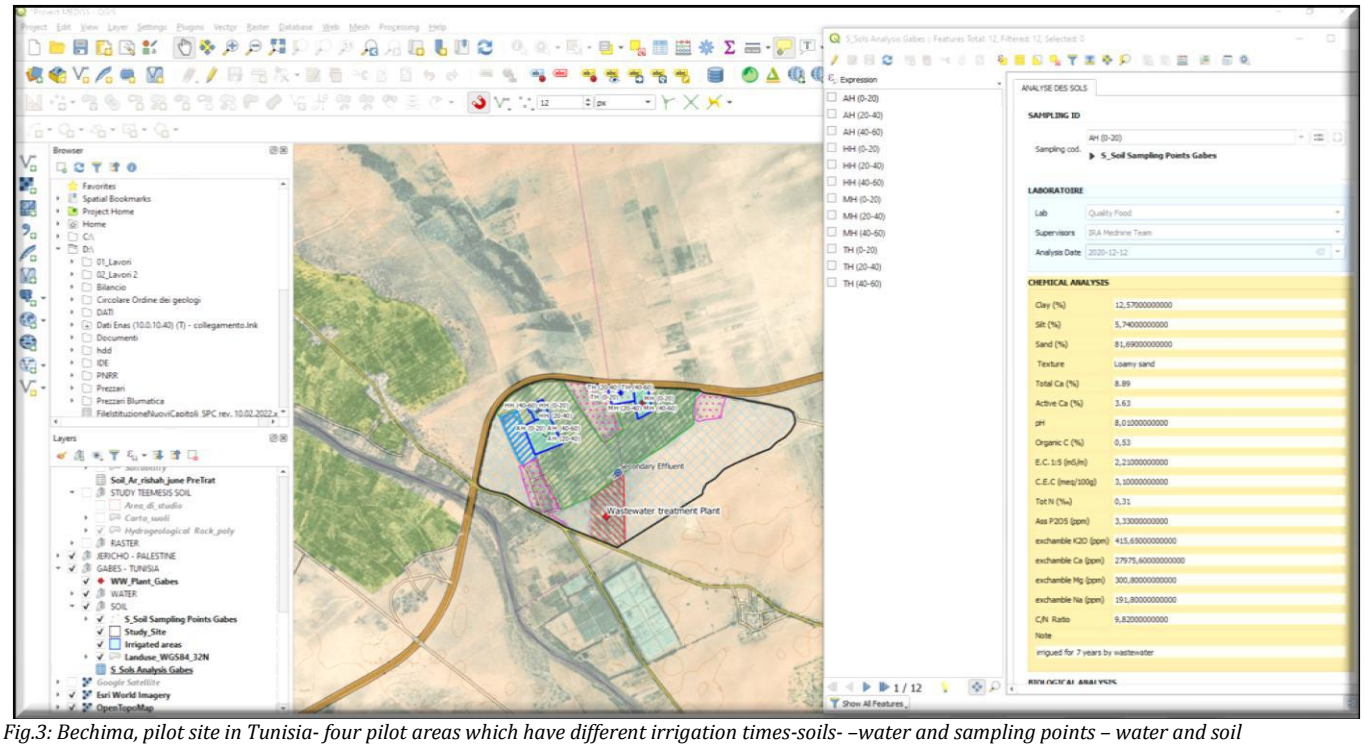


Fig.3: Bechima, pilot site in Tunisia- four pilot areas which have different irrigation times-soils- –water and sampling points – water and soil dataset - soil classification.

For Al Risha (Aqaba), the pilot site in Jordan there is loaded with the groundwater data of the deep well-named "Reehseh Well NO.9". The new desalinisation plant is completed and will supply water for agriculture in the Reishah area. For the soils, Timesis company (the associated partner of the Mediss project in Jordan and Palestine) analyzed 35 soil sample points. It provided the related Thematic Maps (Land Units map, Soil Map, Land Suitability for drip irrigation Map, Location of soil observations).

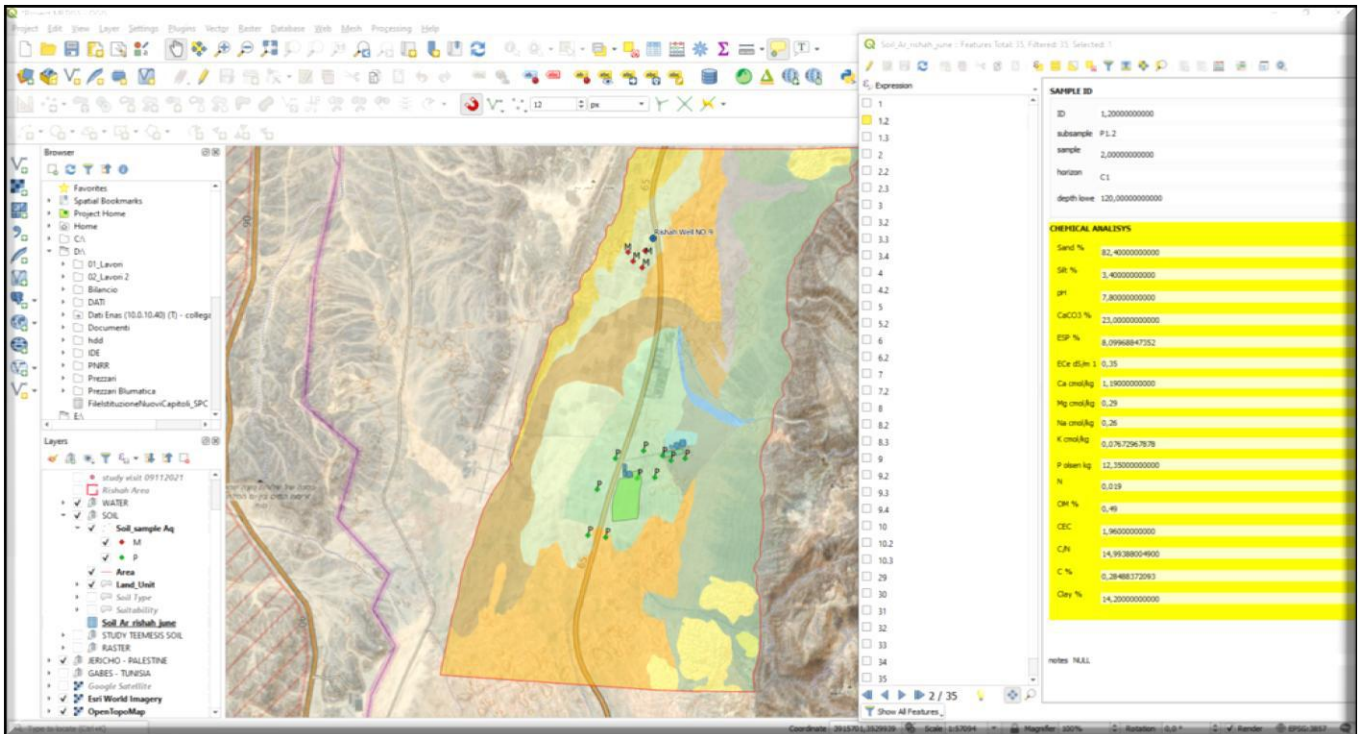


Fig.4: Al Risha (Aqaba), pilot site in Jordan - water and soil sampling points - water and soil dataset - soil classification.

In Jerico, the pilot site in Palestine groundwater are collected in different mixing tanks where they will be blended with the wastewater and then distributed for crop irrigation. In addition like in Jordan, the data soil was uploaded into the Qgis project, 80 sample points, and the related Thematic Maps for the soils derived from the study campaign made by Timesis. In the digital copy on CD you will find the 4 GIS project specific for each site that can be implemented in the future.

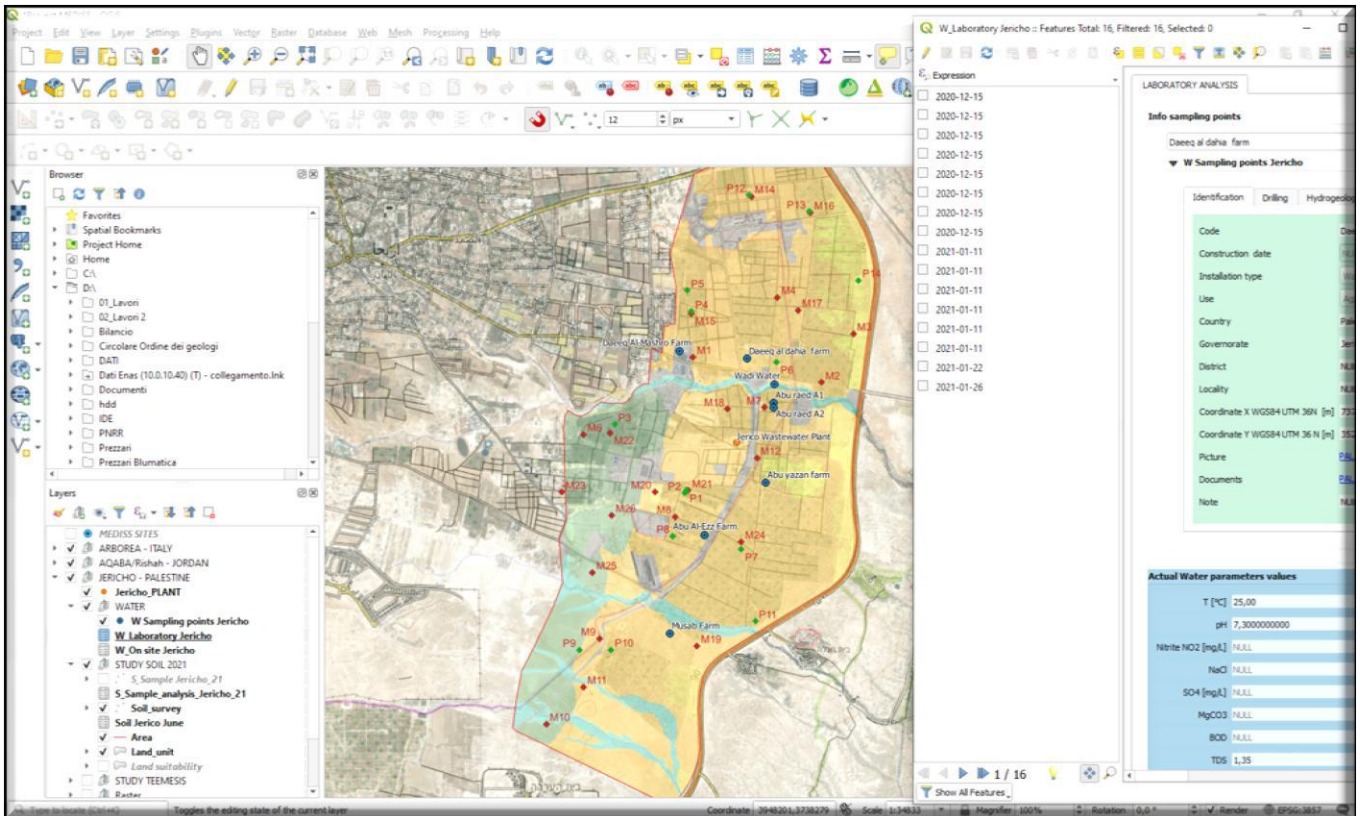


Fig.5: Jerico, pilot site in Palestine – water end soils sampling points – water and soil dataset - soil classification.

WP3 Activity 3.2.2 Baselines surveys – General oulines of the four sites

The MEDISS Data collection was prepared by outlines of the DCP that is a management tool of the project. Information sharing is a necessary step when contingency strategies and deviations occur. Moreover the elaboration of up-scaling proposal and the final technical report are helped by the MEDISS data collection tool.
In this annex ENAS and each partner completed the information proposed on DCP, discussed during the 1st KoM of the project. The DCP was elaborated evaluating the local beneficiaries and target groups as well as the data needs to elaborate a MEDISS database (WP3 activities 3.2.1 and 3.2.2) . The main aim of the Plan is to ensure the collection of relevant and consistent data in each MEDISS area.
ENAS coordinates the activities of BoE and supervises the monitoring and evaluation of activities while pilots are operative, referring to database (WP3) and providing feedback (including strategy/contingency plans if is necessary).
The Data Collection is the core of the data base that must be implemented along the project life with the results of the monitoring activities on test sites (pilots).
The preliminary data collection proposed was organized in sections (points) where each partner will indicated the main characteristics of pilots area. Descriptive and detailed information on existing data are requests, as well as georeferencing data and reference literature etc. The main aim of the proposed DCP is to collects comparative information for every pilot area.
The following pages show the state of the art of collecting basic data for the 4 pilot areas.
All these data will be part of the GIS project in progress for the 4 pilot areas.

PILOT AREA OF ARBOREA, SARDINIA, ITALY

1 Project description and expected goals

The Arborea plain is the most important agricultural area in Sardinia, mainly devoted to the dairy industry. This area is the result of the reclamation of a previous wetland, which occurred between 1919-1935. The landscape is characterized by regular and uniform fields with rectangular plots of equal size. The area is well facilitated with a system of canals and dikes with dewatering pumps that regulated the levels of waters. The management of waters distribution system is operated by "Consorzio di Bonifica of Oristanese". Moreover the irrigation system was changed recently ensuring a reduction of water quantity use.
In Arborea area two WWTP were built, one is dedicated mainly to the dairy industry (3A -Dairy Industry) and the other one for the rest of wastewater (EX-SIPAS). The Ex-SIPAS sludges will be used by the pilot test for ammonia stripping in the pilot WWTP . The plant is also equipped (not working at the moment) with a system for energy recovery through biogas cogeneration, which allows producing large amounts of electricity and heat that contribute to the support of the plant itself.
The pilot plant will be built in the north-east of the Arborea area where the high-efficiency biogas-powered cogenerator is present, produced by anaerobic fermentation of biomass and sludge stored in special structures. The pilot plant will be itself equipped with a photovoltaic plant to reduce the cost of energy in the system.This pilot plant removes ammonia from wastewater streams. The pilot is designed for a treated flow of 450 - 750 L/h. The pilot is suited for 24 hours of operation and all relevant measurements. A pre-treatment of waters protects the membranes from particles. The chemicals which can be used are technical sulfuric acid 96% and sodium hydroxide 50%. The ammonia stripping process t installation is designed for a flow-through operation on the wastewater side and closed-loop operation on the ammonium sulfate side. The inflow particle size is assumed ≤ 150 µm. Recovery of ammonium from various waste streams, like water from digestion processes, or manure is becoming more and more important. Nitrogen is ranked in the top three to global issues way beyond any reasonable boundaries of sustainability.

2 General location

The study area is in the western coastal area (Fig.1) and is included in a sensitive area for a organic nitrate-vulnerable zone (NVZs). The Arborea plain is the most important agricultural area in Sardinia, mainly devoted to the dairy industry. This area is the result of the reclamation of a large wetland, which occurred between 1919-1935. The landscape is characterized by regular and uniform fields with rectangular plots of equal size. The area is well facilitated with a system of canals and dikes with dewatering pumps that regulated the levels of waters. The management of waters distribution system is operated by "Consorzio di Bonifica of Oristanese". Moreover the irrigation system was changed recently ensuring a reduction of water quantity use.
Water and soils data available for the area are already in digital format manageable on GIS which will be replicated for all the test areas envisaged in the Mediss project.

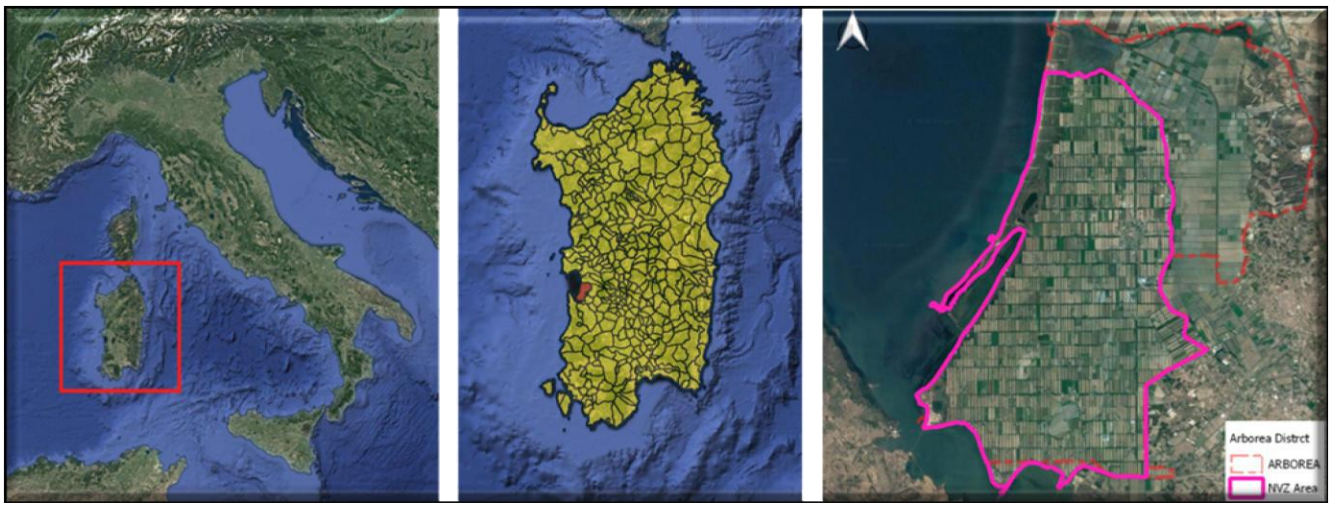


Fig. 1 Location area

Our project has particular relevance for a positive response apply at integrating irrigation water with ammonium sulfate (produced in the plant) to the reduction of the nitrate load.

Coordinates

- Geographical coordinate : Logitude 8.564567° - Latitude 39.780367°
- Project coordinate UTM WGS 84 32N: 462712.67 m E –4403471.19 m N
- Project coordinate Monte Mario Italy Zone 1: 1462742.698 m E - 4403477.279 m N

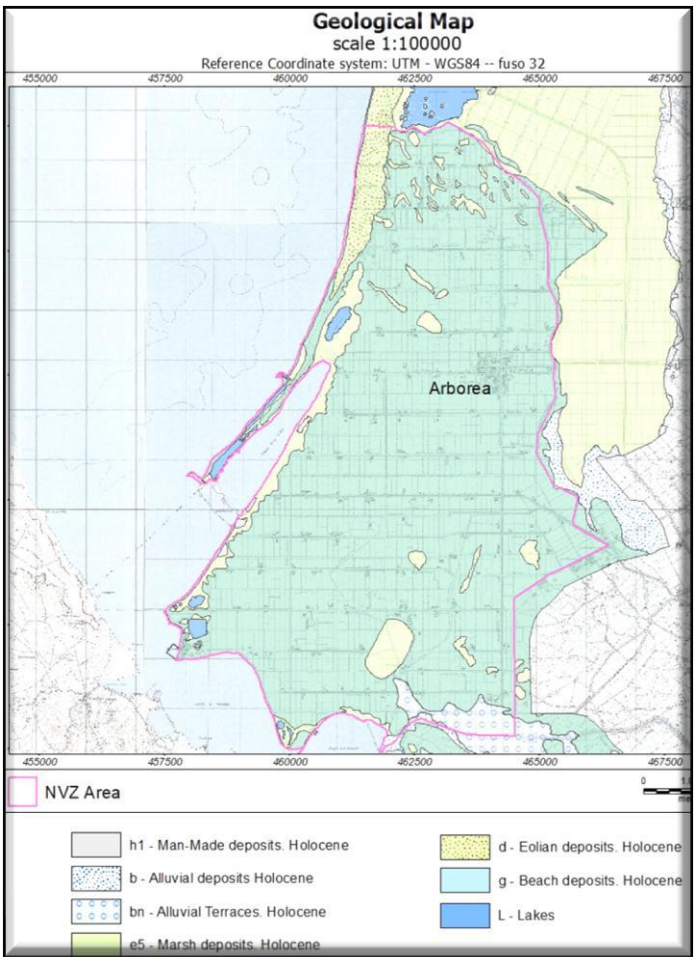
Elevation:

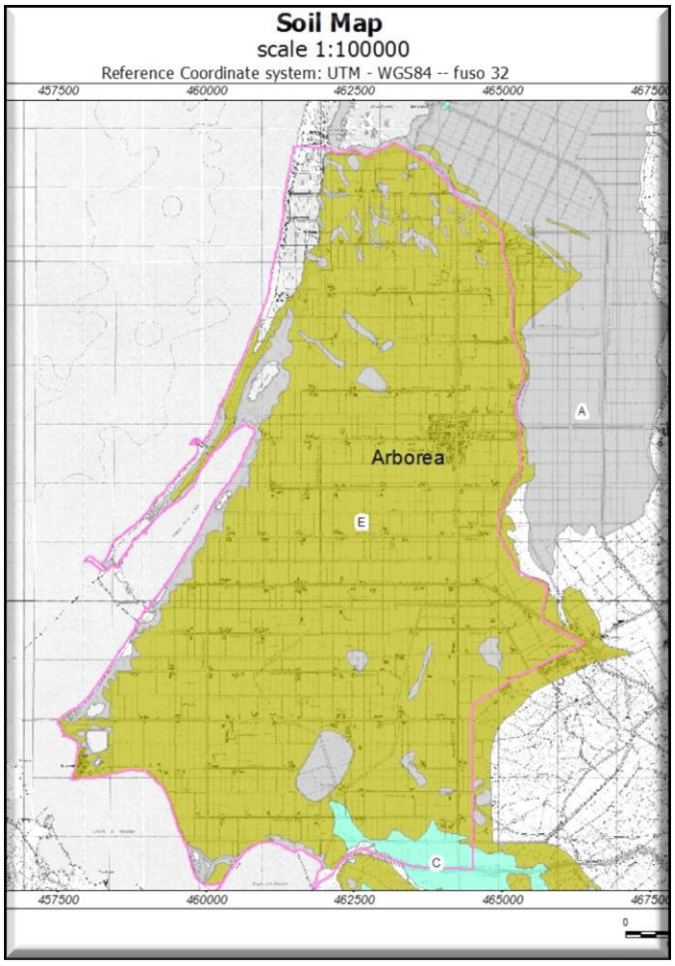
- Max Elevation: 9.7 meters above sea level
- Min Elevation: - 0.95 meters

3 Physical oulines of the pilot site

3.1 Geology and geomorphology

The Municipality of Arborea is in the central-western area of Sardinia in the floodplain of the northern Campidano between the inhabited centers of Marrubiu at the east (5.4 km), Terralba at south-east (7.9 km) and Santa Giusta at the north (12 km). The municipal area includes, beyond the urban center of Arborea, the villages of Centro Uno, Due, Tre Sassu, S'Ungroni, Pompongias, Luri, Torrevecchia, and Linnas.
Most of the territory is occupied by sands of probable wind origin, obtained following the landslide of the Wurmian (Pleistocene) wind dunes covering the quartz sandy floods and the filling of the swamp depressions propagated with the reclamation works.
The municipal territory covers an area of 115 km2 and is characterized by the presence of productive agricultural areas and the presence of various and important wetlands of naturalistic value and ecological importance.





The current morphology is the result of the impressive reclamation works, which since 1919 have affected the wetland of about 18,000.
The reclamation radically transforms the territory through drying up of the marshes in order to make it livable and productive. Moreover, it transformed one of the poorest and most malarial areas of Sardinia into one of the most productive areas.

3.2 Geopedology

The soil types that currently used for agricultural purposes are attributable to different landscape units, that is, homogeneous units for lithological and morphological characters (within which the soils themselves have similar behaviors and attitudes).

3.3 Catchment area and surface waters

3.3.1 Surface waters

The examined area is included in two main basins of Flumini Mannu di Pabillonis stream and that of the Riu Mogoro Diversivo canal, as well as by a series of coastal basins.
For the purposes of the project, the basin of interest is that of the Rio Mogoro Diversivo, with an extension of about 600 km2 and a river auction about 45 km long.

CARTOGRAPHIC UNIT	LITHOLOGICAL SUBSTRATE	MORPHOLOGY AND HYDROGEOLOGY	SOIL DESCRIPTION	CLASSIFICATION (Soil Taxonomy, U.S.D.A.)	IRRIGABILITY CLASSES	LIMITATIONS OF USE
A	Current silty-clayey marsh deposits of the Holocene	Flat or slightly depressed areas in correspondence with ancient reclaimed ponds (Sassu, Luri) or close to minor ponds and coastal areas. Hydromorphic areas and sauces, with sub-superficial groundwater (0.5-1.0 m from the ground level.)	Soils with AC and A-Btg-Cg profiles, from deep to very deep, from sandy-clayey and clayey-silty at depth, not very permeable and with slow or impeded drainage, moderately saline, the reaction from sub alkaline to alkaline, organic substance poor, media cation exchange capacity, saturated in bases	TYPIC FLUVAQUENTS MOLLIC HAPLUDALFS ENTIC HAPLUDALFS TYPIC SALORTHIDS	3 - (6)	High saline content in coastal areas prevented or slow drainage Flood hazard
C	Alluvial sandy and sandy-silty-clayey terraced deposits, recent and current of the Holocene	Low slope flat areas, with superficial groundwater (1,5-2,5 m from the ground level)	Soils with profile A-Bw-C and A- (Bg) -C, from deep to very deep, from sandy-free to deep clayey, from permeable to slightly permeable in-depth, with possible temporary hydromorphy, neutral reaction, low or medium organic matter, medium to high cation exchange capacity, saturated.	FLUVENTIC HAPLOXEREPTS AQUIC HAPLOXEREPTS AQUIC XEROPSAMMENTS TYPIC XEROPSAMMENTS TYPIC XEROFLUVENTS	1 - 2	Flood hazard
E	Ancient beach deposits, sands, sandstones, gravels with gastropods from the upper Pleistocene - Holocene	Sub-flat areas, in correspondence with the reclaimed area of the Arborea plain, with superficial groundwater (1.0-2.0 m from the ground level)	Soils with profile A-Bt-C, and A-Btg-Cg, locally Ap-Btcg-Cc, very deep (> 100 cm), from sandy to sandy-frank on the surface to Franco-sandy-clayey in-depth due to the presence of clayey horizons, contained in medium or low skeleton, very permeable on the surface to slightly permeable in-depth, from acid to moderately alkaline, poor organic substance, exchange capacity in general from low to medium, sometimes high, saturation in bases varying from low to medium, sometimes high. In some areas, there are calcium carbonate nodules on the soil surface and carbonate concretions along with the profile	TYPIC PALEUDALFS TYPIC HAPLUDALFS ARENIC PALEUDALFS ARENIC HAPLUDALFS	2-3	Fast drainage

The river originates on the southern slopes of Monte Arci and is limited by the reservoir on the Rio Mogoro in S.Vittoria. The last stretch of the Rio Mogoro course was deviated from the original route forcing it into an artificial channel banked with east-west direction, which takes the name of Rio Mogoro Diversivo.
Another body of water is the “Canale delle Acque Medie”, built as an irrigation canal for the water coming from the Tirso River.

3.3.2 Aquifers

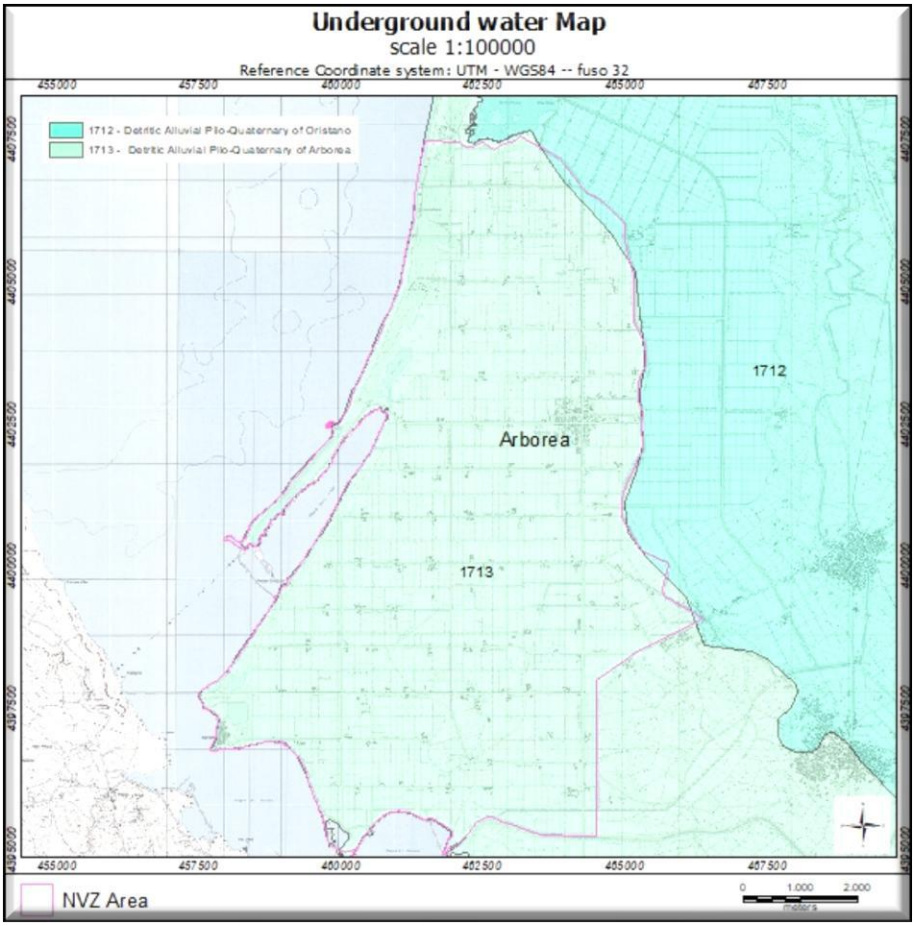
The aquifers are attributable to the hydrogeological complex of Campidano plain, which can be distinguished in two types: the Detritic-Alluvial Plio-Quaternary of Oristano (Code 1712) and the Detritic-Alluvial Plio-Quaternary of Arborea (Code 1713), according to the coding reported in the study "Characterization, objectives and monitoring of Sardinia's underground water bodies" carried out by RAS (Regione Autonoma della Sardegna, 2010).
The two aquifers comprise sediments belonging to hydrogeological units which stand out in terms of porosity and permeability:
- plio-quaternary flood units: consisting of conglomerate alluvial deposits, arenaceous, clayey; lake and marsh deposits, characterized by a permeability for medium-low overall porosity; locally medium-high in most matrix levels coarse;
- quaternary detrital-carbonate unit, consisting of sea beach and sand dunes, aeolian sandstones with high permeability due to porosity.
Groundwater, such as surface water, constitutes a fundamental element for the economic development of this area.

The Arborea plain is a Nitrogen Vulnerable Zone (NVZs) and for this reason, is an under-strength control by the Regional Environment Agency (ARPAS).
Historical analysis is based on examination of analytic results concerning 48 cycles of monitoring (March 2006 - February 2019). Particularly, elaborations concern the nitrate concentrations in the first and the second aquifers and the conductivity electrical parameter to control saline water intrusion.

The monitoring stations are distinguished based on the interception of the 2 aquifers:

- 33 stations on the first aquifer, which includes both piezometers and (P01, P02, P03, P04, P05, P06, P07, P08, P09, P10, P11, P12, P13, P14, P15, P16, P17, P20, P21, P22, P23, P24), and private wells (P31, P33, P34, P36, P38, P39, P40, P41, P42, P43, P47);
- 10 station on the second aquifer, which includes both piezometers that draw from the second aquifer in which the first aquifer was sealed(P26, P27, P28, P29, P30), and depth private wells where the contribution of the first aquifer to the withdrawal can be considered negligible (P32, P35, P37, P44, P46);
- 2 station in the Sassu remediation area, neighboring at (NVZs) of Arborea.

For the specific informations see the paragraph Monitorang plan.



4 Water facilities and infrastructures

The irrigation area covers a total area of about 85,360 hectares which falls within twenty-five municipalities in the province of Oristano and has the following subdivision:

- Campidano di Oristano area, for an area of 50,317 hectares;
- Terralba Arborea area, for an area of 35,046 hectares.

The irrigation systems of the Consorzio di Bonifica di Oristano (CBO), the water supply management authority in agriculture, are fed with the waters of the Tirso River, which are filled with the Busachi Dam, via the Santa Vittoria dam located further downstream of the reservoir, located about twenty kilometers as the crow flies from the Terralba-Arborea district.
For the satisfaction of the irrigation needs of the CBO, a total water volume of 141 Mmc was assigned for the year 2019.
The territory is divided into districts fed through a main supply network consisting of free-surface canals. The adduction network is divided into two separate systems for the territories on the right and left of the Tirso river respectively.
Adductor canal on the Right Tirso, are exclusively used by the Campidano di Oristano district and serve an currently equipped irrigation area of 8,843 hectares.
Adductor Channel on the Left Tirso (also called Canale Acque Medie) supply the irrigation systems of the Terralba Arborea District, serving a currently equipped irrigation area of 14,500 hectares, of which 6,390 hectares in the Campidano di Oristano district . To manage water were built two dams the Santa Vittoria for irrigation purposes and the Mogoro dam for the flooding retention.

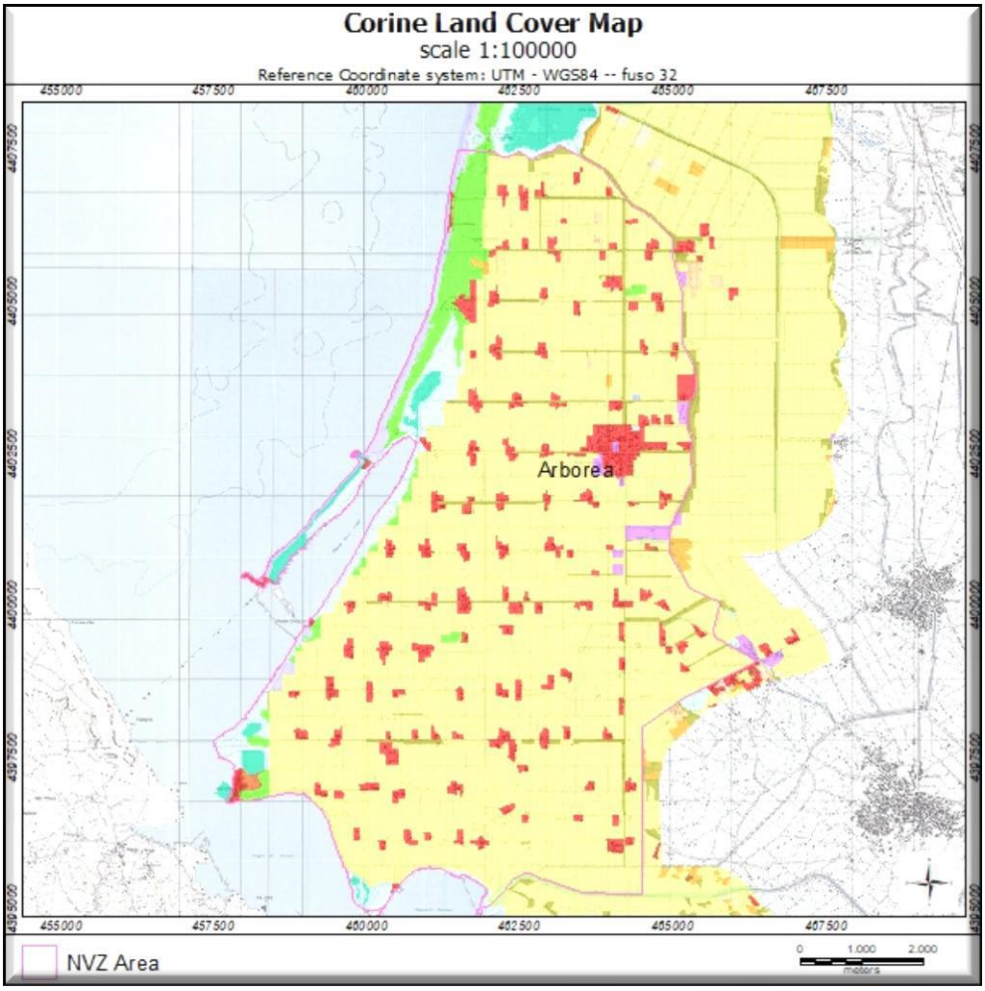
The dam of Santa Vittoria is located about 1.5 km from the town of Ollastra Simaxis, with a flow rate of about 21 mc / s for irrigation, corresponding to the need in irrigation peak period.
The hydraulic system serving the Piana di Terralba and Arborea refers to a complex network of canals which develops for a total length of about 50 km and an average density of the draining network of 1.4 m / ha.
Approximately 6,000 hectares are mechanically drained thanks3 water-pumping stations called Pauli Longa, Sassu and Luri, with a maximum total flow of 17 mc / sec. The excess waters are conveyed to the lagoons of S'Ena Arrubia and San Giovanni.

Irrigation needs
Irrigation needs are calculated by the average daily needs for the main crops.

Areas	Spring/summerneeds [mc] April/September	Winter needs [mc] October/March	Total [mc]
Irrigated area CBO	**20.500.000**	**2.050.000**	**22.550.000**

5 Social relevance of the project

This project shows a relevance for the Cooperative Producer of Arborea in term of agricultural and livestock management and in term of water and soil protection in this vulnerable area for nitrate pollution. Partners showed to beneficiaries the ammonia stripping purposes and his advantages to extract fertilizer and reduce the charge of ammonia in the sludges produced.
Different stakeldorse take part of the activities: Cooperative, Livegreen (spirulina cultivation), Laore (agency for agricultural development), Arpas (Environmental Agency) etc.
In the very close area another project is coming: the Menaware project and the Re-Waste water concluded on 2021.
The Beneficiaries agree very much the MEDISS challenges and they have a very good impression about the real possibilities of the application in the area of Arborea, in particular, the advantages for the Cooperative members in the future. They expressed



readiness to help and support the MEDISS group during the implementation of the project. The project was presented by the President during the own General Assembly of the Cooperative.

6 Current land (including water) use

Arborea plain is mainly used for the intensive fodder crops (alpha alpha, corn, etc.) as well as for the vegetable for human feed (potatoes, carrots, aborigines, eggplant, zucchini, tomatoes, lettuce, strawberries, watermelon, melon). Usually, a seasonal alternation of culture is common practice with fodder in autumn and winter and corn in spring-summer. The higher request for nutrients for grains culture favored the use of manure while chemical fertilizers are less used.
Livestock farm is mainly of cows representing 85% of economy in this area with an average of 30.000/40.000 cattle and 200 farms. Farmers are organized in Coop (Cooperativa Produttori Arborea).

7 Factors (past, present or potential) adversely affecting the site, including changes in land (including water) use and development projects

Arborea plain is affected by higher concentration of nitrates in the groundwater for that is declared a nitrate-vulnerable zone (NVZs). In 2001-2002 the Regional Authority started a monitoring program to check the groundwater and soil quality as indicated by laws. This study shows that manure spread practice in the fields affects groundwater nitrates concentrations and soil.

8 Restoration measures taken

The area of Arborea is very sensitive for the groundwater nitrate pollution from agricultural and livestock and a lot of Regional Agency time to time monitoring the water quality and soil inside.
In particular the Environmental water Agency (ARPAS), the Agricultural technical assistance (LAORE), the District water agency (ADIS), others). We collect a lot of data about groundwater and soil, for different years, from them, and we present all the tables and maps to the Cooperative representative to verify the state of the art and to decide the data we need and then start to understand where to realize the monitoring network. The network will be localized close to the plant area and outside and also the piezometers will be allocated in two areas where the pollution is very low to verify, during the monitoring, if the application of the fertilizer gives good results on water quality without pollution.

9 Current management activity

The area is managed by farmers for agricultural purposes (see land use map).

10 Jurisdiction and legislative references

European Directives (Dir.91/676/CEE and Dir. 2000/60/CE) impose the reduction nitrates pollution from agricultural origin and the prevention of any further issues of this type. For this the Arborea plain is constantly monitored because is under specific environmental pollution laws. In applicazione della Direttiva 676/91/CEE e del D.Lgs 152/99 la Giunta Regionale della Sardegna, con la deliberazione n. 1/12 del 18.01.2005 ha designato, quale Zona Vulnerabile da Nitrati di origine agricola (ZVN), una porzione del territorio del Comune di Arborea che si estende per 55 kmq. Tale designazione è stata ricompresa nel Piano di Tutela delle Acque.
The European directives have been transposed by the Italian State through Legislative Decrees 152/99 and 152/06, which provide for the identification of vulnerable zones from nitrates (ZVN) as well as polluted or potentially agricultural site polluted by nitrogen compound with the establishment of an Action Program at the regional level.
In Arborea plain, some sites are designated as a nitrate-vulnerable area by Regional Authority that included it in the Water Protection Plan (PTA) approved on January 2005.
Sardinia Authority adopted the Action Program for the nitrates vulnerable zone by agricultural origin, providing a series of obligations that involve the stakeholders and local authorities interested.

Furthermore, Arborea's Utilization Plan Agronomic (PUA), managed by the companies, fix an amount of nitrogen from livestock effluents > 3000 Kg/year, while the Fertilization Plan for small companies an amount of nitrogen ranging 1000 and 3000 kg/year (Delib. G.R. n.21/34 del 5/06/2013).
The Sardinia Region and the local authorities draw up at the Monitoring and Control Plan (MPC) (October 2006). To verify the effectiveness of MPC a water and soil measurement stations network was realized data is collected by the regional environmental information system (SIRA).
In order to verify the effectiveness of the measures contained in the Action Programme, the Province of Oristano together with ARPAS through the Department of Oristano and the Geological Expert Department, ensure the monitoring and control actions provided for within the"Monitoring and control plan" (PMC). In particular, the Agency shall monitor the quality of bodies of water, surface and groundwater, soil and discharges. The ARPAS works in coordination with the District Agency which coordinates the monitoring and control activities of the quantity and quality of water on a regional scale
The PMC has a first duration of 24 months and at the end of every biennium is produced the conclusive summary report on the monitoring activities that the ARPAS has carried out in the two-year period considered. The ARPAS monitoring network in the Arborea area represent a very useful historical data base for planning monitoring activities at the MEDISS pilot area level.
he presence of different environmental systems has determined the potentialities of the territory through the development of numerous activities of use of the present resources, from the agriculture, to the fishing, aquaculture and tourist and recreational use. In the territory there are also some wetlands of particular naturalistic interest declared sites of Community importance, included in the Natura 2000 network as bioitaly sites, identified both as SCI areas and as SPA areas: the SCI "Stagno di S'ena arrubia and neighboring territories" (ITB030016) and the SCI "Sassu– Cirras" (ITB032219) inside which partly overlaps the Zone of Special Protection "Stagno di S'arrubia (IT82211). There are two permanent Oasis of Wildlife Protection (L.R. 23/1998), the Oasis of corru S'ittiri and corru mannu and the Oasis of the Pond of Marceddì and San Giovanni, protected by the Ramsar Convention in 1977 and banned hunting.
The Stagno di S'ena arrubia is considered as a sensitive area in the PTA within the meaning of art.91 of D. Lgsl. 152/2006 and Directive 91/271/EEC. In addition to these there are other protected areas: the SCI area called "Stagno corru S'ittiri" (ITB030032) and an SPA, partially overlapping called "corru S'ittiri, Stagno di San Giovanni and marceddì" (ITB034004) partly in Terralba territory.

11 Management authority

COOPERATIVA PRODUTTORI ARBOREA
Società Agricola - Strada 14 Ovest - 09092 Arborea (OR)

- Telefono : 0783 80.321
- Fax: 0783 80.32.218
- Email – info@produttoriarborea.it
- Email pec – produttoriarborea@pec.it
- http://www.produttoriarborea.it/content/contatti

12 Ecosystem services

To evaluate the ecosystem services supply by the area was applied the analysis of Common International Classification of Ecosystem Services (CICES) with its id codes (https://cices.eu/).
The Arborea plain is a result of a reclamation activity occurred in the past century that transform a large lagoon in highly productive farmland. The area is maintained dry by a canals system and by the activity of water-pumps that conveyed in a coastal lagoon. This area is devoted mainly for the dairy industry and greens cultivation but it is relevant also for the mussel and fish production. The S'Ena Arrubia lagoon, the final point of the reclamation system, is affected by eutrophication processes but at the same time supply economic source for the fishermen and touristic activities. Furthermore, this lagoon is relevant for the conservation of biodiversity hosting a high number of threatened waterfowl, becoming a site of interest for the international scientific community. The citizens of this area came from different parts of Italy, mainly from north-east of the Italian peninsula, forming a community with a proper identity well integrated into the social Sardinian contest. The reclamation area and their facilities, as well as the buildings of the town, showing a relevant interest from a historical point of view.

In the tabs are listed the ecosystem services for the Arborea area by CICES codes.

CICES V5.1	Site: Arborea - Italy			
Section	**Division**	**Group**	**Class**	**Code**
Provisioning (Biotic)	Biomass	Cultivated terrestrial plants for nutrition, materials or energy	Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes	1.1.1.1
Provisioning (Biotic)	Biomass	Cultivated aquatic plants for nutrition, materials or energy	Plants cultivated by in- situ aquaculture grown for nutritional purposes	1.1.2.1
Provisioning (Biotic)	Biomass	Reared animals for nutrition, materials or energy	Animals reared for nutritional purposes	1.1.3.1
Provisioning (Biotic)	Biomass	Reared aquatic animals for nutrition, materials or energy	Animals reared by in-situ aquaculture for nutritional purposes	1.1.4.1
Provisioning (Abiotic)	Water	Ground water for used for nutrition, materials or energy	Ground water (and subsurface) used as a material (non-drinking purposes)	4.2.2.2
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	Filtration/sequestration/storage/ accumulation by micro-organisms, algae, plants, and animals	2.1.1.2
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	Control of erosion rates	2.2.1.1
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	2.2.1.3
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	Wind protection	2.2.1.4
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination (or 'gamete' dispersal in a marine context)	2.2.2.1
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Seed dispersal	2.2.2.2
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Maintaining nursery populations and habitats (Including gene pool protection)	2.2.2.3
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Pest and disease control	Disease control	2.2.3.2
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of soil quality	Weathering processes and their effect on soil quality	2.2.4.1
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of soil quality	Decomposition and fixing processes and their effect on soil quality	2.2.4.2

CICES V5.1	Site: Arborea - Italy			
Section	**Division**	**Group**	**Class**	**Code**
Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	Surface water used as a material (non-drinking purposes)	4.2.1.2
Provisioning (Abiotic)	Water	Ground water for used for nutrition, materials or energy	Ground water (and subsurface) used as a material (non-drinking purposes)	4.2.2.2
Provisioning (Abiotic)	Non-aqueous natural abiotic ecosystem outputs	Non-mineral substances or ecosystem properties used for nutrition, materials or energy	Non-mineral substances or ecosystem properties used for nutritional purposes	4.3.2.1
Provisioning (Abiotic)	Non-aqueous natural abiotic ecosystem outputs	Non-mineral substances or ecosystem properties used for nutrition, materials or energy	Solar energy	4.3.2.4
Regulation & Maintenance (Abiotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of waste, toxics and other nuisances by non-living processes	Dilution by freshwater and marine ecosystems	5.1.1.1
Regulation & Maintenance (Abiotic)	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	Liquid flows	5.2.1.2
Regulation & Maintenance (Abiotic)	Regulation of physical, chemical, biological conditions	Maintenance of physical, chemical, abiotic conditions	Maintenance and regulation by inorganic natural chemical and physical processes	5.2.2.1
Cultural (Abiotic)	Direct, in-situ and outdoor interactions with natural physical systems that depend on presence in the environmental setting	Physical and experiential interactions with natural abiotic components of the environment	Natural, abiotic characteristics of nature that enable active or passive physical and experiential interactions	6.1.1.1
Cultural (Abiotic)	Direct, in-situ and outdoor interactions with natural physical systems that depend on presence in the environmental setting	Intellectual and representative interactions with abiotic components of the natural environment	Natural, abiotic characteristics of nature that enable intellectual interactions	6.1.2.1
Cultural (Abiotic)	Indirect, remote, often indoor interactions with physical systems that do not require presence in the environmental setting	Spiritual, symbolic and other interactions with the abiotic components of the natural environment	Natural, abiotic characteristics of nature that enable spiritual, symbolic and other interactions	6.2.1.1
Cultural (Abiotic)	Indirect, remote, often indoor interactions with physical systems that do not require presence in the environmental setting	Other abiotic characteristics that have a non-use value	Natural, abiotic characteristics or features of nature that have either an existence, option or bequest value	6.2.2.1

PILOT AREA OF AL RISHA, JORDAN

1 Project description and expected goals

The project aims to desalinate the water of The new Well No. (9), which will provide the people of the region with water suitable for human consumption , the production capacity of up to 48 m3/h, the people of the region will benefit from the water returned from the desalination process by producing some agricultural crops, which will help them feed their livestock, and contributes to the development of remote and rural areas , Risha village is considered one of the pockets of poverty in Jordan.

2 General location

Coordinates

- Geographical coordinate: Logitude 35.211668° - Latitude 30.190358°
- Project coordinate UTM WGS 84 36N: 712928.30 m E – 3341946.13 m N
- Project coordinate JTM: 327826.191 m E - 342065.504 m N

Elevation:

- Average Elevation: 194 meters above sea level

Risheh village is located (Fig.2,3) at the southern part of Jordan the nearest large town is Aqaba (80 KM).

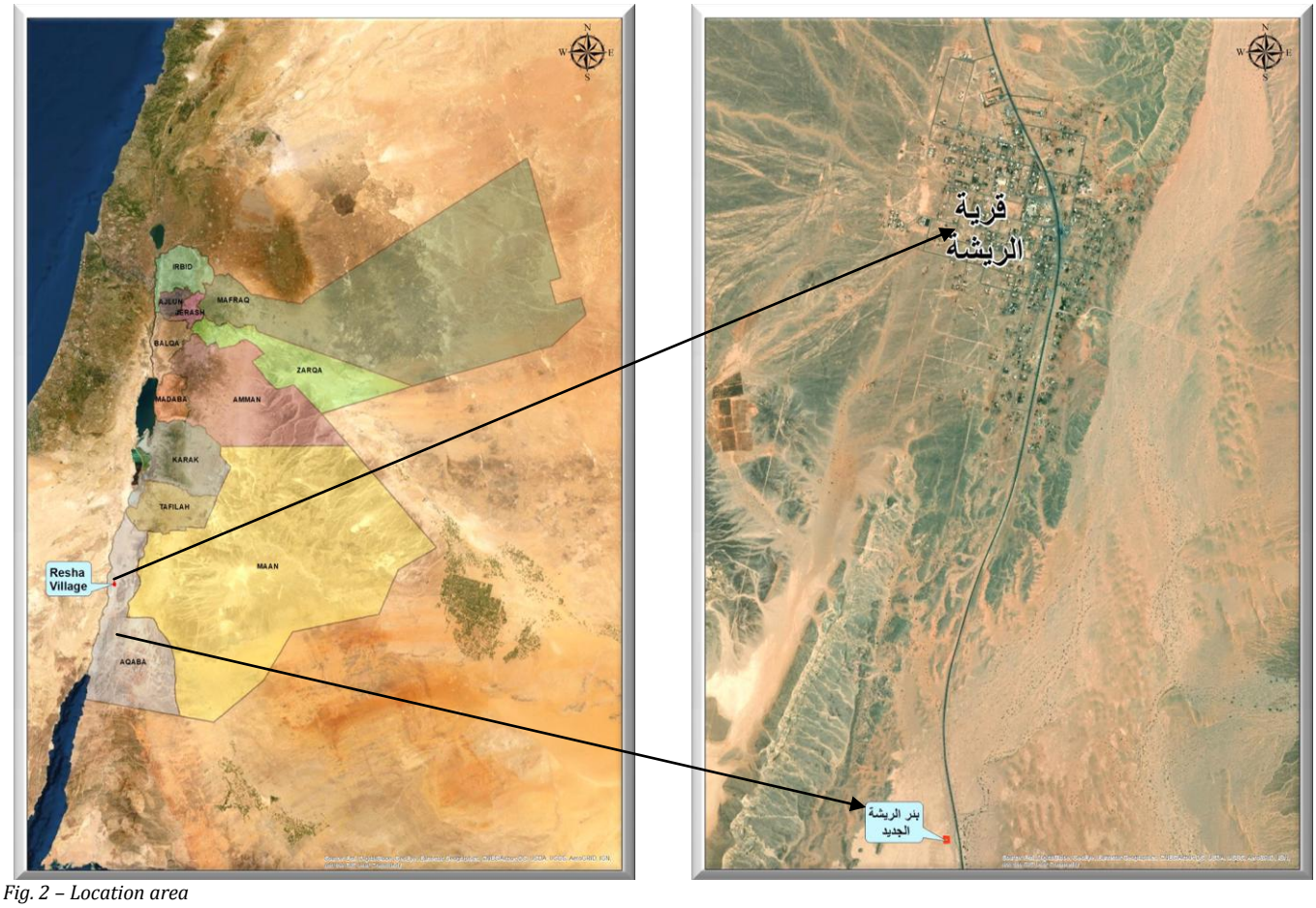


Fig. 2 – Location area

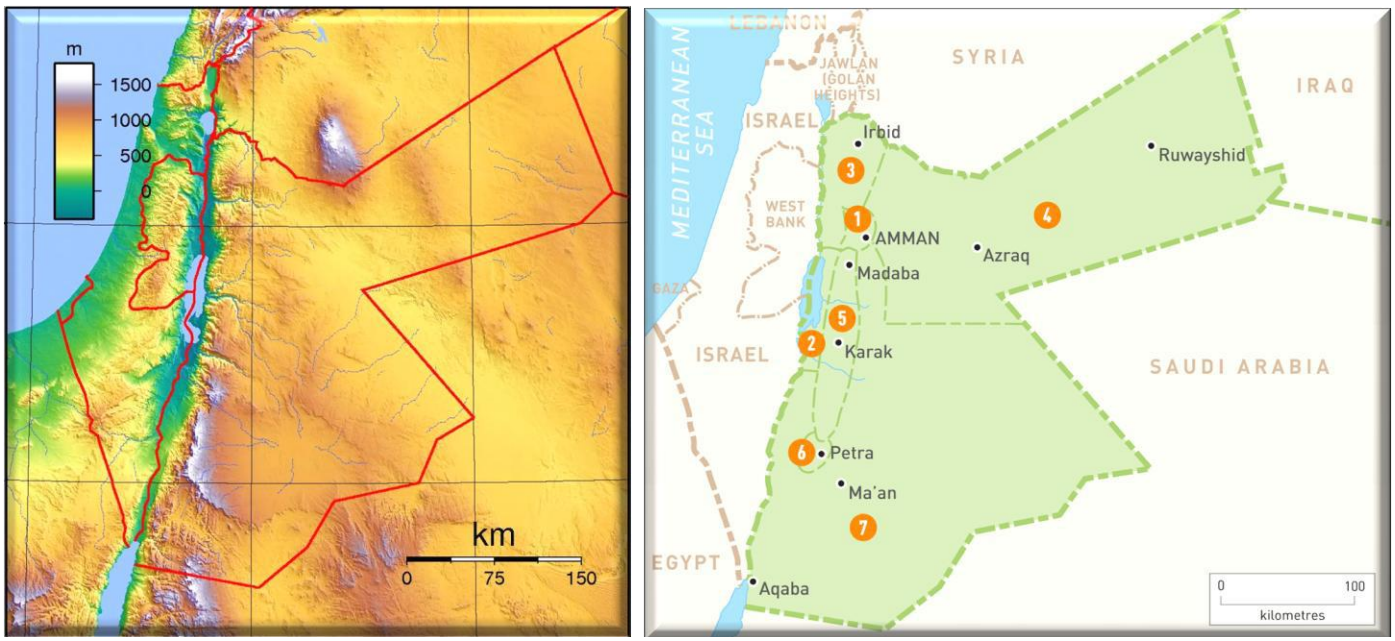


Fig. 3 Aerial photos and DTM of elevation of the location area.

3 Physical outlines of the pilot site

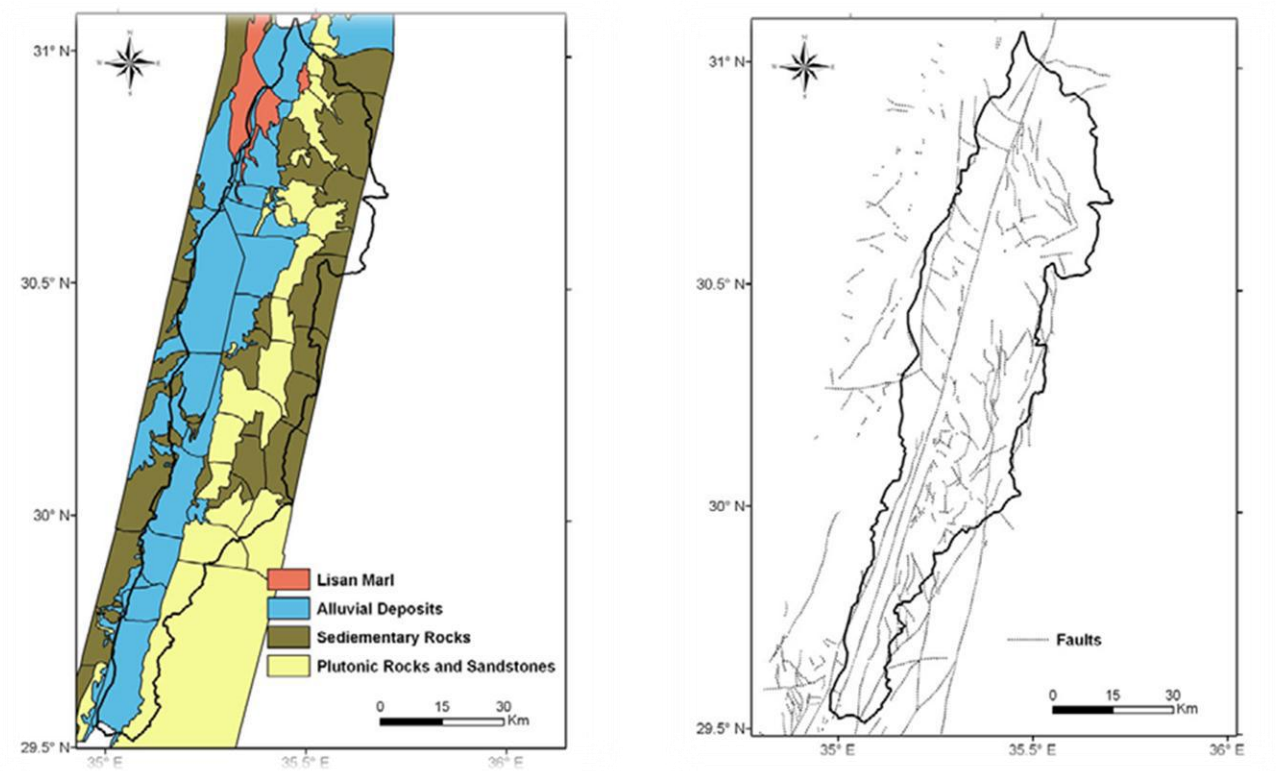
3.1 ***Geological Structures in Wadi Araba*** (Ali El-Naqa, Nezar Hammouri, Khalil Ibrahim and Masdouq El-Taj. *Integrated Approach for Groundwater Exploration in Wadi Araba Using Remote Sensing and GIS,* Jordan Journal of Civil Engineering, Volume 3, No. 3, 2009)

The Wadi Araba-Jordan Rift runs from the Gulf of Aqaba to the Dead Sea in 15° direction (southern graben) and then gradually takes a turn to the north (northern graben), The most fundamental structure of the basin is the Wadi Araba-Jordan Graben, which constitutes 360km of the East African–North Syrian Fault System that extends for about 6000 km (Bender, 1974). The Wadi Araba–Dead Sea–Jordan Rift separates the "Sinai–
Palestine micro plate" in the west from the Arabian Plate in the east. However, the Arabian Plate block punge northward more rapidly than the Sinai–Palestine micro plate in the west. The contrast between the surface geology of the two crustal blocks gradually becomes less towards the north of the Dead Sea until there is no longer any fundamental difference in the position of the Mesozoic and Cenozoic sequences on the two sides of the graben.

The study area is highly faulted and has a complex pattern of fault structures of which three categories of faults and fault zones cut the study area from north to south. The dominant fault zones (known as Border fault) strike north, northeast and north–northwest. The younger rocks down faulted against older rock complexes to the east. The major faults and flexures strike north and northeast at an acute angle into the rift, with some faults striking northwest at wider angle into the rift. The dominant fault zones which border the rift in the east are not parallel to the rift valley but are at different angles to it; they strike north, northeast and north-northwest. The network of faults dissecting the mountain range east of the border faults has the same characteristic trends as the border fault.

The lithologic character of the exposed rocks is significant in governing recharge. Some studies neglect this factor once they use the lineament and drainage (ElShazly et al., 1983; Edet et al., 1998). This is because they consider the lineaments and drainage characters as a function of primary and secondary porosity, thus providing information on the lithology. However, others (Salman, 1983; El-Baz and Hamida, 1995) incorporate the lithology factor because of its strong influence on water percolation. Lithology characterized by massive rock has little influence compared with topography in the control of availability of groundwater. The rocks become aquifers through development of weathering and fracturing by secondary porosity (Sener et al., 2005). The outcropping rock units can be summarized as follows:

1) Alluvial Deposits;
2) Lisan Marl;
3) Plutonic Rocks and Sandstones;
4) Sedimentary Rocks.



Generalized geological map of Wadi Araba basin and Major structural faults

3.2 Catchment area and surface waters

3.2.1 Drainage Density (Ali El-Naqa, Nezar Hammouri, Khalil Ibrahim and Masdouq El-Taj. *Integrated Approach for Groundwater Exploration in Wadi Araba Using Remote Sensing and GIS,* Jordan Journal of Civil Engineering, Volume 3, No. 3, 2009)

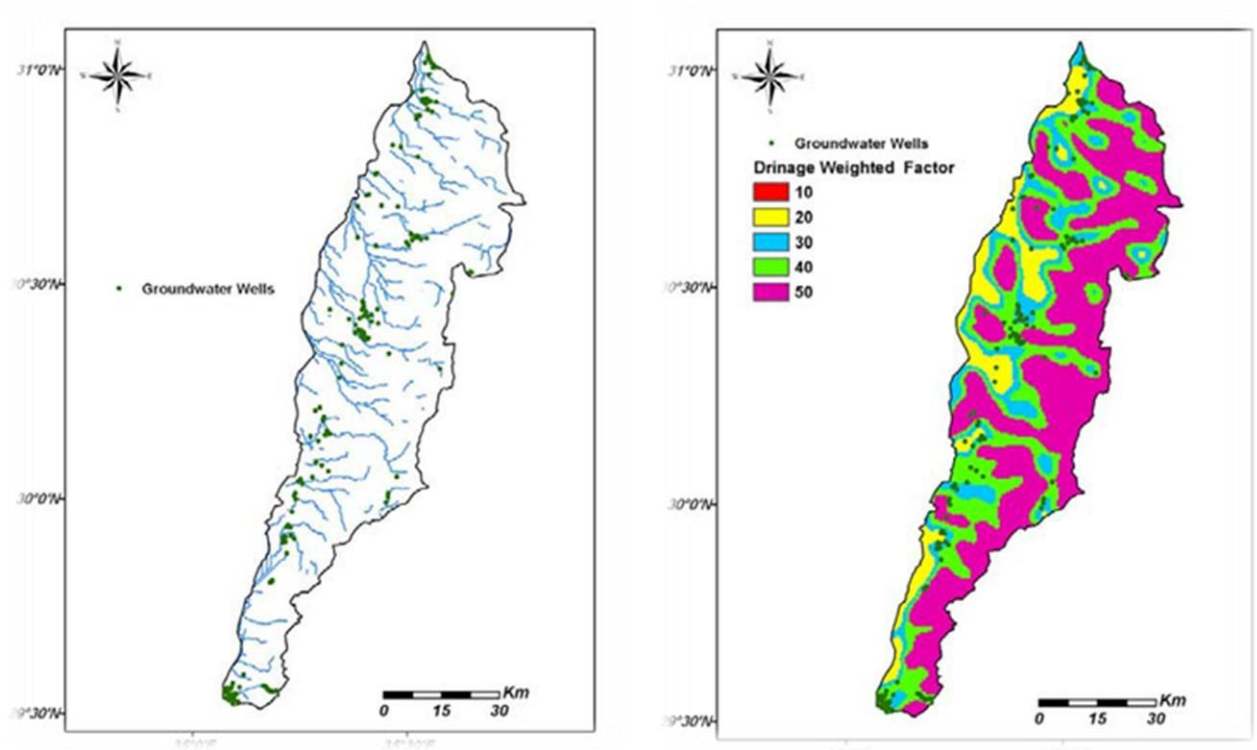


Fig.4,5 - Extracted drainage network Thematic map for the scored values of drainage density.

Drainage pattern is one of the most important indicators of hydrogeological features, because drainage pattern and density are controlled in a fundamental way by the underlying lithology (Charon, 1974). In addition, the stream pattern is a reflection of the rate that precipitation infiltrates compared with the surface runoff. The infiltration/runoff relationship is controlled largely by permeability, which is in turn a function of the rock type and fracturing of the underlying rock or surface bedrock (Edet et al., 1998). When comparing two terrain types, the one that contains the greatest drainage density is usually less permeable (Edet et al., 1998). Many workers combined only the lineament map with drainage map to presume the target areas of groundwater potential areas (Tomes, 1975; Edet et al., 1998). It is well known that the denser the drainage network is, the less is the recharge rate and vice versa (Edet et al., 1998).
Figure (Fig.4, 5) on the left shows the drainage map for the study area which was created using ArcHydro ToolTM and Digital
Elevation Model (DEM) with 30m cell size. Figure on the right shows the scored values of drainage density.

3.2.2 Aquifers

Hydrogeology of Wadi Araba Basin Density (Ali El-Naqa, Nezar Hammouri, Khalil Ibrahim and Masdouq El-Taj. *Integrated Approach for Groundwater Exploration in Wadi Araba Using Remote Sensing and GIS,* Jordan Journal of Civil Engineering, Volume 3, No. 3, 2009) (Fig.6,7).
The Wadi Araba basin is divided into a northern sub- basin and a southern sub-basin. The drainage divide between the two coincides with the groundwater divide and lies to the north of Qa' es Sai'diyeen on the western side of Jabal Ar-Risha, about 75 km to the north- northeast of Aqaba. The southern sub-basin drains into the Gulf of Aqaba while the northern one drains into the Dead Sea (National Water Master Plan (NWMP), 2004).

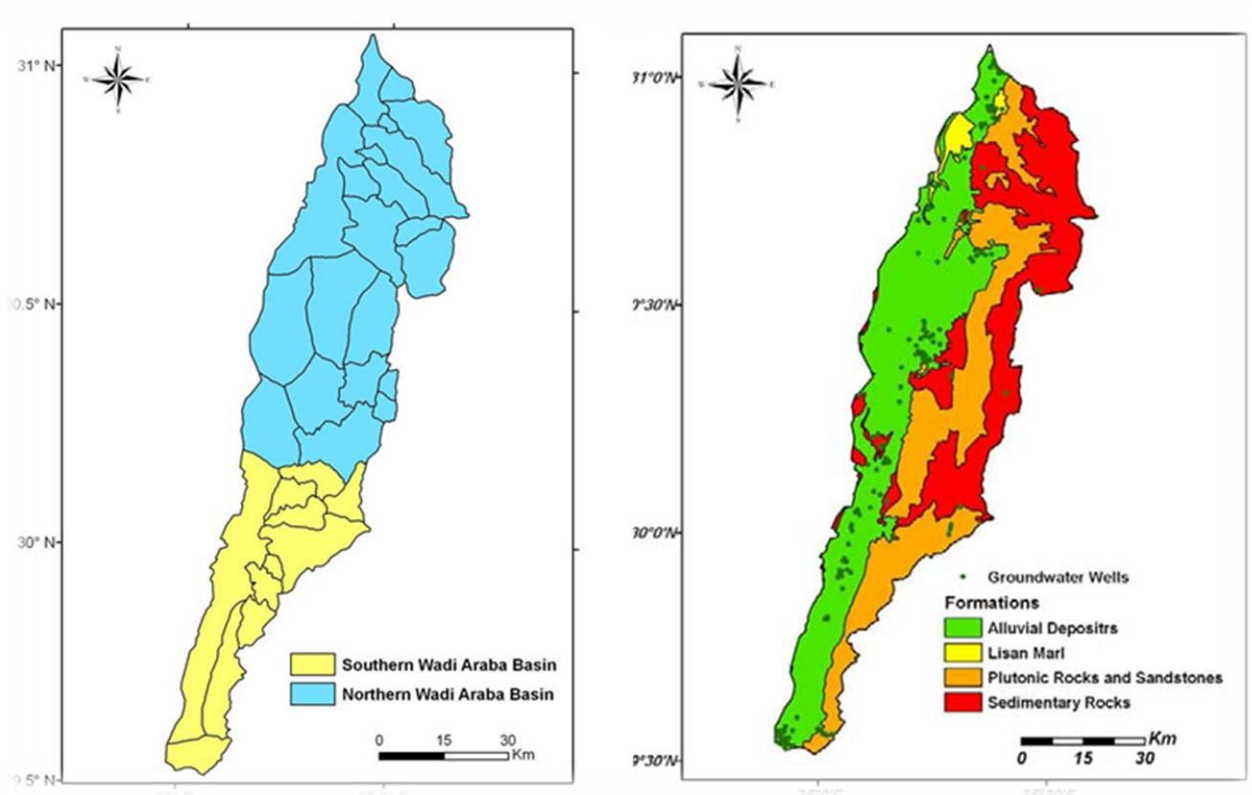


Fig.6,7 - Location map of the northern and southern Wadi Araba basin and Main rock units exposed

The lithological composition of the aquifer is very heterogeneous, with conglomerates, gravels, sands, silts and clays in some places mixed together, interbedded and/or intercalated. The following aquifer systems exist within Wadi Araba area (NWMP, 2004). The major aquifers can be summarized as follows:

- Water-bearing sandstones of Cambrian and Ordovician, constituting Disi Group aquifer system;The Ram Group Aquifer (Disi) forms a large aquifer system in Jordan, which underlies the entire area of the

country. It crops out only in the southern part of Jordan and along Wadi Araba-Dead Sea Rift Valley.(NWMP, 2004);

- Kurnub Group aquifer, consisting of Low Cretaceous sandstones;
- Water - bearing carbonate rocks of Upper Cretaceous age constituting the so-called Amman - Wadi Sir (or B2/A7)) aquifer system;
- Alternating water-bearing and water- confining/supporting Upper Cretaceous and Tertiary undifferentiated strata;
- Shallow aquifer system occurring in the Quaternary deposits, i.e. the valley fills of Wadi Araba.

3.2.3 Alluvium Aquifer System (shallow aquifer system) (Ali El-Naqa & Mustafa Al Kuisi. Groundwater resources assessment for irrigable agricultural lands in the Wadi Araba area, southern Jordan, Saudi Society for Geosciences 2012)

This aquifer system underlies the Wadi Araba floor all over the rift from the Dead Sea to the Red Sea with different lithological units in the Quaternary deposits. Most wells in this area are mainly occurring in the fluvial–lacustrine and fluviatile deposits, which are composed of conglomerate, gravel and sand, and interfingering occasionally with Lisan formation. The thickness of the Quaternary water-bearing sediments increases going from the east escarpment foot towards the central portion of Wadi Araba. In total, the thickness of these water-bearing sediments is estimated up to 300 m (GTZ 1977). But due to the rift valley structure, considerable irregularities are also evident by outcropping with irregularities of the bedrock (Fig.8,9)

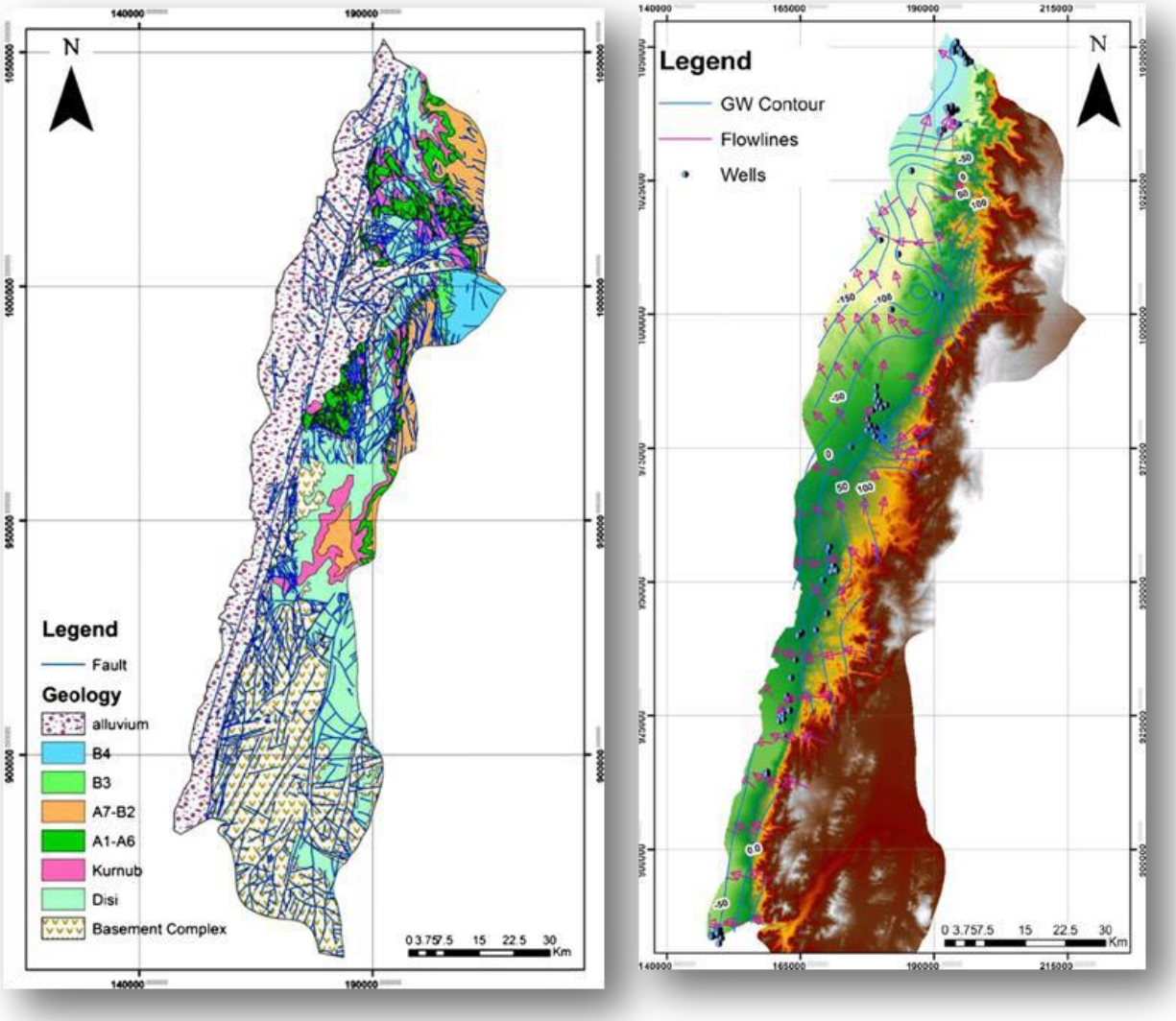


Fig.8,9 - Hydrogeological rock units nomenclatures in Wadi Araba basin and Location map of new drilled wells

Well Name	Easting	Northing	Q_{max} (m^3/day)		S_{max} (m)	Maximum specific capacity (Q/S) (m^3/h/m)	Well efficiency (%)
			Continuous pumping	Intermittent pumping			
WDMI	177,560	984,938	154.7	1,200	350	22.3	0.44
WMSH1	181,512	980,796	376.2	1,392	65	1.90	0.60
WMSH2	182,358	979,072	260.4	2,472	125.9	1.02	0.50
WMSH3	180,873	981,933	157.0	1,368.0	65.7	0.97	0.28
WMSH4	181,570	981,639	31.1	720.0	39.7	6.12	0.28
WMSH5	177,004	984,257	33.5	720.0	88	0.25	0.28
WMSH6	177,362	984,785	24.9	120.0	73	0.07	0.45
QSSH-1	169,771	953,991	38.8	720.0	86.4	4.22	0.28
Total sustainable well yield (m^3/day)			1,076.6	8,712			

Q_{max} estimated maximum sustainable well yield (cubic meters per hour), S_{max} maximum allowable drawdown (meters), Q_{max}/S_{max} maximum specific capacity of the well

The evaluation of the pumping test data of the drilled wells in the Wadi Araba area was carried out using the standard methods of pumping test interpretation. This was based on the available water table measurements at well locations and knowledge of water flow in the general Wadi Araba region.

The sustainable yield of each well was calculated based on the pumping test parameters. The simplified model indicates that pumping out of Beer Mathkor wells should not exceed 1,100 m^3 day in the case of continuous pumping and 8,700 m^3/day in the case of intermittent pumping.

Since the water table did not significantly change with small changes in pumping (it took an eightfolds of magnitude increase in pumping from 1,100 to 8,700 to show a significant drop in the water table equivalent to about 5.5 MCM per year from the aquifer, therefore, a comparison of pressure cones between Beer Mathkor and the active pump-ing wells was used to reach a crude estimate of the maxi- mum safe yield for the Beer Mathkor wells.

The paucity of data and the complexity of the problem led to numerous problems during the creation and calibration of the results of the model. The model presented here is a good estimate in point of view

available data. The data available can give good estimation when it overlapped with pumping test analysis. In order to have a more accurate model, expensive measurements are required to make good data to be available.

4 Water Facilities

The ground water well is the main source for drinking water in this area, the well produce around 40m3/hr from well depth 450m underground this quantity is pumped through pipe diameter of 10 inches long 7 km to be collected in Reservoir capacity of 300m3 which distribute to the network with different diameters with long of 10 kms.

5 Social relevance of the project

The project will provide around 3000 person with drinking water and for human use in this area with high quality water after treatment

6 Current land (including water) use

The land in the area is available but no water for irrigation now.

7 Factors (past, present or potential) adversely affecting the site, including changes in land (including water) use and development projects

Free land and no pollution events

8 Restoration measures taken

Describe reclamation and restoration measures takes to improve the water quality as well as the environment protection (max 2000 characters)

9 Other measures proposed but not yet implemented

Provide measure of protection, restoration or reclamation proposed but not implemented today e.g. management plan in preparation; official proposal as a legally protected area, etc. The site is free (Free Land-Desert)

10 Jurisdiction and legislative references

Wadi Araba Devolopment Company is the main responsible of the area

11 Management authority

- wadiaraba development company

PhoneNumber :06 5603649
Fax:06 5626778
E-mail:info@wadiaraba.com

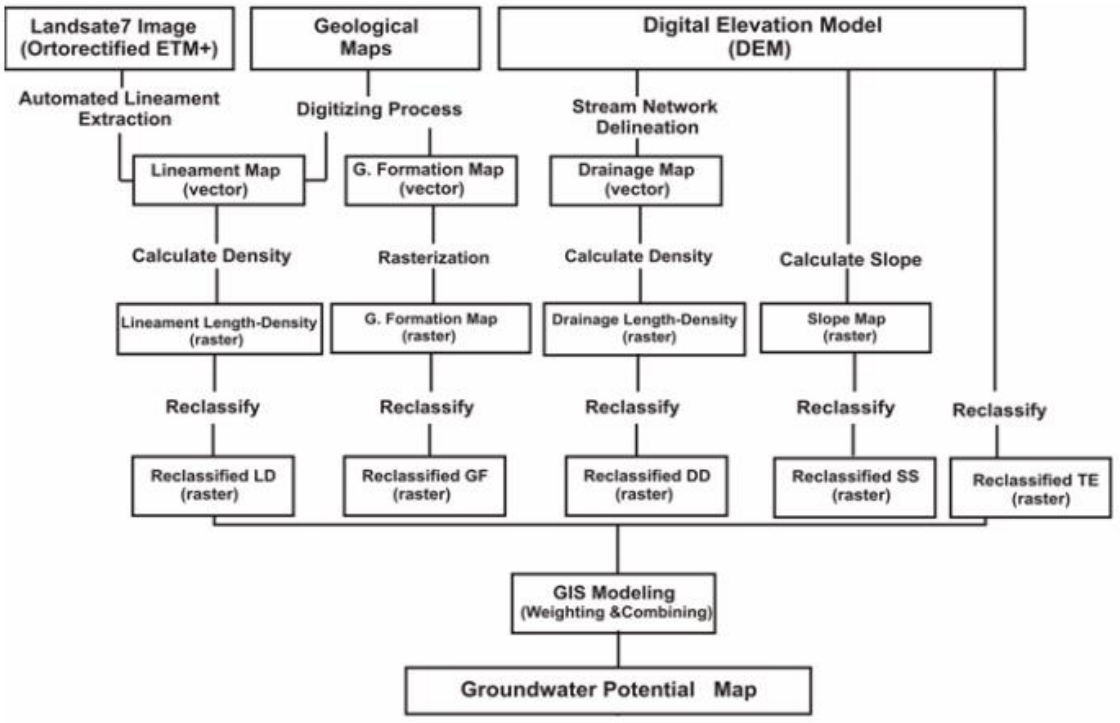
- Aqaba water Company

12 Ecosystem services

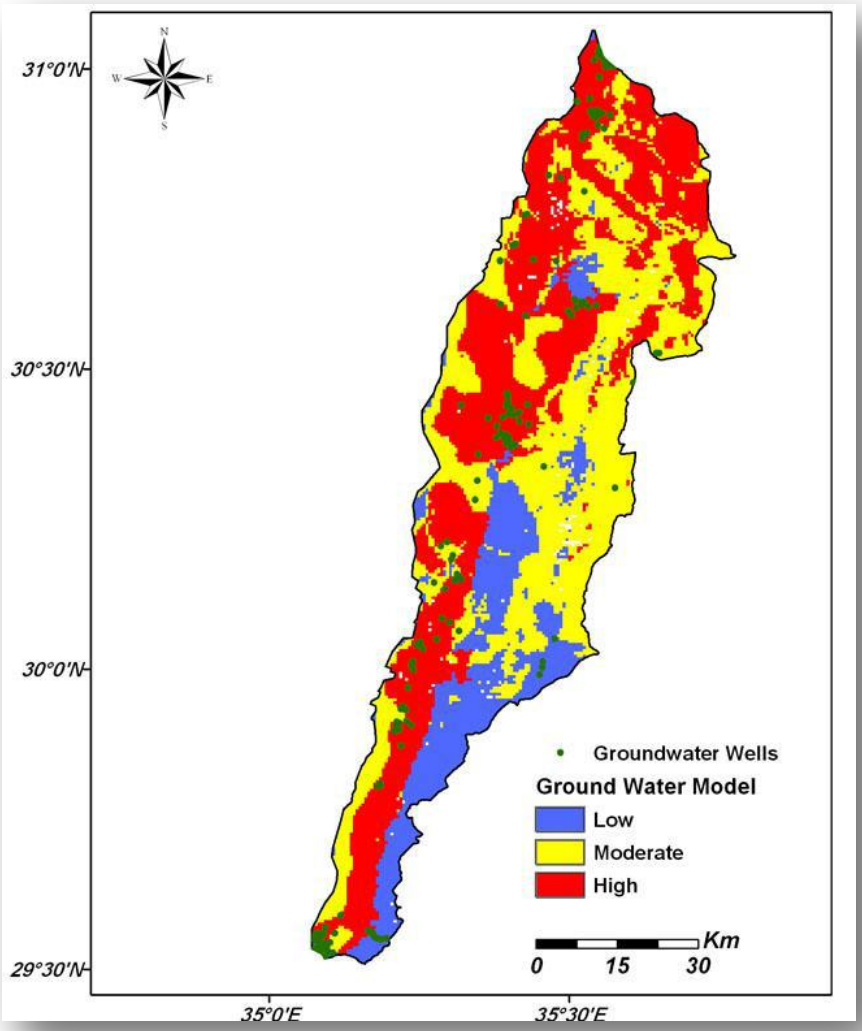
Free land no industries in this area

13 Territorial framework - Geo-Database

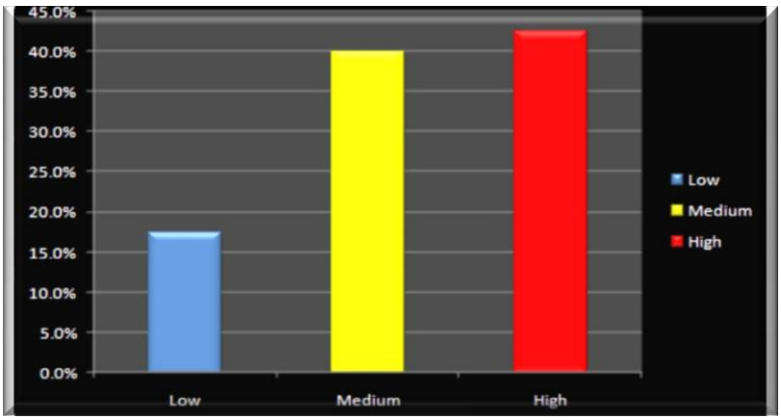
Provide a GIS-Database on hydrology, geology, land use and soils, water facilities, network infrastructure technology, structures system, pipeline net, socio-economic, protected areas as well as for the information for sections n. 3.4, n. 8 and n. 10, reported above. Information reported below in "Data Collection Plan Activity" explains the requests of this point.



Flow chart of the processes followed to implement groundwater potential model.



Groundwater potential model



Histogram of the classified categories obtained from groundwater potential model

In the article "Integrated Approach for Groundwater Exploration in Wadi Araba Using Remote Sensing and GIS" published by Jordan Journal of Civil Engineering, Volume 3, No. 3, 2009, an integrated approach using GIS and remote sensing was adopted to find new potential sites for groundwater exploration in the alluvial aquifer. A weighted overlay model was implemented using eight different effective weighted parameters including; annual rainfall, lithology, lineament density, topography, slope and drainage density. The groundwater potential map was obtained by algebraic summation of these effective parameters being multiplied by their effective weights.

This was classified into three different classes reflecting the potential of groundwater exploration. The final map of groundwater potential model shows that about 40% of Wadi Araba was classified as high potential areas for groundwater exploration. These areas are concentrated along the valley floor and are parallel to the major Dead Sea transform fault system. Furthermore, about 20% of the study area falls within the class of low potential for groundwater exploration. These areas are located in the eastern southern part of Wadi Araba, where the basement rocks are outcropping. The rest of the area was classified as moderate potential for groundwater exploration.

PILOT AREA OF JORDAN VALLEY, JERICO, PALESTINE

1 Project description and expected goals

Water scarcity is the major constraint limiting large-scale development of the Palestinian Jordan Valley. Since Palestine's share of the Jordan River Basin water resources is the smallest among the three countries, settlements in the Jordan Valley are large consumers of water and Israel control most of the water resources in the area and the supply of water barely meets Palestinian demand. Economic development in the Jordan Valley depends mainly on access to water, not to forget here that the agriculture in the Jordan Valley depends totally on irrigation water and not rain fed.

2 General location

Coordinates

- Jericho is located in Palestine (Fig.10)
- DMS latitude longitude coordinates for Jericho are: 31°52'0.01"N, 35°27'0"E.
- Latitude position: Equator ⇐ 3543km (2202mi) ⇐ Jericho ⇒ 6464km (4016mi) ⇒ North pole.
- Longitude position: Prime meridian ⇒ 3332km (2071mi) ⇒ Jericho. GMT: +2h.

Elevation

- Jericho is located at an average altitude of 273m below sea level.

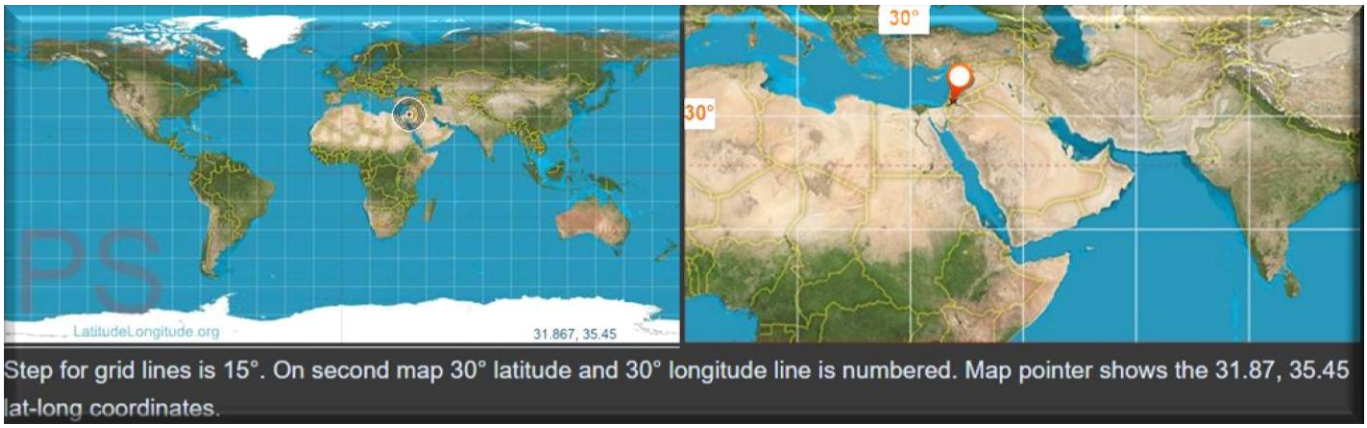


Fig. 10 - Location area

3Physical outlines of the pilot site

The Jordan Valley forms the border between Jordan to the east, and Israel and the West Bank to the west.
It is home to nearly 65,000 Palestinians, including the population of Jericho city, which is 2 percent of the Palestinian population, according to official data.
The Jordan Valley has comparative advantages in the fields of agriculture and tourism. Its land is highly fertile and rich in natural resources, the area as a whole benefits from a warm and all year round tropical climate, and is suitable for growing diverse agricultural products.
The percent of cultivated land area from Total Area of Jericho and Al-Aghwar Governorate is only 4.7%

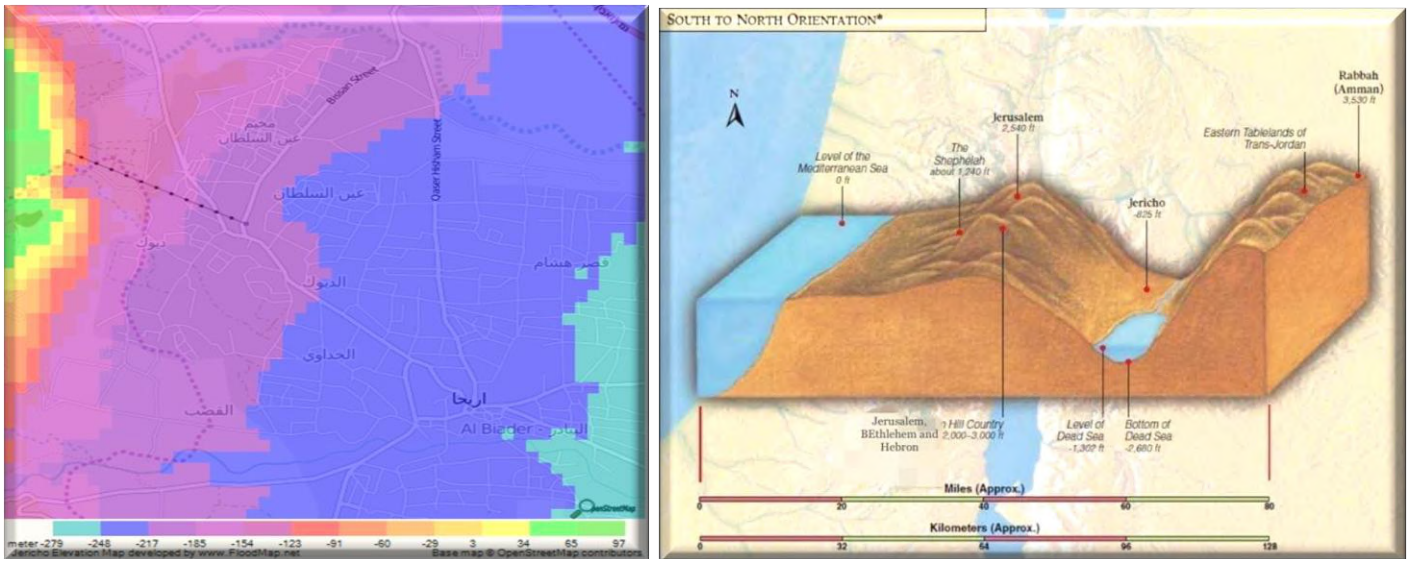
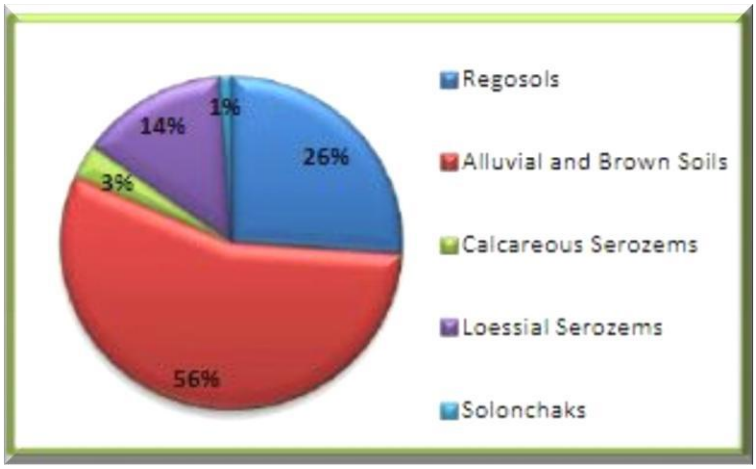


Fig. 11 Elevation and morphology

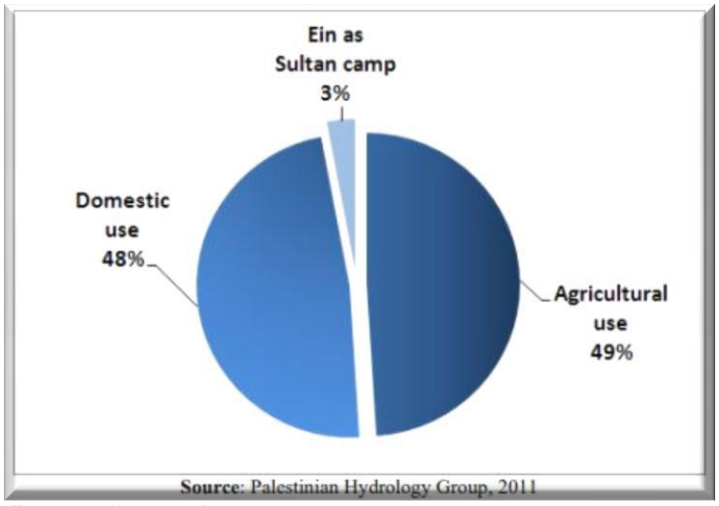


Soil of the project location is the same main soil that cover Jericho area, which is alluvial arid brown soil, which covers an area of about 6,470 hectares. It is made of alluvial fans and plains, formed as a result of erosion of calcareous silty and clayey materials (Fig. 11). It is worth mentioning that the project will make a soil survey and soil analysis, soil maps will be made as well.

3.2 Catchment area and surface waters

3.2.1 Surface waters

Six main Wadis cross the Jericho district, namely Wadi Al-Mallaha, Wadi Al-Auja, Wadi Abu Ubeida, Wadi An-Nuw'ema, Wadi Al-Qilt and AL-Ghazal, Wadi Al-Mallaha runs north south, while the remaining five wadis run west east. All wadis have intermittent water flow.



Allocation of 'Ein as Sultan spring water quotas, 2009

3.2.2 Aquifers

As Palestinians in the West Bank do not have access to the Jordan River, the main water resource left to them is the Mountain Aquifer. This groundwater resource lies under both Palestine and Israel. It is 130 km long and some 35 km wide, fed mainly by rainwater falling over the mountains of the West Bank as shown in Figure below.

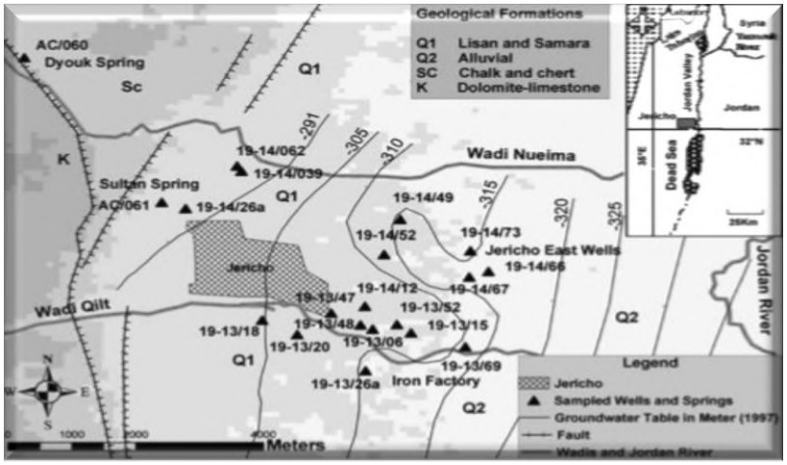
The project location as well as Jericho Governorate in general is located over two aquifers, a shallow aquifer with a total and yearly renewable discharging capacity of about 11 million m3 per year and a deep aquifer which is 500-700 meters deep with a discharging capacity exceeding 140 million m3 per year. Palestinians are allowed to exploit only the shallow aquifer where the deep aquifer is exploited by illegal Israeli settlements constructed illegally over Palestinian land. Palestinian need of water is increasing to cope with needed agricultural activities and increase of domestic water need due to increase of living standards, it is estimated that the Palestinian need in the Jordan Valley is 17 million cubic meter per year. Therefore, there is a deficiency of 6 million cubic meters per year.

Jericho is currently being provided with water by 'Ein as Sultan water spring; Jericho Municipality provides the residents with the spring's water through the public water network established in 1955.

The average rate of water discharged from 'Ein as Sultan spring is approximately 650 cubic meters/ hour; the spring water is being distributed in specific quantities among the public water network, the agricultural channels and 'Ein as Sultan camp water network. In 2009, the public water network was supplied with 310.7 cubic meters/ hour of the spring's water, which is equivalent to 48% of the spring's rate of discharge. The picture below shows the amount of water consumed through the network according to type of use; the percentage of water loss through the network reaches about 23.7%.

With a total average yield of 679-734 MCM/yr., the Mountain Aquifer is divided into three parts: the Western Aquifer Basin, North-Eastern Basin and Eastern Aquifer Basin. It is a very important resource for both Israelis and Palestinians. It contributes about 25% of Israel's total water budget. Israel extracts about 80% of the Mountain Aquifer's potential yield, and restricts Palestinians to only about 20% of its estimated potential. Furthermore, Israel reportedly withdraws water from the Mountain Aquifer up to 50% beyond its sustainable yield, to provide water for its citizens and for illegal settlers in the West Bank.

The major aquifer system in Jericho forms part of the eastern basin of the West-Bank which extends along the Jordan rift valley. This system is of Quaternary Pleistocene Recent age, and mainly composed of the formations as shown in figure below. The main recharge sub-basin for this system is the Jerusalem Ramallah Mountains, in which runoff water drains through Wadis flowing from the west to the Jordan rift valley in the east. The lithology of the Pleistocene is varied marl, consisting of thin layers of gypsum and limestone, and forming dark and light alternating bands, whereas the alluvium and gravel fan formations are of Holocene age and cover the flood plains of the Jordan River. They consist of laminated marls and gravel fans. The main sub-basin feeding the Quaternary aquifer system in the area is the Jerusalem-Ram Allah sub-basin which drains mainly through Wadi Qilt and Wadi Makkuk, the Neogene and Pleistocene Lower and Upper Cenomanian aquifers, and then flows to the east and southeast. This sub-basin also contains three major spring systems:



1. Wadi Qilt spring system: this includes Ein Qilt, Ein Fara and Ein Fawwar.
2. Wadi Makkuk (Nuaymah) spring system: this includes Ein Dyouk, Ein Nuaymah and Shosha.
3. Ein Al-Sultan spring system.

All of the above mentioned springs are used for agricultural irrigation, except Ein Al-Sultan which is also used for domestic water supply as mentioned before. The water quality of these springs is relatively good compared with that of other groundwater wells in the area. These wells are highly impacted by salinization, an EC of >6,000mS having been recorded in the eastern part of the area. The source of increasing salinity in this area is as yet not well known, although previous studies identified three major sources of salinity. These are (1) the in situ dissolution of salts within the Lisan Formation, (2) saline water from adjacent deep brine aquifers (related to over extraction), and (3) anthropogenic effluent mainly of agricultural backflow and domestic sewer.

4 Social relevance of the project

The project will contribute to make available extra agricultural water quantities, this is due to the fact that the project will capture hundreds of thousands of extra water cubic meters which will be pumped from Wadi quilt to the Medjool date orchards, large Wadi water quantities will be blended with saline and treated wastewater as well, this will contribute to increase the cultivated area as well as to improve the date quality. All of the above will contribute to enhancement of the economy and reduction of the stress on the aquifer; this will contribute to better environmental protection.

5 Current land (including water) use

The project area is cultivated with Medjool date, this is due to water salinity, date has certain resistance to saline water and Medjool date has certain economic value, which is above average of other regular date. Some of the Jordan Valley area is cultivated with cash crops like eggplants, tomato, vineyard, and cucumber, etc.

6 Factors (past, present or potential) adversely affecting the site, including changes in land (including water) use and development projects

The project site was historically cultivated with cash crops (vegetables) but due to water salinity and water scarcity, the farmers have started to cultivate Medjool date.

7 Restoration measures taken

Use of water from the Wadi and blending it with aquifer saline water as well as with treated domestic wastewater will contribute to water quality improvement. It is worth mentioning that the project will install irrigation network, which will convey the blended water to the nearby date orchards.
The project will also implement soil survey and soil analysis as well as soil mapping, these together with an agronomy study will contribute to better crop rotation ad water balance all together leading to better environmental and socio economical satiations.

8 Other measures proposed but not yet implemented

Please read above with regard to water blending and irrigation.

9 Current management activity

The site is cultivated with Medjool dates.

10 Jurisdiction and legislative references

The land is under the Palestinian National Authority (PNA) Jurisdiction, it makes part of Jericho Municipality urban plan, The project is in line with the goals and aspirations of Palestinian National Authority (PNA) according to the Palestinian law and regulations that believes in increasing water supply in a sustainable way as a key to local economy development at a large.
In addition to the impact on local communities as well as institutions through contributing to behavioural change on the re-use of non-conventional water; increase the income of the farmers by having better quality and quantity of harvested crops (i.e. quality “Medjool” palm dates).
and Department of Palestinian Ministry of Agriculture provides technical advisory services.

11 Management authority

Palm Farmers Cooperative Association in Jericho and Al-Aghwar.

PILOT AREA OF BECHIMA (WADI CHERKA), ELHAMMA, GABES, TUNISIA

1 Project description and expected goals

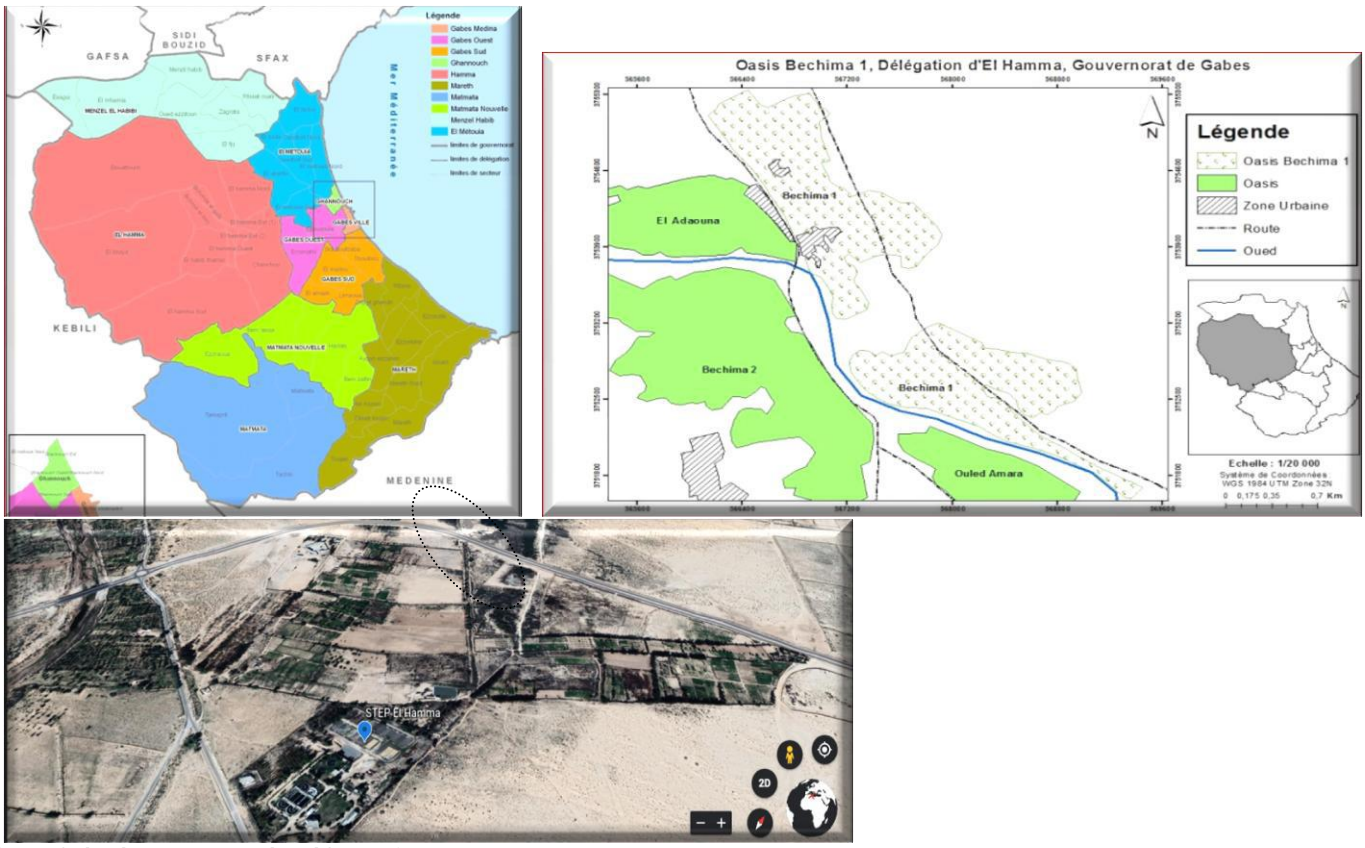
La Tunisie compte parmi les pays les moins lotis en ressources hydriques. Les perspectives de pénurie d'eau sont devenues évidentes. Ces dernières se déclinent dans l'espace selon les conditions locales des ressources souterraines et superficielles. Ces ressources hydriques limitées menacent la durabilité de l'activité agricole. De ce fait, l'irrigation par des eaux usées traitées, peut constituer une ressource hydrique supplémentaire potentielle et pérenne. En effet, ces eaux peuvent porter profit à différents niveaux. Cette technique d'irrigation non conventionnelle contribuerait notamment à l'amélioration des rendements agricoles ainsi qu'à la fertilisation du sol par des substances biodégradables.
L'objectif de cette étude est d'évaluer l'impact de l'irrigation avec des eaux usées traitées secondairement sur la qualité des sols agricoles afin de déduire des outils d'aide à la décision pour une meilleure gestion intégrée des ressources en eaux dans une zone d'exploitation aride (sud de la Tunisie) en compte la composante environnementale.
In this site, treated municipal wastewater seems to be an alternative water resource for forage crops irrigation with a correct salts management. However, studies of different types of wastewater and soils are needed before these results can be generalized, because changes in microbial community are also considerably influenced by soil type and certain agricultural practices. To evaluate the chronic soil contamination and the cumulative impact of wastewater, we have to do soil analysis of the region of Bechima-Gabes which has been irrigated for fifteen years with treated wastewater (secondary effluent). since its inception, no analysis of soils irrigated with treated wastewater has been published, so our job is to sample in different areas of this irrigated perimeter, during different seasons and at different depths in this soil to subsequently perform analyzes of the different physicochemical and microbiological parameters. four small plots were chosen
To evaluate the chronic soil contamination and the cumulative impact of wastewater, the MEDISS tunisian partner Institut des Régions Arides de Médenine (**IRA Médenine**) have to do soil analysis of the region of Bechima-Gabes, MEDISS pilot area, which has been irrigated for fifteen years with treated wastewater (secondary effluent).
L'objectif de cette étude est d'évaluer l'impact de l'irrigation avec des eaux usées traitées secondairement sur la qualité des sols agricoles afin de déduire des outils d'aide à la décision pour une meilleure gestion intégrée des ressources en eaux dans une zone d'exploitation aride (sud de la Tunisie) en compte la composante environnementale. Ce travail de recherche est articulé autour de trois axes : 1- Evaluer de façon expérimentale l'impact des eaux usées sur les paramètres physico-chimique et sur les communautés microbiennes indigènes du sol. 2- Evaluer l'impact des eaux usées sur les paramètres éco-physiologiques des oliveraies. 3- Evaluer l'impact de cette pratique sur les paramètres de rendement et de qualité du produit fini (l'huile d'olive).

2 General location

Coordinates
Coordinates: 33°50'51'' N; 9°47'59''E
Rough GPS position Latitude. 33.9167°, Longitude. 9.7333°

Elevation:
Average elevation : 42m/137.8 feet

Bechima (Wadi Cherka) is a village in the south of Tunisia located a few kilometers from El Hamma (governorate of Gabès) (Fig.12). It consists of two parts; this distinction is made between the part near a hill a hundred meters high, called El Galb, and the part located near an ancient limes called El Borj. This village has a majority of peasants living mainly from the product of their crops and livestock.



(DGAT/Atlas du Gouvernorat de Gabès 2011)

Fig. 12 Location area

3 Physical features of the site

3.1 Geology and geomorphology

There are the late Cretaceous formations in which the jebels which border the low dome of Chott El Fejij and which cover the whole of the north-west of the governorate of Gabes were shaped (delegations of Menzel El Habib and El Hamma).

The geomorphological unit, then, which characterizes this site is the mountains and jebels which border the Chott El Fejij and which extend over the delegations of El Hamma and Menzel El Habib. Their altitude varies between 200 and 400m to the north (Jebels Sif El Lham, Oum Ali, Al Battoum, Al Halfay) and to the south of the chott (Jebels Tebaga et Aziza). Ces monts sont des crêts qui ont été façonnés dans l'anticlinal dont le centre évidé est occupé par Chott El Fejij.

Nom de zone d'étude	Bechima (Wadi cherka)
Gouvernorat	Gabès
Délégation	El Hamma
Superficie(ha)	214
Nombre de parcelles	36
Nombre d'exploitants	53
Date d'exploitation	2005
Climat	Aride supérieurà hiver frais
Sol	Sols peu évolués non climatique d'apport alluvial. Sols halomorphe: Salé Sols Calcimagnesiques: gypseux

3.2 Physical features of the catchment area and surface waters

3.2.1 Surface waters

Geographic features around Bechima:

Wadi:

Wādī `Ā'id (5.1km) Wādī al Bawl (10.6km)

Wādī al Oudak (11.1km) Wādī al Ḥāmmah (12.7km)
Wādī Seradou (15.3km) Wādī Telmam (17.2km)
Wādī al Murţibah (17.5km) Wādī Banī `Īsá (17.5km)
Wādī al Kharjah (17.5km) Wādī al `Aqāribah (19.1km)
Wādī Soutteuf (19.8km) Wādī al Ghīrān (20.4km)
Wādī Bū Lūfah (21.1km) Wādī Sukrah (21.2km)
Wādī Sidrat adh Dhi'b (23.9km) Wādī al Ḥadīfah (25.3km)

Populated place

Bū `Aţţūsh (4.6km) Sembat (6.1km)
Al Qaşr (8.2km) El Hamma (8.2km)
Ad Dabdābah (9.2km) Bin Rhilouf (14.5km)

Well

Shanshū (19.8km) Bi'r `Ammār (21.2km)
Bi'r al Khanāfis (22km) Bi'r al Midassi (22.1km) Bi'r as Suwaysī (22.8km)

Hill

- Jabal Haïdoudi (16.6km) Jabal al Babis (23.6km)
- Manqab Iklia (24.1km) Kudyat al Ḥammāmāt (24.2km)

Spring(s)

- `Ayn al `Uwaynah (2.4km) `Ayn as Samā'idah (5.1km)
- `Ayn as Sakrānah (8.2km) `Ayn al Ḥājj `Umar (10.6km)

Dune(s)

Qalb Bechima (0km) Qalb Dukhān (19.8km)

sabkha(s)

Sabkhat al Ḥāmmah (9.6km)

3.2.2 Aquifers

* The water table of El Hamma-Chenchou:

The reservoir of this aquifer is made up of a conglomerate and gravelly formation, as well as sandy clays. The El Hamma region is characterized by a network of faults which play an important role in feeding the water table from the deep aquifer of the intercalary continental. A second source of water supply is formed by the infiltration of rainwater during floods of wadis crossing the region and mainly Oued El Khardak and Oued El Aid and their tributaries. The general flow of this aquifer is mainly from the South to the North-West, the salinity of the waters increases appreciably from the South-East to the North-West and varies from 3.5 to 7 g / l The exploitable resources are estimated at 4.4 Mm3 / year, the exploitation evaluated in 1997 was 9.01 Mm3 / year While in 2005, the exploitation was 8.6 Mm3 / year which releases a continuous deficit of about 4.40 Mm3 /year. The exploitation rate of this aquifer is 195%.

* The Continental Intercalaire tablecloth, like a deep tablecloth.

It is a deep and fossil table, very little renewable. It has been known since the 1950s after the completion of the two oil wells CF1 and CF2. The water table has appeared on the surface for a long time. Indeed, it is exhaled by the sources of Ben Ghilouf and Oued El Hamma. It is used for the irrigation of the irrigated areas of Ben Ghilouf, El Khbeyat, Bechima and El Hamma and for the transfer of water to the industrial zone of Gabès. This aquifer is exploited by 15 boreholes.

4 Water facilities

The irrigated perimeter of Wadi Chirka (Bechima) is supplied by two main pipes coming from the treatment plant: urban waste water and the other geothermal water which comes from the Hammam (big bath) outlets (less polluted) in the irrigated perimeter these two types of wastewater mixes; one quantity of this water is intended for irrigation and the other will be discharged into the receiving environment.

More information are available on the network and infrastructure that will be available for the GIS realisation.

5 Social relevance of the project

This environmental and social impact study relating to this project gives high priority to agricultural development and the sustainable management of natural resources. Indeed, the development of productive activities requires support, scientific monitoring and supervision of farmers to guide them in the right direction (We can help them by manipulating the physico-chemical and bacteriological analyzes of water and soil…)

6 Current land (including water) use

At Bechima (Wadi cherka), the date palm is still cultivated and is represented by Kenta, Rochdi, Roteb, Ksseba. The arboriculture is diverse and mainly includes the pomegranate (Gabsi) and the olive oil. On the other hand, vegetable crops, in particular carrots and fodder (green barley and oats) are not practiced. Certain species are much endangered, in particular cotton, local apple trees and bargoug (apricot trees).
Livestock (mainly sheep and goats), although it is considered a tradition for oases, the high numbers do not exceed a few female reproductive units and this is mainly due to the absence of labor (even family) , the considerable increase in the prices of the concentrated food and the fall in the financial profitability of this speculation for the oases. The majority of oases in the area source pasteurized milk to meet the milk needs of their families.

7 Factors (past, present or potential) adversely affecting the site, including changes in land (including water) use and development projects

Development issues are important at the level of the area which we cite the most indicated by the populations:
- Period between two water towers is very distant
- Insufficient irrigation water
- High cost of electricity
- Uncontrolled discharges from the Béchima treatment plant upstream of the perimeter. This station causes damage to agricultural holdings (rising water table and suffocating plant roots)
- Development of natural wild plants that have become niches for wild boar and destroys oasis soil and flora
- The phenomenon of siltation which attacks this perimeter of its northwestern part.

8 Restoration measures taken

Deficient data

9 Other measures proposed but not yet implemented

Provide measure of protection, restoration or reclamation proposed but not implemented today e.g. management plan in preparation; official proposal as a legally protected area, etc. (max 2000 characters)

The Guidelines proposed to safeguard the oasis of Bechima 1 and El Hamma in general mainly concern the maintenance of waterways and the renovation of pipes and concrete saguias, as well as the sanitation of the area and the fight against pollution, and the activation of the construction of the tourist area linked to the spa and the tourist and artisanal circuit of El Hamma, with the promotion and support for the marketing of dates and artisanal products of the oasis.

10 Current management activity

Describe the current management of the site selected for the MEDISS project (max 2000 characters)

11 Jurisdiction and legislative references

Legislation and policies
Wadi chirka Bechima Elhamma, Gabes Tunisia
Regional Commissariat for Agricultural Development of Gabès/ Regional Directorate for the Environment south-east.

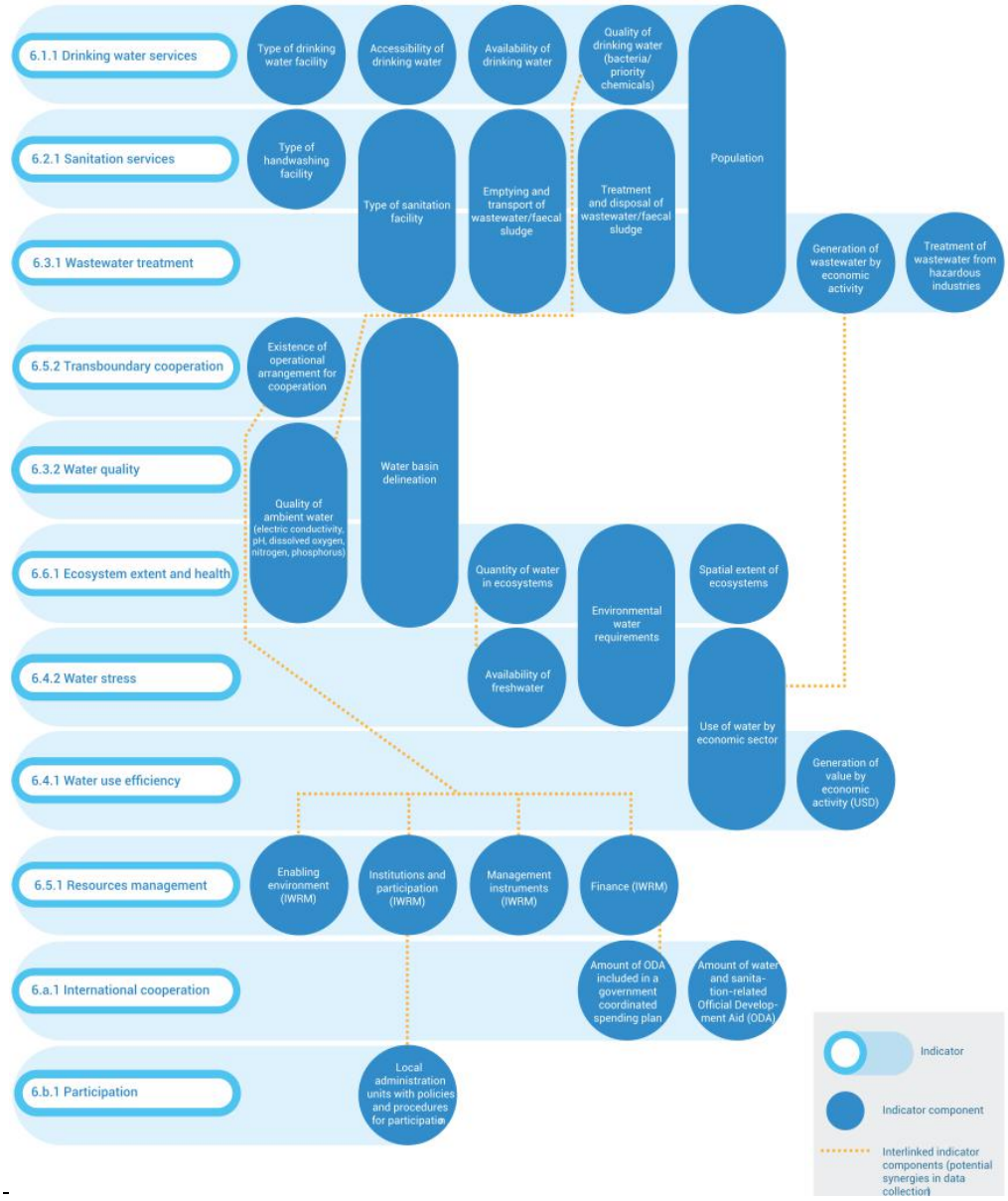
12 Management authority

Association of wadi cherka under direction **Regional commissariat for agricultural development of gabès**
Adresse: Rue Abou Kacem Chebbi – 6019- Gabès
Téléphone: (+216) 75 292 262
Fax: (+216) 75 290 668
Email: crda.gabes@iresa.agrinet.tn

WP3.2.2 Baseline survey - Socio economic analysis and water related data

AGENDA 2030 AND SELECTION OF INDICATORS

The MEDISS Data collection Plan (DCP) adopts United Nations Sustainable Development Goals1 as the theoretical and practical framework during the indicators' selection process2. With respect to water related issues UN-Water (www.unwater.org) supports the Integrated Monitoring Initiative on Sustainable Development Goal 6 on water and sanitation (SDG 6), in collaboration with World Health Organization (WHO)/United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP), the Integrated Monitoring of Water and Sanitation-Related SDG Targets (GEMI) and the UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS). MEDISS partners share with UN-Water the firm belief that in order to maintain sustainable communities water and sanitation are at the very core of any planning activity. Safe drinking water is a prerequisite for human health and communities well-being and consequently for



[1] https://sustainabledevelopment.un.org.

[2] The global indicator framework was adopted by the General Assembly on 6 July 2017 and is contained in the Resolution adopted by the General Assembly on Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313). For an overview of 2030 Agenda indicators, see: https://unstats.un.org/wiki/display/SDGeHandbook/Home?preview=/34505092/38535788/SDGeHandbook-150219.pdf

any use related to economic activities. Moving away from a sectoral approach to water resources management MEDISS partners are aware that only an integrated approach can cope with complexity of water related issues. In order to face such a challenge SDG 6 provides a coherent framework including information on communities, ecosystem resources, water management and wastewater, water-related risks. During the design of the Data collection Plan (DCP) tools and methods coherent with United Nations Sustainable Development Goals[3], including the indicators' selection process[4], have been selected. Sustainable Development Goal 6 aims to "Ensure availability and sustainable management of water and sanitation for all" by adopting sustainable management of water resources, wastewater and ecosystems. The SDG 6 indications introduce some elements that can be used for the calculation of multiple indicators and in some cases are interlinked, as shown in the following image.

The image clearly summarize the existing relationships between ecosystems, communities and water resources that stand at the very foundation of MEDISS project idea [5]. Similarly, the follow-up of 2030 Agenda for Sustainable Development progresses with respect to water related actions can be assured by adopting a set of integrated targets and global indicators. The following table summarize general targets and related indicators as defined according to the 2030 Agenda for Sustainable Development by The UN-Water Integrated Monitoring Initiative for Sustainable Development Goal (SDG) 6[6].

Target 6.1, Drinking Water, "By 2030, achieve universal and equitable access to safe and affordable drinking water for all."

- 6.1.1 Proportion of population using safely managed drinking water services

Target 6.2, Sanitation and hygiene, "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations."

- 6.2.1 "Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water"

Target 6.3, Water quality and wastewater, "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".

- 6.3.1 "Proportion of wastewater safely treated"
- 6.3.2 "Proportion of bodies of water with good ambient water quality"

Target 6.4, Water use and scarcity, "By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity".

- 6.4.1 "Change in water-use efficiency over time"
- 6.4.2 "Level of water stress: freshwater withdrawal as a proportion of available freshwater resources"

Target 6.5, Water resources management, "By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate."

- 6.5.1 "Degree of integrated water resources management implementation (0-100)"
- 6.5.2 "Proportion of transboundary basin area with an operational arrangement for water cooperation"

Target 6.6, Water-related ecosystems, "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes."

[3] https://sustainabledevelopment.un.org.

[4] The global indicator framework was adopted by the General Assembly on 6 July 2017 and is contained in the Resolution adopted by the General Assembly on Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313). For an overview of 2030 Agenda indicators, see: https://unstats.un.org/wiki/display/SDGeHandbook/Home?preview=/34505092/38535788/SDGeHandbook-150219.pdf

[5] Image from: The UN-Water Integrated Monitoring Initiative for Sustainable Development Goal (SDG) 6, 2017, *Integrated Monitoring Guide for Sustainable Development Goal 6 on Water and Sanitation Targets and global indicators*, available at https://www.unwater.org/publication_categories/integrated-monitoring/

[6] https://unstats.un.org/sdgs/indicators/indicators-list/

- 6.6.1 “Change in the extent of water-related ecosystems over time”

Target 6.a International cooperation and capacity-building “By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.”

- 6.a.1 “Amount of water- and sanitation-related official development assistance that is part of a government coordinated spending plan”

Target 6.b, Stakeholder participation, “Support and strengthen the participation of local communities in improving water and sanitation management.”

- 6.b.1 “Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management”

TEST SITE - ARBOREA (ITALY)

The first official act marking the birth of what will later become the most important agricultural district in Sardinia dates back to 1919. In those years a large area in the south of Oristano was granted in emphyteusis by the mayor of Terralba municipality to Giulio Dolcetta, the managing director of Società Bonifiche Sarde company. The new agricultural district was delimited by the S'Ena Arrubia pond to the north, the Sassu pond to the east, the San Giovanni pond to the south and the Gulf of Oristano to the west. The hydraulic reclamation project was undertaken starting from 1925 involving about 9000 ha, 3000 of which concerning the Sassu pond and 6000 ha a large dune field hosting swampy areas on clayey lenses. The reclamation work was largely carried out by hand smoothing of the dune system, building a dense network of canals and planting a 700 ha coastal pine forest and it ended in 1937. In 1926 peasant families from the countryside of Veneto, Tuscany, Romagna and Sicily started the large scale human settlement of the area. In 1928 a city called Mussolinia was founded (it will become Arborea in 1944) counting about 1200 inhabitants a year later. Overall an area of about 4800 ha was parceled into 253 farms from 12 to 4 ha, depending on the soil quality. An area of 500 ha was destined for the cultivation of vineyards (today largely explanted), citrus groves and nurseries. Each parcel was equipped with a farmhouse, a stable, a well, shelters for machines and tools. Due to soils characteristics the area was only suitable for breeding being forage crops made possible by the production of the manure. In the mid-1950s the sharecropping relationship with the owners was replaced by land direct assignment to farmers and following the agrarian reform an efficient cooperative organization.

Today a crucial role is played by the Cooperativa Latte Arborea, accounting for about 280 members, leader in cow's milk collection, processing and marketing of in Sardinia. Another strategic actor is the Cooperativa Servizi, a reference for technical assistance in relation to stable activities, for the supply of soil improvers, plant engineering but also for the administrative and accounting management of a majority of the companies involved in the cooperative initiative. Furthermore, a bank, called Banca di Credito Cooperativo was created together with the other cooperative institutions.

The agricultural district total area was estimated at 6747 ha in 2001, 6600 ha of arable land (4938 ha in Arborea and 1727 ha in Sassu), 62 ha of meadows and 88 ha of pastures. The prevailing production sector is breeding and the related forage cultures (corn, ryegrass, alfalfa) but the horticultural production (strawberries, potatoes, carrots, watermelons, melons and onions) is also significant. Intensive breeding for the production of milk and meat involves about 33000 animals (over a third of the regional bovine stock) in about 270 livestock. For the most part Arborea hosts the Italian Friesian breed with high genealogy, but accounts also for a good presence of the Italian Brown breed. Milk production exceeds 153 million liters per year (with an average of 31 liters per head per day).

Population

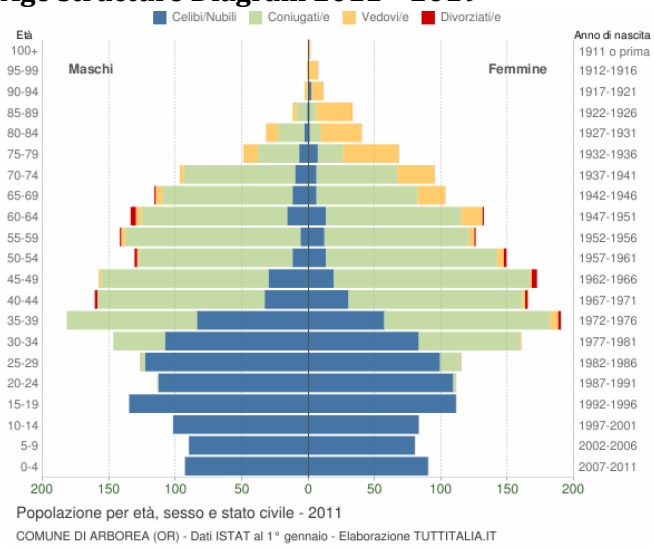
After the foundation of Mussolinia the population of the municipality of Arborea grew and it showed a notable decrease (-28.8%) in the 1951-1971 years. Starting from that date the economic growth leaded to a 10%, increase in the population, a trend that continued until 2011. A challenging population indicator is the progressive aging of the inhabitants for the forecasted impacts on the generational turnover of farmers.

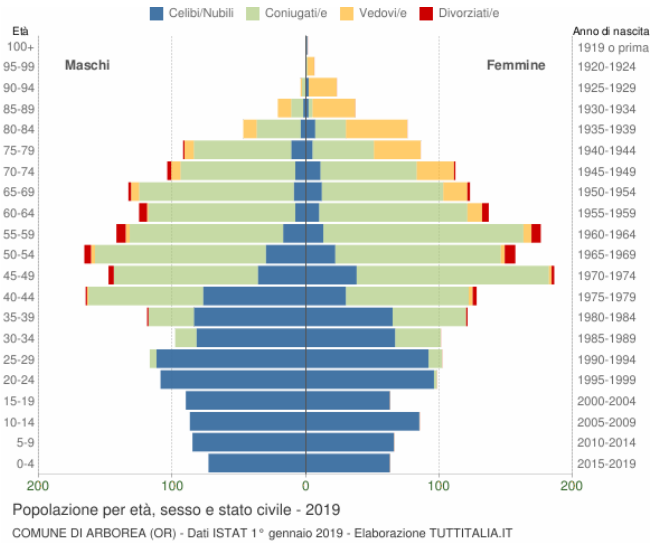
Population structure (Provides information on number, sex, age, urban/rural ratio)

Year	Resident population on 1st January	Growt rate (intercensuses) (%)	Growt rate (intercensuses) Population younger than 15 years	Rural vs urban ratio	Sex ratio (Males to Females)	Ageing index
2018	3.872	-4.3%	-14.7%	46.4	98.8	162.28
2011	4.048	3%	-1,9	53,2	99,2	130,1
2001	3.927	4,1%	-2,2	52,1	97,9	69,9
1991	3.785	11,2%		53,4	98,9	43,7

Source: ISTAT

Age structure Diagram 2011 – 2019





Source: ISTAT

The age structure diagram shows a combination of several ongoing processes: rising of life expectancy, lower fertility rate and ending of baby-boom generation. Those trends imply a rapid increase in the older dependency ratio.

Population education (Measures by gender and ethnic group the percentage of regular education, elementary school, high school, and university education)

	Gender gap in secondary education	Lifelong learning & training adults	Degree holders to adult with middle school education	Illiteracy rate	School dropout rate	Tertiary education attainment 25 to 64 years old having completed tertiary education	Tertiary education attainment 25 to 34 years old having completed tertiary education	Youth education attainment level 15 to 19 years old	Adult with middle school education
2018									
2011	88,4	4,2	89,6	0,4	33,5	39,5	11,4	97,7	44,1
2001	93,2	5,3	68,5	0,6	30,4	28,3	7,2	96,3	41,4
1991	106,7	2,0	54,2	1,1	41,7	17,7	5,6	90,5	32,8

Source: ISTAT

Population with Access to Improved Drinking Water monitors progress in the reasonable accessibility of populations to water derived from an improved drinking water source (e.g. piped water in a dwelling, plot or yard). It is considered a good universal indicator of human development due to its association with socioeconomic characteristics, such as education and income.
In Arborea district 100% of the population can access from an improved drinking water source
Population Served by Wastewater Collection measures the proportion of people served by wastewater collection systems to identify communities where collection is lacking and where action is required to protect ecosystem and human health.
In Arborea district 98% of population is served by wastewater collection systems
Wastewater Treatment measures proportion of municipal wastewater treated, against total volume of wastewater generated. Increased treatment of wastewater addresses both water quality and quantity concerns by reducing potential sources of water pollution, and by increasing share of water for productive use.
Two sewage treatment plants operate in the territory of the municipality of Arborea. The first one treats wastewater from the 3A milk transformation industry and waters are drained into the S'Ena Arrubia pond. The second is the ex Sipas plant in Arborea currently collecting waste waters from the city center, from the municipal

slaughterhouse as well as a part of animal breeding liquid wastes. Waters are drained into the left channel Tirso (also called Canale Acque Medie or Canale Tirso-Arborea), currently managed by ENAS. The canal empties collected into the environmental sensitive area of S'Ena Arrubia pond.

Liquid waste Daily liquid waste production/person

Irrigation period volume	April – September	153.000 m3
Winter volume	October – March	163.000 m3
Total Volume	All year	316.000 m3
Forecasted Production	April – September	690.000 m3
Forecasted Production	October – March	410.000 m3

Source: ADIS

In 2011 the sewage treatment scheme collected used waters from about 4ooo inhabitants. In the last decade the sewage networks of the marina and of the houses scattered in Arborea as well of the Tanca Marchesa and Marceddì villages in the municipality of Terralba were added. This leaded to an increase in the number of equivalent inhabitants and in the volumes treated, while no increase is expected in the quantity of treated rainwater.

Volumes treated monthly by the *ex-Sipas* treatment system in Arborea.

Month	**2009, m3/month**	**2010, m3/month**	**2011, m3/month**	**2012, m3/month**
January	29.540	25.639	25.368	29.090
February	28.839	24.775	24.776	25.110
March	24.314	23.827	23.828	25.980
April	25.116	29.076	29.075	25.770
May	24.563	28.183	24.099	32.230
June	18.222	24.099	28.183	24.900
July	22.187	24.304	24.304	24.240
August	17.282	22.440	22.440	24.510
September	20.160	23.357	23.357	25.810
October	21.653	22.479	22.479	25.912
November	20.778	32.987	33.587	26.550
December	21.518	33.704	33.704	28.320
Total	274.172	314.600	315.200	318.422

Source: ADIS

Population Using Safely Managed Sanitation Services monitors progress in the reasonable accessibility of populations to basic sanitation facilities at the household level, which are not shared with other households and where excreta is safely disposed in situ or treated off-site. This is a core socioeconomic and health indicator that is a key determinant of child and maternal health.

Houses equipped with toilets.

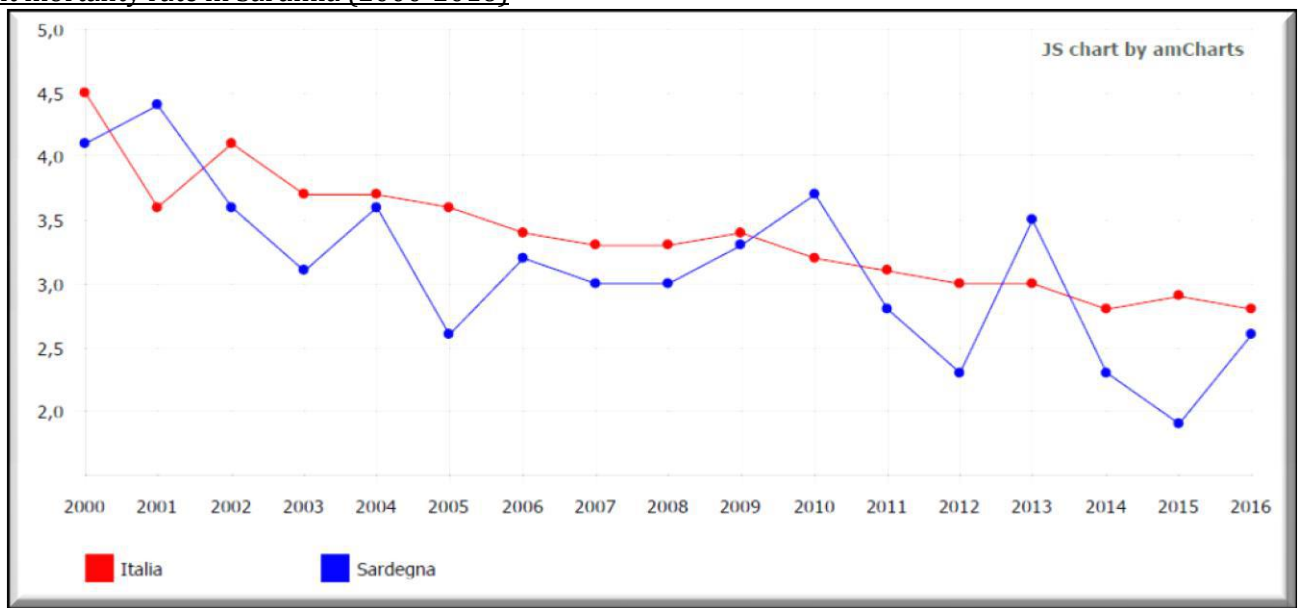
2011	98,8%
2001	99,1%
1991	94,7%

Source: Istat

Under-five Mortality Rate is a good indication of child health and overall development in country/specific area, and is one of the most widely used indicators of health and development. This indicator measures the probability of dying before the age of 5 of a baby born in a specific year or period.

Infant mortality in Sardinia is below the national average, accounting for 2.6 deaths per 1000 live births in 2016 (2.8 deaths per 1000 live births in the rest of Italy), among the lowest levels in Europe (SisREG 2020 DATA).

Infant mortality rate in Sardinia (2000-2016)



Population Growth Rate measures how the size of human populations changes over time. Population trends contribute significantly to shape water requirements, and population growth is a direct determinant of increased water demand and resource use.

Year	Resident population	Growth rate (intercensuses) (%)	Growth rate (intercensuses) Pop. younger than 15 years
2018	3.872	-4.3%	-14.7%
2011	4048	3%	-1,9
2001	3927	4,1%	-2,2
1991	3785	11,2%	

Water consumption gives an indication of water sold and used by the population but also an indication of the access to potable water (litres/person/day).
In the water district of Sardinia including the whole island the volume of the resource introduced into the water distribution networks oscillates around 275 Mm^3 / year, net of adduction and distribution losses. This value corresponds to 454 l /day per inhabitant. For the year 2015, ISTAT reports a loss of 55.6% of the drinking water introduced into the distribution networks.

Non-revenue water accounts for water which enters the distribution system but does not give any revenue, is produced and lost. It can include also unbilled authorized consumption, leakage, theft, and legal uses for which no payment is made.
A the regional scale urban waste waters are free of charge for the reclamation consortia or municipalities also using irrigation resources indirectly through the withdrawal from the wastewater receiving bodies. Regional regulations allow the use of wastewaters after tertiary treatment and the free provision of primary resources to reclamation consortia for an amount of 50% of the wastewaters volume used.

The unit operational cost measures resources used to achieve the productivity required expressed by annual volumes of water sold (€ /m3 sold/year)
The standard rate for water in Sardinia and also in Arborea district is 0.056 €/m^3.

Unit total costs measures total costs (running & capital) per cubic meter of authorized consumption (€/m3)

Unitary contributions for the different uses, 2018	
Raw water for industrial use	0.230 € / mc
Raw water for industrial use exceeding the assigned annual volume	0.300 € / mc
Raw water for civil use up to an annual consumption of 205 Mm3	0.035 € / mc
Raw water for civil use for annual volumes exceeding 205 Mm3	0.069 € / mc
Raw water for irrigation up to the annual consumption equal to the basic volume	0.006 € / mc
Raw water for irrigation for annual consumption between the basic volume and the assigned volume	0.015 € / mc
Raw water for irrigation for annual consumption exceeding the assigned volume	0.025 € / mc
Raw water directly distributed to the end user. Increase compared to the basic sector value	0.030 € / mc

Unit running costs measures running costs per cubic meter of authorized consumption (€/m3)

Water cost per crop and different sources

Crop	High pressure Arborea (cost/ha)	High pressure other areas (cost/ha)	Low pressure other areas (cost/ha)	Channel other areas (cost/ha)
Rice		313	246,83	150,14
Corn, Alfalfa	286,69	245,95	185,72	112,79
Vegetable Crops	247,23	214,13	162,81	98,79
Fruits, Artichokes	207,76	182,3	139,89	84,78
Ryegrass	92,09			

Number and type of wells installed measures the proportion of population with sustained availability of clean water for proper domestic use and pressure on water resources
Currently water supply sources are separate according to the use of the water:

Domestic uses	Drinking water network
Agricultural irrigation	Reclamation Consortium network
Breeding and industrial use (washing stables and milking machines) and drought agricultural irrigation	Perforations from deep layers (second aquifer between 12 and 32 meters)
Gardens and secondary uses often limited to the summer period	From the first water table, between 5 and 6 meters.

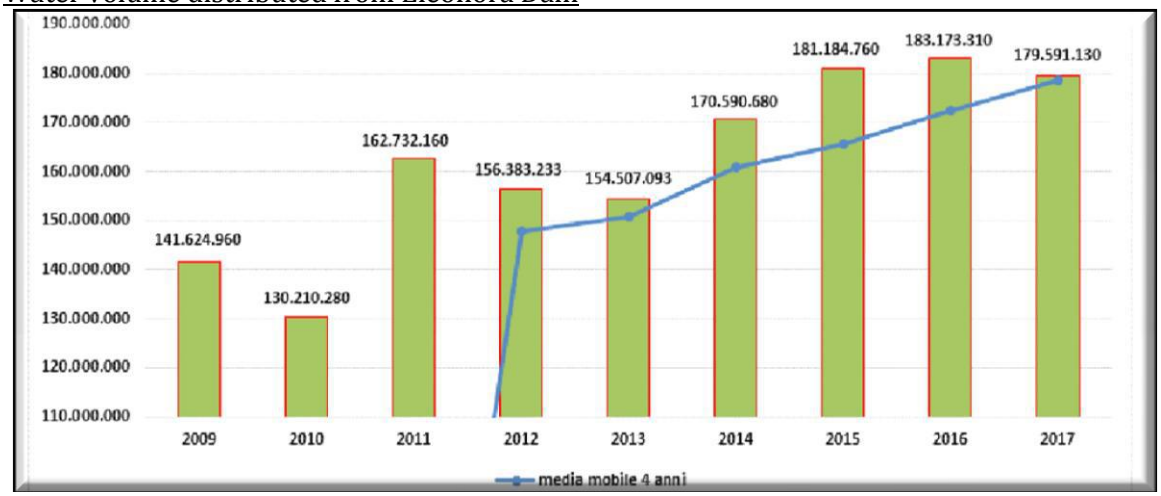
Withdrawals from the first water table tend to decrease gradually over time due to pollution, greater water requirements and limited production capacities of the wells. The last data available reports 84 wells registered in the first aquifer and about 50% of these are inactive or scarcely used. Consequently, it can be reasonably assumed that the total withdrawals from the first aquifer amount to a few hundred thousands of m3/year. Nevertheless, excessive and uncontrolled draining from the second water table has caused seawaters intrusion and the consequent salinisation of the aquifer particularly close to the sea and the ponds.
Wells are mainly used for breeding purposes throughout the year for several hours a day, with withdrawals varying between 1 and 10 l/s. Considering that 281 wells almost all active have been registered deep ground withdrawals can be quantified in 3 million m3/year, reaching 4-5 millions m3/year in drought years when wells are used to irrigate the fields in addition to water supplied by the Reclamation Consortium.

Water withdrawals per sector and per source (surface or groundwater)

Water volume from regional SIMR for civil, industrial and agriculture uses (2008-2018).

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total Volume Mm2	594,04	596,99	575,74	650,32	678,13	643,12	693,96	686,02	686,38	707,88	538,37
Civil uses Mm2	232.71	229.57	220.1	224.43	230.14	227.87	229.42	219.86	215.99	216.4	204.4
Agriculture Mm2	330.13	340.18	329.42	401.18	425.3	391.62	441.92	442.21	448.77	471	313.02
Industrial uses Mm2	31.2	27.24	26.22	24.71	22.69	23.63	22.62	21.95	21.62	20.48	20.95
Authorized Volume/supplied volume Mm2	0.31	0.31	0.30	0.34	0.36	0,36	0.39	0.38	0.39	0.40	0.31

Water volume distributed from Eleonora Dam



Average water volumes for agriculture uses in Arborea district

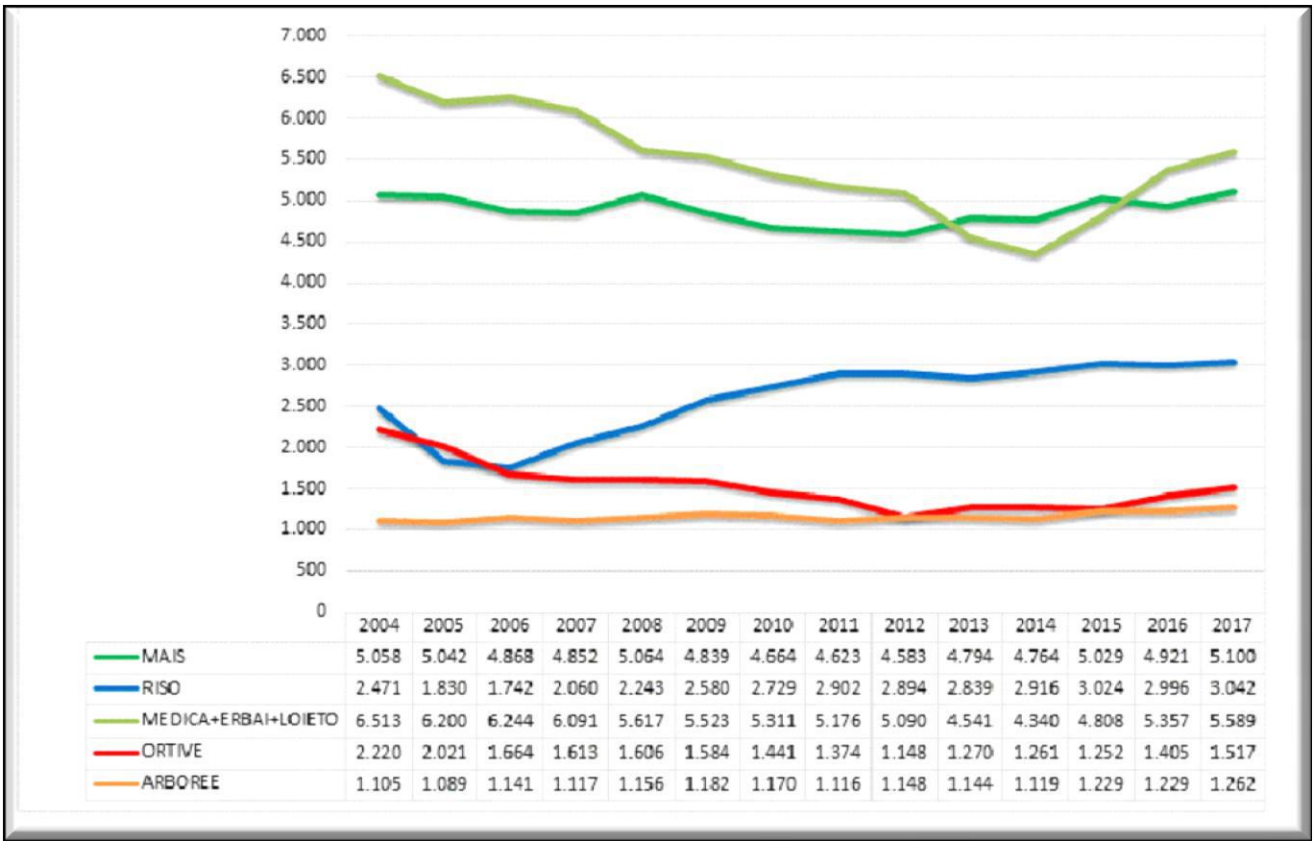
	J	F	M	A	M	J	J	A	S	O	N	D	Tot
Average water volumes (Mm3)	0.0	0.1	0.8	2.2	3.0	4.5	6.4	5.3	1.9	0.7	0.2	0.0	25.1

Source: ADIS

Agriculture Withdrawals **measures total water withdrawals used for agricultural purposes, including irrigation and livestock watering, as share of total withdrawals. It gives an indication the importance of agriculture in the country's/basin\'s water balance.**

Withdrawals	Surface of the water bodies involved (Km2)	% of the surface of the district groundwater bodies under pressure by typology of use
Agriculture	235	51%
Drinking water	175	38%
Industrial	164	36%
Hydroelectricity	41	9%
other uses	298	65%
Total	456	100%

Irrigated surfaces according to crop at the regional level (Mais: corn; Riso: rice; Medica: alfalfa; Loieto: ryegrass; Ortive: vegetable crops; Arboree: arboreal)



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MAIS	5.058	5.042	4.868	4.852	5.064	4.839	4.664	4.623	4.583	4.794	4.764	5.029	4.921	5.100
RISO	2.471	1.830	1.742	2.060	2.243	2.580	2.729	2.902	2.894	2.839	2.916	3.024	2.996	3.042
MEDICA+ERBAI+LOIETO	6.513	6.200	6.244	6.091	5.617	5.523	5.311	5.176	5.090	4.541	4.340	4.808	5.357	5.589
ORTIVE	2.220	2.021	1.664	1.613	1.606	1.584	1.441	1.374	1.148	1.270	1.261	1.252	1.405	1.517
ARBOREE	1.105	1.089	1.141	1.117	1.156	1.182	1.170	1.116	1.148	1.144	1.119	1.229	1.229	1.262

Area Irrigated by Groundwater calculates the share of total irrigated land which is irrigated by groundwater, which gives an indication of the dependence on groundwater for the irrigation of agricultural land
Deep ground withdrawals in Arborea district can be quantified in 3 million m3/year, reaching 4-5 millions m3/year in drought years when wells are used to irrigate the fields in addition to water supplied by the Reclamation Consortium. This value can fluctuate between 10 and 15% of total irrigation consumption.
Total Irrigated Area measures total irrigated area to provide information on irrigation water requirements and associated pressures on water resources.

Municipality, 2010	Not irrigated surface	Irrigated surface	Total irrigated surface
Arborea	1.835	5.897	7.732

Municipality, 2010	Units with irrigated surface	Total irrigated surface volume
Arborea	267	22.172.080

Cultivated land and irrigation proportion of irrigated land over the total cultivated land (meaning the sum of arable land and permanent crops).
In the territory of Arborea surfaces used for production purposes are all irrigated

	Employment rate in the agricultural sector %
2018	40.2
2011	42,3
2001	49,2
1991	50,0

Employment by Sector accounts for the percentage of population in employment, aggregated by sector (or subsectors of economic activity).

	Employment rate in the agricultural sector	Employment rate in the industrial sector	Employment rate in the non-commercial tertiary sector	Employment rate in the commercial tertiary sector	Employment rate in medium and highly specialized professions	Employment rate in craftsmen, workers or farmers sectors	Employment rate in not specialized professions
2018	40.2						
2011	42,3	11,9	28,4	17,4	22,0	36,0	16,5
2001	49,2	14,0	23,2	13,6	22,3	33,5	28,1
1991	50,0	14,7	23,6	11,7	15,6	61,6	7,3

Industrial Water Use measures industrial water use to provide a baseline for understanding trends in consumptive uses relating to the industrial sector, implications for competing water demands, and increasing pressures on water resources.

Water volume from regional SIMR for industrial uses (period 2008-2018)

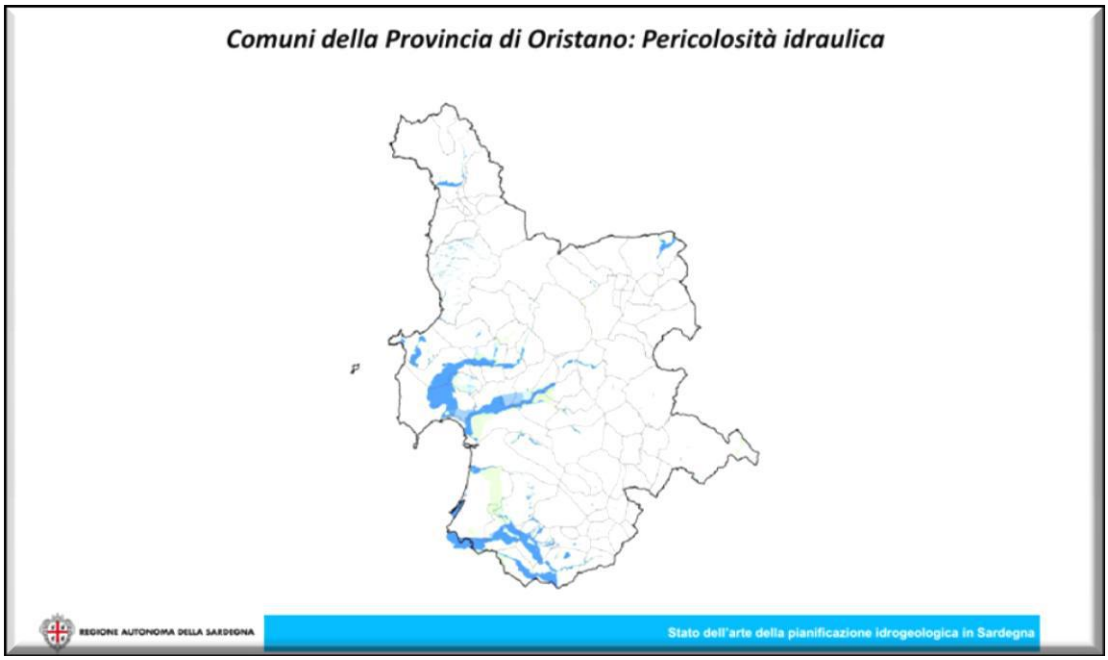
Mm3	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Volume	31.2	27.24	26.22	24.71	22.69	23.63	22.62	21.95	21.62	20.48	20.95

Source: ADIS

Municipalities with Comprehensive Risk Assessments determines whether or not districts/municipalities have taken steps to evaluate hazards and vulnerability, and if they have used these assessments to formulate appropriate response plans.

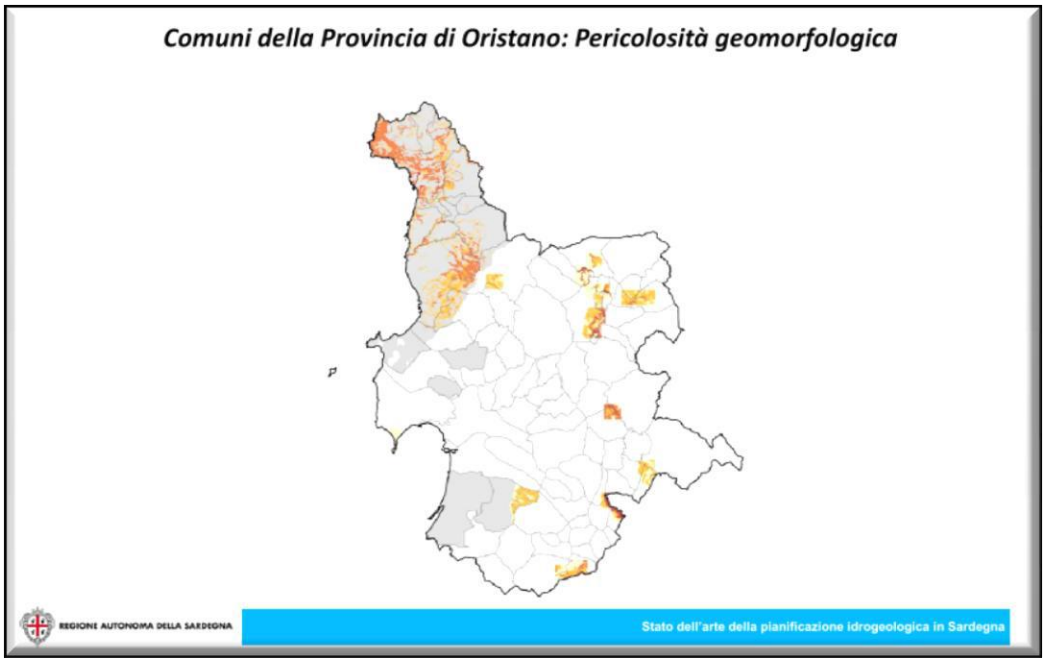
Flood hazard classified areas in Arborea district

Arborea	Surface Classified Hi1 (Km2)	Surface Classified Hi2 (Km2)	Surface Classified Hi3 (Km2)	Surface Classified Hi4 (Km2)	Total	% over municipality total
Surface Classified	22,81	0,02	0,02	8,43	31,28	33,46
Residents in flood hazard areas	124	0	0	39		163

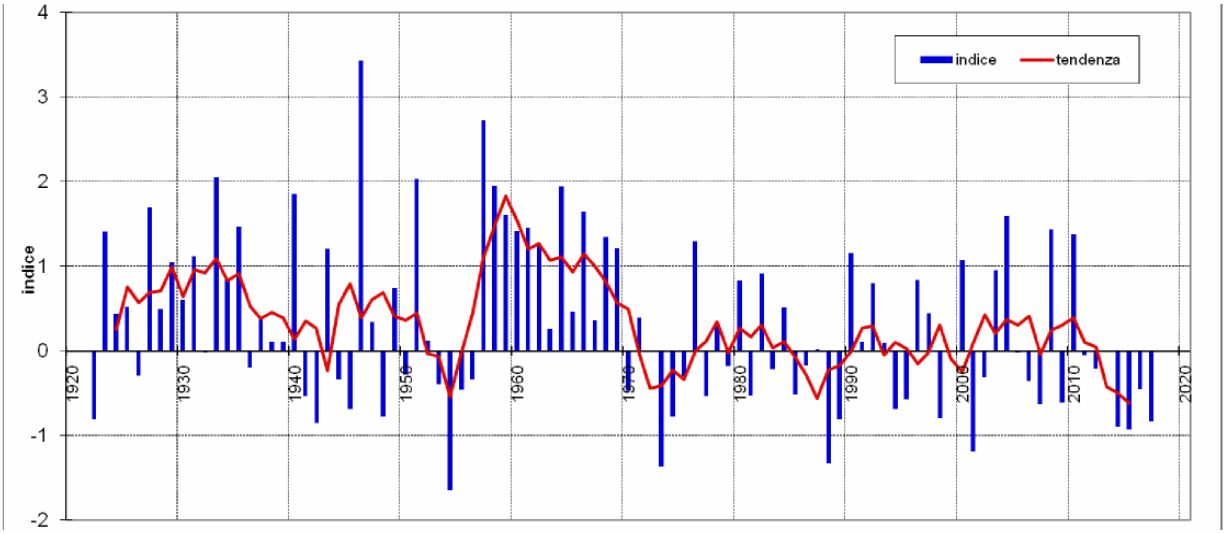


Landslide hazard classified areas in Arborea district

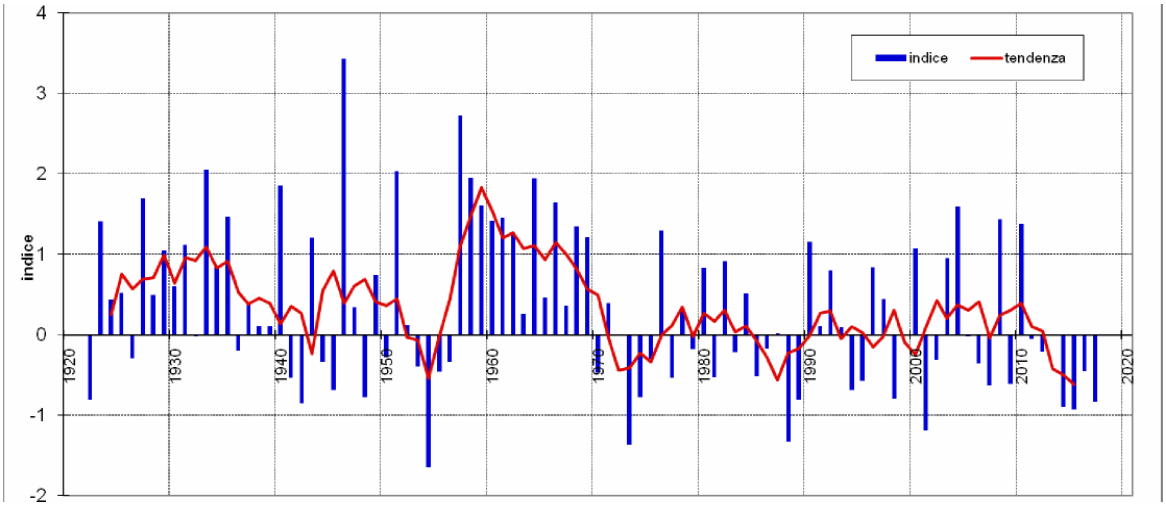
Arborea	Surface Classified Hg0 (km2)	Surface Classified Hg1 (km2)	Surface Classified Hg2 (km2)	Surface Classified Hg3 (km2)	Surface Classified Hg4 (km2)	Total Surface Classified (km2)	% on municipality surface
Landslide hazard (km2)	93,47	0	0	0	0	93,47	100,0
Residents in landslide hazard area	4091	0	0	0	0		4091



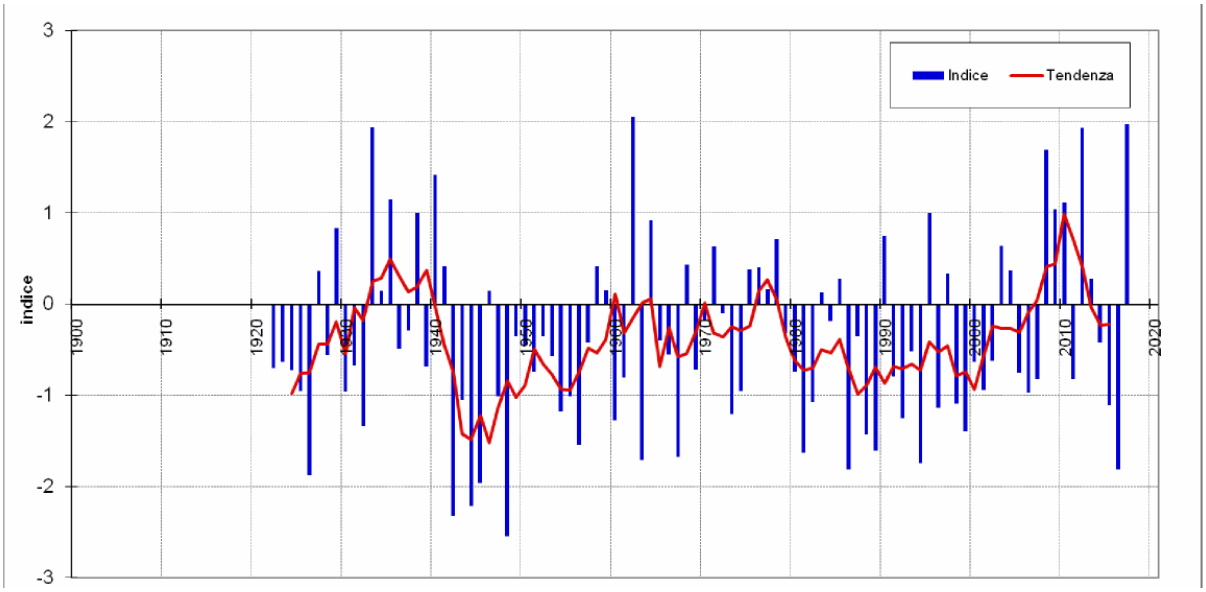
Exposure to climate related hazards can be measured by Precipitation and Temperature interannual variability



Total rainfall volume in Sardinia (October - December) from 1920 to 2020



Total rainfall volume in Sardinia (October - September) from 1870 to 2020



Number of rainy days in Sardinia (October - September) from 1920 to 2020

)	J	F	M	A	M	J	J	A	S	O	N	D	Tot
Average Rainfall (mm)	79,8	70,0	60,8	55,3	35,1	14.1	2.7	6.7	44.2	87.5	101.1	102.3	659.6
Average Temperature (°C)	10.7	11.1	12.7	15.0	18.4	22.7	26.2	26.1	23.5	19.3	15.1	12.1	17.7
Average watering (mm)	0.0	1.8	14.6	40.0	54.6	81.1	116.4	96.4	34.5	12.7	3.6	0.0	456.4
Average watering (Mmc)	0.0	0.1	0.8	2.2	3.0	4.5	6.4	5.3	1.9	0.7	0.2	0.0	25.1
Average Rainfall + watering (mm)	79.8	71.8	75.4	95.3	89.7	95.9	119.1	103.1	78.7	100.2	104.6	102.3	1115.9
Average Evapotranspiration (mm)	20.8	22.0	35.1	51.6	84.5	126.0	167.4	106.9	78.7	71.5	39.1	25.2	828.7
Water infiltration + run off (mm)	59.5	49.8	40.3	43.7	5.2	-30.1	-48.3	-3.8	0.0	28.7	65.5	77.1	287.2

Hydrological balance of the Arborea district (55kmq

Climate change Storage capacity surface water/surface water resources and % of storage/cap (m3/cap)
The SIMR (Regional Multisector Water System) is particularly complex and consists of the following infrastructures:
- 31 dams for a total authorized volume of approximately 1400 Mm3 ready to use;
- 23 river traverses;
- 850 km of aqueducts and pipelines of different materials and diameters;
- 200 km of main water transport canals;
- 50 pumping plants, for a total of 70 MW of installed power;
- 5 hydroelectric plants, for a total of 48 MW of installed power.

Climate change Internal groundwater/IRWR, Internal renewable water resources as that part of the water resources (surface water and groundwater) generated from endogenous precipitation (%).
Sardinia Region shows a peculiar trend with respect to the incidence of surface supply resources that is much higher than in the rest of Italy. In fact, at the regional level the withdrawal from artificial basins clearly prevails (78.2%) while on the national territory withdrawals from wells (48%) and from springs (36.3%) are the main resources.

Tourism Direct GDP measures tourism's direct economic contribution to the national economy as a share of gross domestic product (GDP). Tourism is a quickly growing industry that constitutes an important source of revenue, investment and employment in many developing regions.

In Sardinia tourism related activities are extimated to contribute for around 7 % of regional GDP.

	Authorized agrotourism 2017	Authorized agrotourism with beds 2017	Authorized agrotourism with restaurant 2017
Arborea	2	1	2

	Hotels, b&b and camping	Hotels, b&b and camping	Hotels, b&b and camping 2014

	2016	2015	
Arborea	20	20	19

Arborea, Number of overnight stays in tourist accommodation

	Arrivals 2018	Nights 2018
Arborea	30.197	131.205

Arborea, ratio of overnight stays per number of residents
In Arborea the ratio between tourists overnight stays (131.205) and residents (3.872) is 39 over 1 in 2018.

Water consumption per sector (industry, tourism related activities, primary, etc)/ total consumption
The area served by the Reclamation Consortium in the Terralba - Arborea area is about 120 km2 and the study area in question is about 55 km2, just under half of the entire area. Being the area almost totally cultivated it can be reasonably assumed that 50% of the water supplied in the area by the Reclamation Consortium is destined to the irrigation needs.

Arborea	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Tot**
Average rain water (in mm)	79,8	70,0	60,8	55,3	35,1	14,1	2,7	6,7	44,2	87,5	101,0	102,3	659,5
Average irrigued (in mm)	0,0	1,8	14,6	40,0	54,6	81,8	116,4	96,4	34,5	12,7	3,6	0,0	456,4
R + Irr average (in mm)	79,8	71,8	75,4	95,3	89,7	95,9	119,1	103,1	78,7	100,2	104,6	102,3	1115,9

Women participation and role (if available) rural women face greater constraints than men in accessing land, technology, markets, infrastructure and services. Equal access to productive resources, services and economic opportunities is a precondition to increase agricultural output and to immediate and long term social and economic gains.

	2011	2001	1991
Participation in the labor market M	69,0	73,7	77,9
Participation in the labor market W	42,0	41,2	31,5
Participation in the labor market	55,3	57,0	54,5
Unemployment rate M	8,1	6,2	8,4
Unemployment rate W	15,3	19,3	27,2
Unemployment rate	10,9	11,0	13,9
Employment rate M	63,4	69,1	71,3
Employment rate W	35,6	33,2	22,9
Employment rate	49,3	50,7	46,9

TEST SITE - Al RISHA (JORDAN)

The Jordanian partner Aqaba Water Company selected a remote area surrounding Al Risha village (map at https://goo.gl/maps/U6QP8ABcqABCww2e7) as a pilot site in the framework of the MEDISS project. The main aim of the action is to improve access to water resources for irrigation and domestic use by local inhabitants (Fig.13,14).

According to Jordanian administrative boundaries, the site is part of the Aqaba Governorate and the Wadi Araba district.

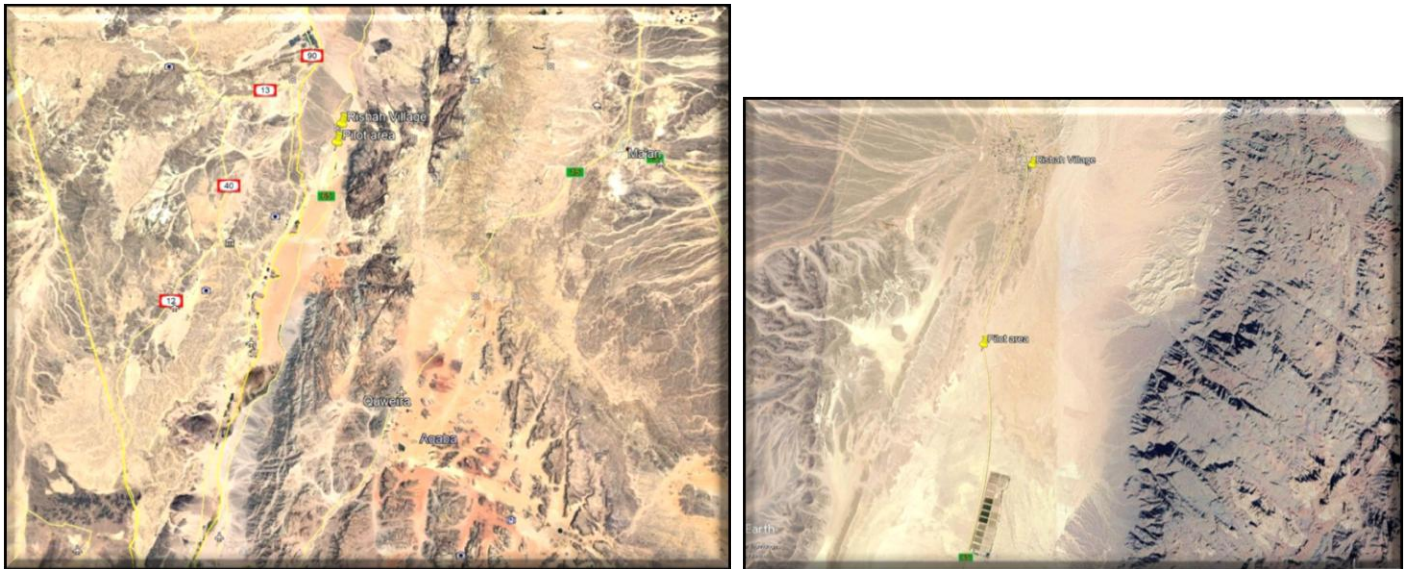


Fig. 13 – Mediss project, pilot area in Jordan

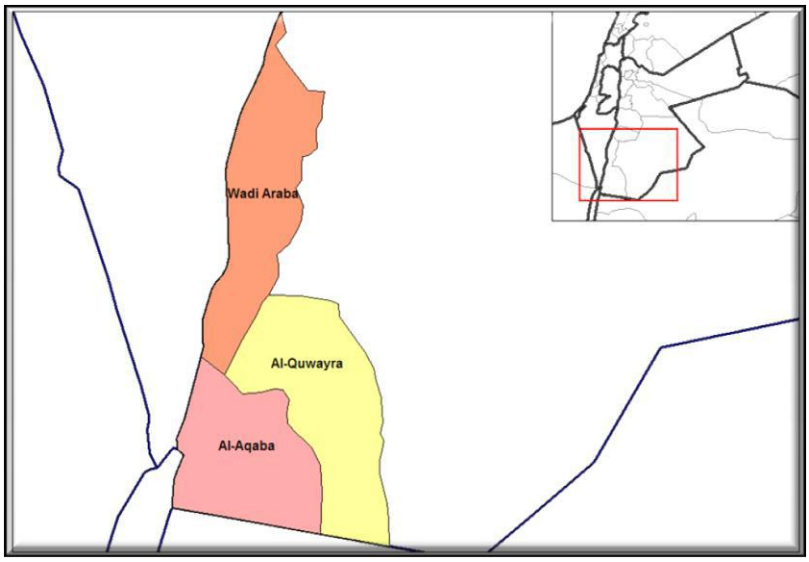


Fig. 14 – Aqaba Governatorate, districts.

The Wadi Araba district covers around 2.5% of Jordan's national territory. It's an underpopulated area with a population of around 6,700, residents mainly in eight centers (Al-Karikara, Al Risha, Rahma, Bir Mathkur, New Feinan, Abu Hashiba, Al-Qatar and Old Feinan) (Fig.15). Apart from residential areas, nomadic population movements on a yearly base are observables, directed to water sources sites. Bedouin tribal culture elements are still part of local communities. Nomadic culture has been relevant until recent times, being traditional economy based on a few date orchard cultivation.

Seasonal mobility from all district areas was also common in the fruit-picking season. In parallel, livestock rising was largely practiced as the main source of revenue in rural communities. The replacement of camels with goats and sheep was motivated by the evaluation of commercial benefits and permanent settlement conditions. On the other hand, goats and sheep need stable sources of water and pasture and in arid environments are more exposed to risks of extreme droughts. Bedouin transition from pastoralism to sedentarization is advanced, even if the economic conditions of local communities are still difficult. Dependence on State help is very common in the passage from nomadic livestock rising to wage labor and sedentary economic activities. It has been estimated that nearly twenty percent of all families are helped by the National Assistance Fund. As a consequence of poor formal education' the access of Bedouin communities to the labor market was and partially still is very difficult.

The army is perceived as a promising working opportunity between local communities while even traditionally part of rural schools have been run by military personnel. The gap between socio-economic conditions of the sedentarised communities in inland areas and the urban population is remarkable and is increasing.

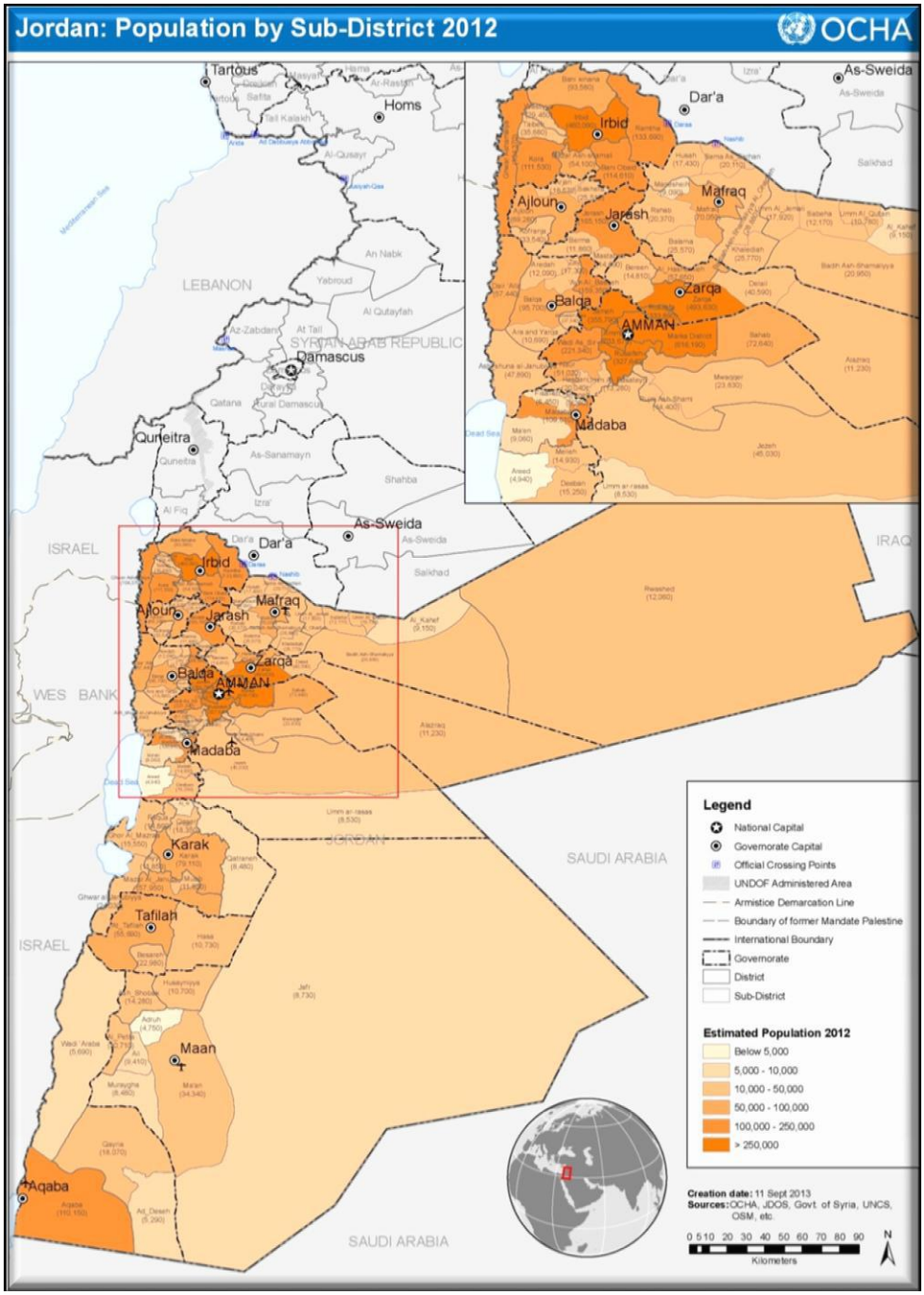


Fig. 15 – Jordan population, sub-districts, 2012, United Nations Office for the Coordination of Humanitarian Affairs

Economic and social conditions

Economic and social indicators place the Wadi Araba district between the poorest areas in Jordan. In 2010 in Jordan 22 of the 27 poor sub-districts had poverty rates higher than 25 percent. Wadi Araba showed the highest poverty rate with 71.5% of the population living in extreme poverty in 2015 (69.3% in 2008, a poor population of 4,492 over 6,481 inhabitants[7]) (Table 1-7).

[7] Department of Statistics, www.dos.gov.jo/dos_home_a/main/Analasis_Reports/poverty_rep/Jordan_%20Poverty_%20Jordan_eng_2008

Poverty rate, Wadi Araba district	
2002	53.5 %
2006	62.5 %
2008	69.3 %
2015	71.5 %

Table 1. – Population Poverty rate, Wadi Araba district, Department of Statistics.

The productive system is underdeveloped as like irrigation network, mainly for extreme drought and weather conditions agricultural units in the district show little productive capacity. The vulnerability of the district's socio-economic conditions was observable during the post-2008 global financial crisis. A study [8] revealed a general increase in food, energy, and transportation expenditures in more than 80% of households in Jordan. In Wadi Araba were reported between the highest transportation expenditure increase. The same study revealed a majority of households involved in loans, debts, and other types of borrowings in the same period, and around 30% of the family units reported that they had to borrow money to cover food needs.

Households living in rural sites reported problems related to lack of liquidity or feed prices growth for agricultural and livestock raising activities. Food price increase affected the food consumption patterns of households in nearly 45 % of families. Wadi Araba was between the most affected areas. Reduction of the overall quantity of food, especially meat and fruit consumption affected several poverty pockets in the countries, and in Wadi Araba food insecurity rates were higher than the average, with more than 8% of the families reported being food insecure. Some years later a second study[9], confirmed the vulnerability of the area. A majority of households in Wadi Araba were reported to adopt some mechanisms for coping with food insecurity meaning "arrangements to which households resort when they do not have enough food or money to buy food" in the biennium 2013-2014.

Furthermore, between national poverty pockets affected by food insecurity, Wadi Araba showed in years 2013-2014 the size of family units considerably above the average. In the district, 8.2 components are the standard value well above 6.6 individuals reported in other national poverty pockets and 5.4 elements of the average Jordanian family. Wadi Araba also shows one of the highest percentages of female-headed households nationally, above the averaged 11% reported in the study.

Table 2. - Percentages of food insecure households, households that are vulnerable to food insecurity, households using coping mechanisms, and households receiving food assistance, by Subdistrict, Jordan, 2013. Department of Statistics and World Food Program.

Governorate	Subdistrict	Food insecure	Vulnerable to food insecurity	Used coping mechanism	Received food assistance
Aqaba	Qasabah	0.0	1.7	9.9	1.0
	Wadi Araba	0.0	1.0	51.7	28.7
	Quweirah	0.0	5.3	34.2	11.0
	Al-Disi	0.0	4.5	25.1	16.5
	Jordan	*0.5*	*5.7*	*33.5*	*9.6*

The role of education as a critical issue for families' access to food and more generally for the improvement of living conditions is well known. Jordan in the biennium 2013-2014 showed a national average of literacy over 90%, but between national poverty pockets illiteracy rate among the heads of households was 24.5%, with an average age of the heads of households surveyed a sample of 46 years. Wadi Araba showed between the highest illiteracy rates among heads of households examined.

Not surprisingly the average monthly income in the Wadi Araba district was between the lowest in biennium 2013-2014. It has been estimated that in twenty poverty pockets the average per capita income per annum was

[8] WFP and JAAH, *Jordan: Food security survey in the poverty pockets*, 2008

[9] Department of Statistics and World Food Program, *The State of Food Security in Jordan (2013–2014), Analytical Report*, 2016.

531 JOD, below the national poverty line of 556 JOD. Based on the average family size of each poverty pocket the following data were elaborated. Wadi Araba was rated the last between the twenty poverty pockets for all the selected indicators (Monthly income per family; Monthly Income per capita; Per capita income per annum; Percentage of Households below the Poverty line of 556JD). Even if it is worth mentioning that the survey was based on limited data and result should be analyzed with care the gap between Wadi Araba and the other poorest regions in Jordan it appears clearly described.

Table 3. - Average Monthly income per household (JOD), 2013-2014. Department of Statistics and World Food Program.

	Monthly income per family	Monthly Income per capita	Per capita income per annum	Percentage of Households below the Poverty line of 556 JOD
Wadi Araba	177	22	261	87.5
Total average	291	44	531	58.8

If compared with the 2008 research *Jordan: Food security survey in the poverty pockets*, 2013-2014 date confirm the perception of a gap between monthly income and expenditure in Wadi Araba families (eventually leading to households indebtedness). On a yearly base increase of households expenditures were reported especially for food, energy and transportation, being the last the most critical sector for Wadi Araba families.
Similarly, data from biennium 2013-2014 showed a constant increase in food prices, as reported in the 2008 analysis. Food consumption patterns were radically affected for around 70 % of the families in poverty pockets analysed. Wadi Araba was again between the most affected areas in terms of quantity of food, especially meat and fruits, consumption. Poor[10] and Borderline food consumption rates in Wadi Araba were reported to be nearly three times higher than average values observed in the other poverty pockets areas.

Table 4. - Geographic Distribution of food Consumption Profiles. 2013. Department of Statistics and World Food Program.

Poverty Pocket	Poor Consumption	Borderline Consumption	Adequate Consumption
Wadi Araba	12.5%	27.5%	60.0%
Total Average	3.7%	8.4%	87.9%

Food insecurity mixed with poverty rates determine an extremely dangerous condition of vulnerability toward adverse events such as exceptional drought or a rise in food prices. By combining the two indicators it emerges that Wadi Araba's exposure to food insecurity is serious. The authors call for "direct intervention in terms of food and non-food assistance, in addition to long term support and capacity building."
Aiming to define food insecurity levels, three ecological zones have been identified in Jordan according to the average annual rainfall[11]. The annual average rainfall in Wadi Araba in biennium 2013-2014 was estimated in 75 mm. Poverty pockets areas with similar precipitation rates are mainly focusing on agricultural and livestock raising activities for domestic consumption. Even if some form of irrigation exists, at least 40 % of crop production is generally allocated to family needs. Water scarcity, high production costs, and reduced property extension limit an increase in market-oriented production. In Wadi Araba livestock raising activities are relevant but domestic consumption is the primary utilization of products. Most reported factors hindering plant production and animal production activities in the area are respectively the presence of pests, prices of feed for livestock, and lack of liquidity.
Rising poverty and unemployment levels are to be recorded in Wadi Araba. Despite the presence of a few relevant economic actors such as the Wadi Araba Development Company operating in the water sector, impacts

[10] Defined as: "Household diet is mainly based on cereals (bread mostly). Limited consumption of pulses, vegetables, dairy products, meat, oils and sugars (mostly 0-1 days per week). Consumption of fruits is very limited (0 days per week in most of the cases)."

[11] Zone 1: Below 100 mm annual rainfall; Zone 2: 100-200 mm annual rainfall; Zone 3: Over 200 mm annual rainfall

on local development are still reduced. A general lack of infrastructure affects residents' life and infrastructures investment' frequently emerges as one of the critical issues at the local scale. Roads connecting the district with other parts of the country are old and in poor maintenance conditions. Furthermore, water-related projects such as dams are under discussion for decades with no appreciable results. Health, education, and social services are poor as like projects targeting female participation in working activities and education programs. Health services are underdeveloped and a public healthcare center in the district would improve living conditions. According to UNDP[12], Wadi Araba is between sub-districts with the lowest percentage of households visiting government hospitals (1.9 percent). Furthermore, the district shows one of the lowest rates of use an ambulance for emergency purposes at households level (between 0 and 5 percent of the total). Around 20% of households in Wadi Araba reported walking to hospitals and health centers. The following tables [13] describe the level of access to services and local communities' perception of living in poverty conditions in Wadi Araba.

Table 5. - Households and he family's ability to provide services, 2011.

Services	*Always*	*Some times*	*Rarely*	*Never*	*N/A*	*Total*
Services						
Provide three meals a day	41.0	51.4	7.6	0.0	0.0	100
The provision of meat, chicken and fish at least twice a week	19.4	55.1	25.5	0.0	0.0	100
The provision of vegetables and fruits at least twice a week	42.6	43.1	14.3	0.0	0.0	100
Paying Bells regularly	14.7	36.9	48.4	0.0	0.0	100
Keep home warm	46.5	37.7	15.8	0.0	0.0	100
Buying clothes and shoes that household needs	46.2	32.8	21.0	0.0	0.0	100
Purchase of medicines needed by household	31.9	50.7	17.4	0.0	0.0	100
Services Purchase of medical devices (diabetes devices,…)	0.0	1.9	2.9	0.0	95.2	100
Take care of each child's teeth regularly	7.8	16.5	21.1	12.0	42.7	100
Purchase of schools supplies	20.8	24.7	13.4	0.0	41.0	100
Address the family/friends at least a meal once a month with the family	11.1	35.4	52.3	1.2	0.0	100
Services Travelling to attend family occasions (between governorates)	11.1	27.4	56.4	3.2	1.9	100
Services for households who have members seeking job						
Provide three meals a day	14.2	78.9	6.9	0.0	0.0	100
The provision of meat, chicken and fish at least twice a week	14.2	55.9	30.0	0.0	0.0	100
The provision of vegetables and fruits at least twice a week	31.5	38.5	30.0	0.0	0.0	100
Paying Bells regularly	8.3	28.4	63.3	0.0	0.0	100
Keep home warm	20.0	44.1	35.9	0.0	0.0	100
Buying clothes and shoes that household needs	25.7	30.5	43.9	0.0	0.0	100
Purchase of medicines needed by household	25.7	38.4	35.9	0.0	0.0	100
Purchase of medical devices (diabetes devices,…)	0.0	8.0	0.0	0.0	92.0	100
Take care of each child's teeth regularly	14.2	16.3	30.2	19.5	19.8	100

[12] UNDP, Jordan Human Development Report, 2015.

[13] United Nations United Nations Development Programme, Department of Statistics, and Ministry of Planning and International Cooperation, *Thinking Differently About The Poor. Findings from Poverty Pockets Survey in Jordan (Based on Household Expenditure and Income Survey 2010)*, 2012

Purchase of schools supplies	31.5	24.2	24.4	0.0	19.8	100
Address the family/friends at least a meal once a month with the family	14.2	24.6	61.2	0.0	0.0	100
Travelling to attend family occasions (between governorates)	14.2	16.7	61.2	0.0	8.0	100

Table 6. - Households and the time it takes to reach the nearest shop or service, 2011.

Services	*15 m. or less*	*16-20 m.*	*21-30 m.*	*31-40 m.*	*41-60 m.*	*61 m. or more*	*Total*
shop selling milk	62.8	33.4	2.5	0.0	0.0	1.4	100
shop selling vegetables and fruits	58.5	33.4	2.5	0.0	0.0	5.7	100
store selling coffee and tea	64.2	33.4	2.5	0.0	0.0	0.0	100
nearest public transport stop	86.4	9.9	2.5	1.2	0.0	0.0	100

Table 7. - Relative Distribution of Households and the degree of concern in cases experienced by family 2011

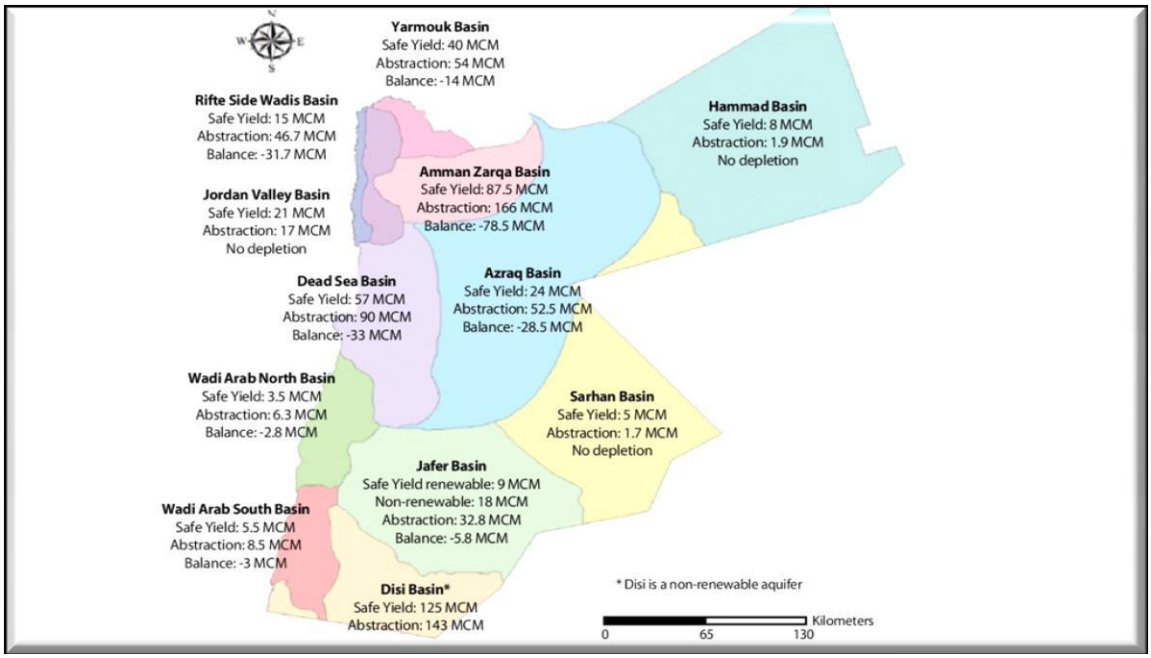
Cases	*Very concerned*	*Concerned*	*Concern to some extent*	*Not concerned*	*Total*
Lack of sufficient income	17.6	46.3	19.5	16.6	100
Hunger	25.7	41.8	8.6	23.9	100
Unexpected spending on health	12.5	46.7	13.1	27.7	100
Lack of housing	23.2	32.0	12.8	31.9	100
Diseases resulting from poor sanitation	36.8	29.4	3.3	30.5	100
Crimes (theft, murder,…)	40.5	23.9	3.7	31.9	100
Air pollution	78.7	9.2	0.0	12.1	100
water pollution	90.6	7.5	0.0	1.9	100
Drought\flood	86.8	7.5	0.0	5.7	100

In summary, the Wadi Araba District shows critical indicators in several domains. Very high percentages of households can rarely or never afford the following services or activities: paying bills regularly (48.4 %), purchase of school supplies (17.4 %), attending family get-together (59.6 %), and inviting friends over meals (53.5%). The same survey reveals that households in Wadi Araba simply do not use newspapers as a job search method and, generally, do not apply for jobs with the Ministry of Labor or Civil Service Bureau but also have the lowest percentages of households filing job applications with private sector institutions.
Economic fragility emerges with respect to families saving capacity: over 60 % of households in Wadi Araba have savings less than one month of expenditure. Education of the disabled and access to work for disabled people is very difficult: more than 75% of households in Wadi Araba reported job placement difficulties for disabled components. More generally in the district difficulties in accessing social protection services exceeded 60 %.

Water related data

The pilot area is positioned in the so called Wadi Araba North Basin area. An overview of the main water basin in Jordan is provided by the following map, developed by FAO[14] (Table 9-15).

[14] FAO, *An assessment of policies, institutions and regulations for water harvesting, solar energy, and groundwater in Jordan. A review and gap analysis*, Food And Agriculture Organization Of The United Nations, Rome, 2018.



IWMI e USAID [15]described the main dimension of Jordan groundwaters and the Wadi Araba North Basin.

Table 8. - Abstraction from Groundwater basins in Jordan and their safe yields in 2015

Basin	Safe yield MCM	Total uses (MCM)	Balance	No of wells	Percent of Safe yield
Wadi Araba North	5-7	6.33	-2.83	37	181

Table 9. - Abstraction from groundwater basins in Jordan and their safe yields in Wadi Araba North.

		1995	2004	2013	2015
	Safe yield	3.5	3.5	3.5	3.5
Domestic Private	Wells	/	0	0	1
	Quantities (MCM)	/	0	0	0.09
Domestic Governmental	Wells	0	5	0	12
	Quantities (MCM)	0.0	0.7	0	1.89
Industrial	Wells	8	11	9	4
	Quantities (MCM)	3.2	2.8	2.6	1.53
Agriculture	Wells	4	17	31	20
	Quantities (MCM)	0.6	3.4	3.9	2.83
Livestock Remote Areas	Wells	5	3	0	0
	Quantities (MCM)	0.1	0	0	0.00
	Total water Abstraction	4.0	6.9	6.5	6.33
	Balance (MCM)	-0.5	-3.4	-3	-2.83
	Total Wells	17	36	40	37
	Percent of Safe yield	114	196.2	186	181

Table 10. - Surface water resources[16].

[15] IWMI e USAID, *Water resources, use and management in Jordan – A focus on groundwater*, IWMI Project Report n° 11, 2016.

Surface Water Basin	Sy	Pop. (1994)	Area (Km2)	Average Annual Rainfall (mm)	Estimated Runoff Coeff (%)	Long Term Rainfall Average 61 Years (MCM)	Surface Water Flows (MCM) Long-Term Av. (1937-1998)
North Wadi Araba	D	79,128	2,975	135	0.7	403	Base: 8.58 Flood: 2.35 Total: 11.13

Table 11. - Water budget, safe yield and abstraction from the groundwater basins for the year 2000. Source: note 11.

Basin	Aquifer	Safe Yield (MCM/a)	Domestic (MCM/a)	Industrial (MCM/a)	Agriculture (MCM/a)	Sum	Sy.-Abst.	Water Quality
North Wadi Araba	ALL, B2/A7, K, D	3.5	0.000	2.784	0.563	3.514	-0.014	Salinization

Table 12. - Domestic Consumption for Jordan Valley. Source: note 11.

Population areas	*Governorate*	*Domestic water (MCM/yr)*
Rahmeh	Al-Aqabah	0.043
Qatar	Al-Aqabah	0.010
Al Resheh	Al-Aqabah	0.047
Fenan	Al-Aqabah	0.016
Beermathkoor	Al-Aqabah	0.022

Table 13. - Total average discharge (MCM/year) and water salinity (mg/l) of saline water springs in Jordan[17].

Basin	Water salinity TDS (PPM)	Average Discharge (MCM/year)	Average Salinity (mg/l)
Wadi Araba	800-2500	0.09	1110-1410

Table 14. - Surface Water Resources in Jordan Long Term Average 1963-1989. Source: note 12.

Basin Name	Base Flow (MCM/Yr)	Flood Flow (MCM/Yr)	Total Flow (MCM/Yr)
North Wadi Araba	15.63	2.57	18.20
Inter Catchments	3.10	0.19	3.29
Feifa	7.43	0.26	7.69
Khanzera	2.32	0.42	2.74
Dahel	0.03	0.23	0.26
Fidan	1.66	0.48	2.08
Buweida	0.80	0.16	0.96
Musa	0.88	0.70	1.58
Hawor	0.09	0.2	0.32

---

[16] The Hashemite Kingdom Of Jordan, Ministry Of Water & Irrigation, Jordan Valley Authority, United States Agency For International Development (USAID), *Jordan Valley Preliminary Land Use Master Plan Project, Final Land Use Report*, 1 of 5, 2004.

[17] The Hashemite Kingdom Of Jordan, Ministry Of Agriculture, National Center For Agriculture Research And Technology Transfer, *Jordan National Report, Harnessing Salty Water To Enhance Sustainable Livelihoods Of The Rural Poor In Four Countries In West Asia And North Africa: Egypt, Jordan, Syria And Tunisia*, 2004

Table 15. - Irrigated areas in Jordan and their water requirements until the year 2010. Source: note 12.

Water Source	Irrigated areas and yearly water requirements									
	1990		1995		2000		2005		2010	
Region	Ha	MCM	Ha	MCM	Ha	MCM	Ha	MCM	Ha	MCM
Wadi Araba	200	neg.	500	5	1000	10	1000	10	1500	15

The following maps provided by UNICEF describes the level of water-related services such as water supply and sewerage system efficiency (Fig.16-18).

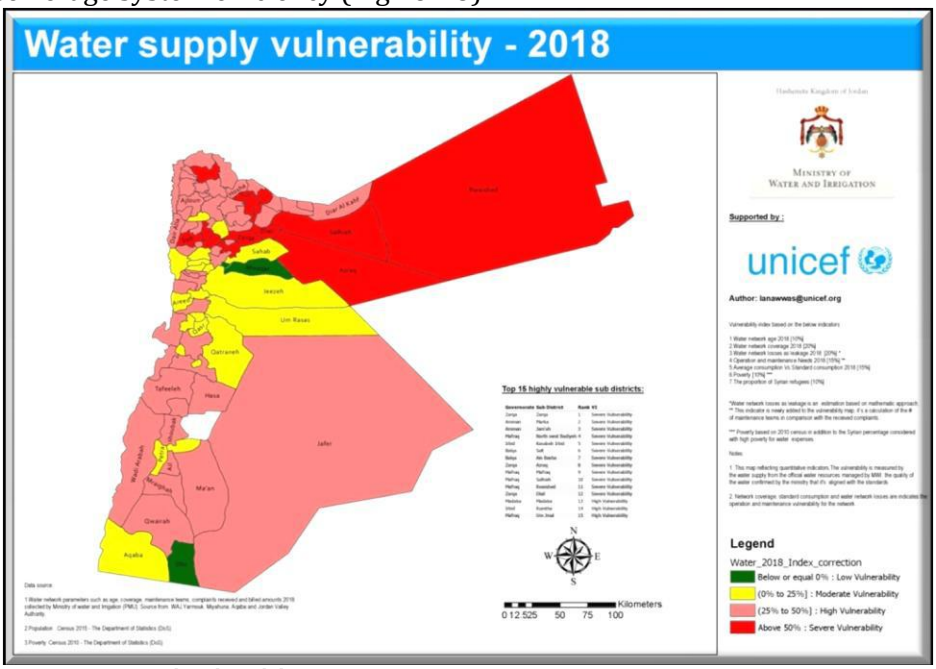


Fig. 16 - Water supply vulnerability, UNICEF, 2018.

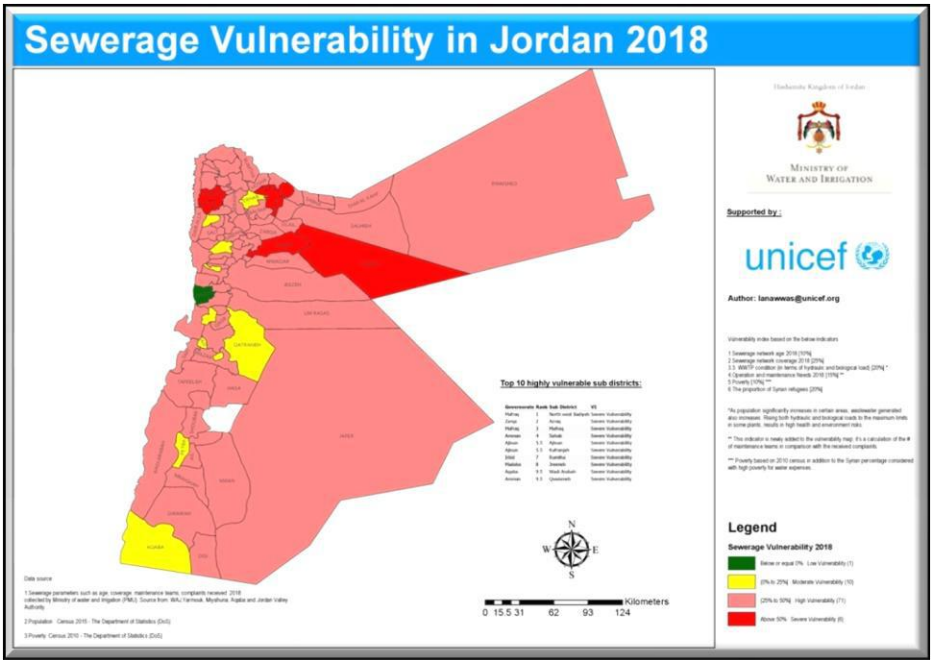


Fig. 17 – Sewerage vulnerability, UNICEF, 2018.

In the previous pages table, 7 shows a high level of concern between the Wadi Araba population. Several events have been registered during the last decades. As suggested by the following map, it appears as the main issue for planning strategies in the area.

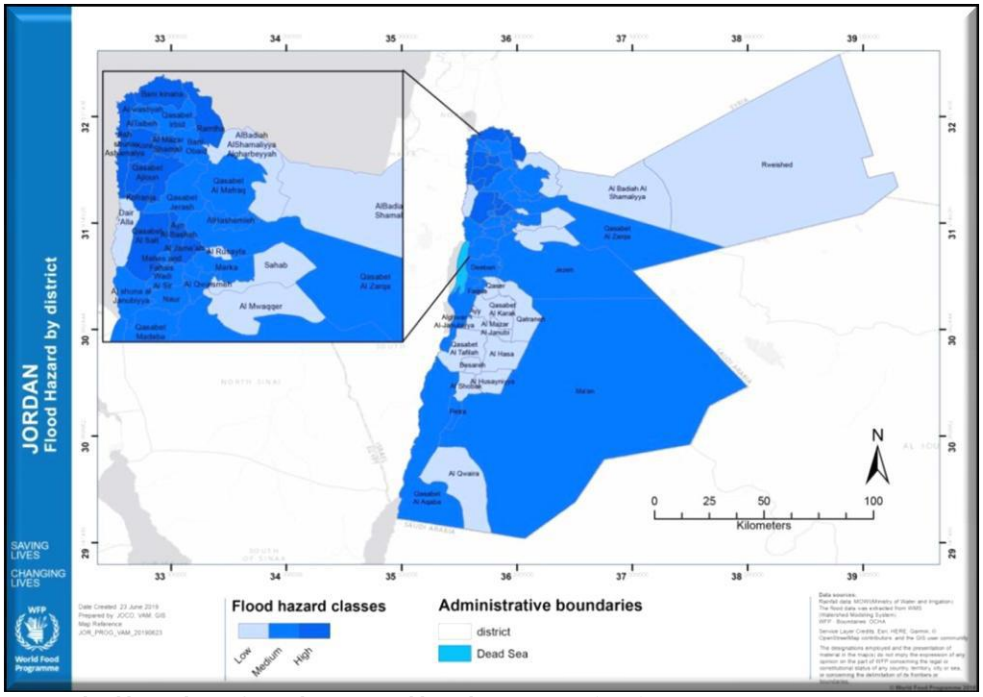


Fig. 18 - Flood hazard map for Jordan, UN World Food Programme (WFP), June 2019.

Projects

Wadi Araba has been at the center of different initiatives aiming at reducing socio-economic disparities with the rest of the country. The main fields of intervention have been water, health, education, and local communities empowerment, gender issues. Several agricultural projects were funded by the Ministry of Agriculture and a network of local cooperatives is active to strengthen the agriculture sector, also in the form of access to credit and diffusion of irrigation infrastructures.

The Jordan River Foundation (JRF) supported several projects[18] in the Wadi Araba district since 2002, and JRF activities have been analyzed in an international evaluation report[19]. The Community Empowerment Programs (CEP) of the Jordan River Foundation selected some rural areas of Aqaba Governorate between others in the country. The Community Empowerment Programs focused especially on poverty pockets areas as identified by the Jordan Department of Statistics, aiming at help communities living below the Jordanian poverty level.

In the pilot area of Mediss project JRF supported two projects (RCCDP - Rural Community Cluster Development Project, 2002 – 2006; LDPLA - Local Development Program for Less- Privileged Areas, 2007 – 2009) part of an integrated agricultural action including several activities such as wells management and irrigation systems; support to organic farming systems; greenhouse farming systems and water management and reuse of sediment silted in reservoirs. The evaluation report positively assessed the project for providing job opportunities for 25 local people and for the support to Ga'a Seedyeen Cooperative, established in 2002, in charge of the coordination and implementation of project's activities from farming to product selling and grouping more than 870 members. Even if all members are males some seasonal jobs for women living in the village have been created. Women work part-time in greenhouses and participated in training sessions, included those focusing on small loan programs. The integrated project is considered a success for the level of engagement of cooperative members in

[18] Jordan River Foundation, Annual Report and Sustainability Report, *"Empowering" Fostering a dynamic Jordanian Society through the empowerment of communities and individuals*, 2008.

[19] Jordan River Foundation, *Impact Evaluation*, The Evaluators' Institute (TEI), George Washington University, Washington, USA, 2013.

defining irrigation and agriculture needs or planning for rehabilitating formerly unproductive soils (high salinity) to be suitable for food production. In collaboration with the Regional Center for Agriculture, new crops demanding less water were tested together with crop varieties that would yield higher profits. In parallel, JRF provided a young people' association in Al Risha with support to activities, events management, and pieces of equipment.

JRF has been working in Rahma Village, near the pilot area of Mediss project. A project run by a local cooperative provided since 2007 services to the local farmers to strengthen the agriculture sector. Apart from creating some job opportunities for residents, the cooperative grouped around 290 members, and female participation was estimated in around 20% of local members. Female participation in working activities should not be underestimated in the area for the influence of traditional community structures, on the contrary, it can be considered a direct beneficial impact of the project. Finally, in the framework of the Youth Leadership Program (YLP) developed in 2009 by JRF, two schools were also renovated in the Wadi Araba district.

The Ministry of Planning and International Cooperation supported several interventions in the district under the Economic and Social Productivity Program (ESPP), building around 150 new residences and providing agriculture facilities such as wells. Other actions focused on transport infrastructures, education and health sectors.

The following figures show some of the main ongoing projects supported by the Ministry of Water and Irrigation in the area[20].

17. Wadi Rahma Dam

Project Information

Location	Aqaba
Objectives	The project aims to construct a dam with capacity of 0.65 MCM to irrigate agricultural land, recharge groundwater, as well as protect Rahma village from flooding. Also, another main objective is for Wadi Arab Development. The project objective considers for a multi purposes.
Description	A homogeneous earth dam 17.5 m high and 186 m long is expected to be erected. Storage capacity is 0.65 million m^3 at the end of Wadi Rahma right before it meets Wadi Araba, west of Rahma village at the coordinates (923100 North and 164500 East).

Project Status

Status	Concept phase, unfunded. Modification and review of existing studies, design and contract documents are required
Financing	Not available
Expected Construction Date	2021 – 2022

Operational Data

Water Supplied	0.65 MCM
Water Saved	-
% Allocation by Type of Use	100 % for Irrigation

Implementation Schedule

Year	1	2	3	4	5	6	7	8	9	10
CAPEX Outlay (%)	50%	50%								
OPEX Outlay (%)			100%	100%	100%	100%	100%	100%	100%	100%

Financial and Economic Indicators

Capital Cost (M JOD)	3.5		
IRR (%)	-	**ERR (%)**	13
NPV (M JOD)	-4.5	**ENPV (M JOD)**	2.0

[20] The Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, Water Sector Capital Investment Plan, 2016-2025, 2016

18. Wadi Moussa Dam

Project Information

Location	Aqaba
Objectives	Project aims to irrigate agricultural land in the area where the dam will be established, and to recharge groundwater. Also, another main objective is for Wadi Arab Development. The project objective considers for a multi purposes.
Description	The project objective is to create a homogeneous earth dam 25 m high and a storage capacity of 2.5 million m^3. The proposed project location is the end of Wadi Mousa, 3 km before it meets Wadi Araba, south west of Beer Mathkour in Om Matla. Coordinates are 975500 North and 184700 East.

Project Status

Status	Concept phase, unfunded. Modification and review of existing studies, design and contract documents are required
Financing	Not available
Expected Construction Date	2021 – 2022

Operational Data

Water Supplied	2.5 MCM
Water Saved	2.5 MCM
% Allocation by Type of Use	100% Irrigation

Implementation Schedule

Year	1	2	3	4	5	6	7	8	9	10
CAPEX Outlay (%)	50%	50%								
OPEX Outlay (%)			100%	100%	100%	100%	100%	100%	100%	100%

Financial and Economic Indicators

Capital Cost (M JOD)	8		
IRR (%)	-	**ERR (%)**	20
NPV (M JOD)	-12.3	**ENPV (M JOD)**	12.4

IRRIGATION WATER

1. Implementing the Wadi Araba Integrated Development Project / Phase II

Project Information

Location	Aqaba
Objectives	The project aims to implement the Phase II of the Wadi Araba Integrated Development Project in order to eradicate poverty and unemployment, to improve the economic and social situation of the residents, and to make the region attractive economically
Description	1. Finan Irrigation Project: establishing a network to irrigate 3,000 dunum, divided into 150 farm units, and drilling five wells for irrigation the lands, in addition to the permanent water runoff 2. Risha Irrigation Project: a network for irrigating 2,000 dunums divided into 100 farm units, as well as drilling two exploratory wells 3. Expansion of Rahma Irrigation Project: an area of 1,500 dunums divided into 75 farm units, as well as drilling 4 wells 4. Wadi Mousa Irrigation Project: an area of 1,500 dunums divided into 75 farm units, as well as drilling 5 wells

Project Status

Status	Concept phase, unfunded, and in need of studies
Financing	Not available
Expected Construction Date	2016 - 2025

Operational Data

Water Supplied	-
Water Saved	
% Allocation by Type of Use	100% Irrigation Water

Implementation Schedule

Year	1	2	3	4	5	6	7	8	9	10
CAPEX Outlay (%)	3%	8%	8.5%	10%	13.5%	13.5%	17%	8.5%	8.5%	9.5%
OPEX Outlay (%)						25%	35%	50%	75%	85%

Financial and Economic Indicators

Capital Cost (M JOD)	60		
IRR (%)		**ERR (%)**	
NPV (M JOD)		**ENPV (M JOD)**	

TEST SITE - BECHIMA (WADI CHERKA), ELHAMMA, GABES, TUNISIA

The Tunisian partner, the Regional direction of Gabes of the Arid Regions Institute - IRA, selected a rural area surrounding El Hamma (map at https://goo.gl/maps/e5vvZWGM8h6Y7af4A) as a pilot site (Fig.19 a 19 b) in the framework of the MEDISS project. The main aim of the action is to upgrade existing pilot plant (8 ha) for tertiary treatment through infiltration percolation, and to test an innovative filter bed of clay.

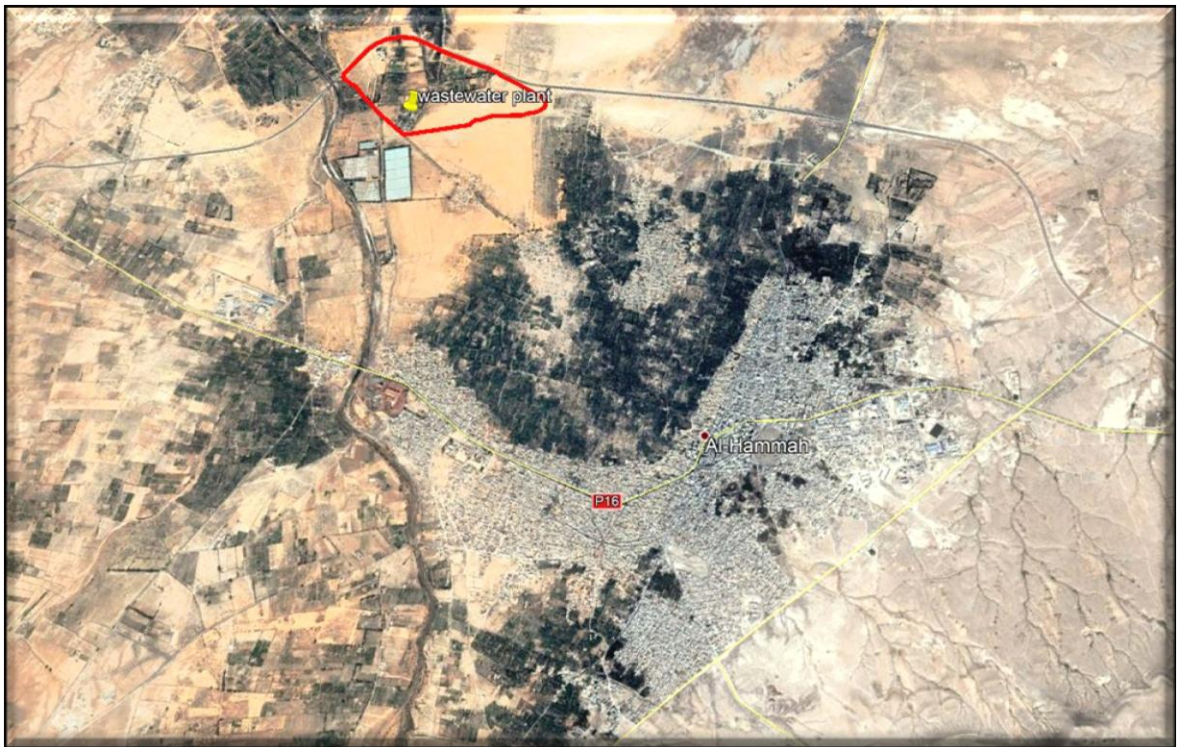


Fig. 19a – Mediss project, pilot area in Tunisia

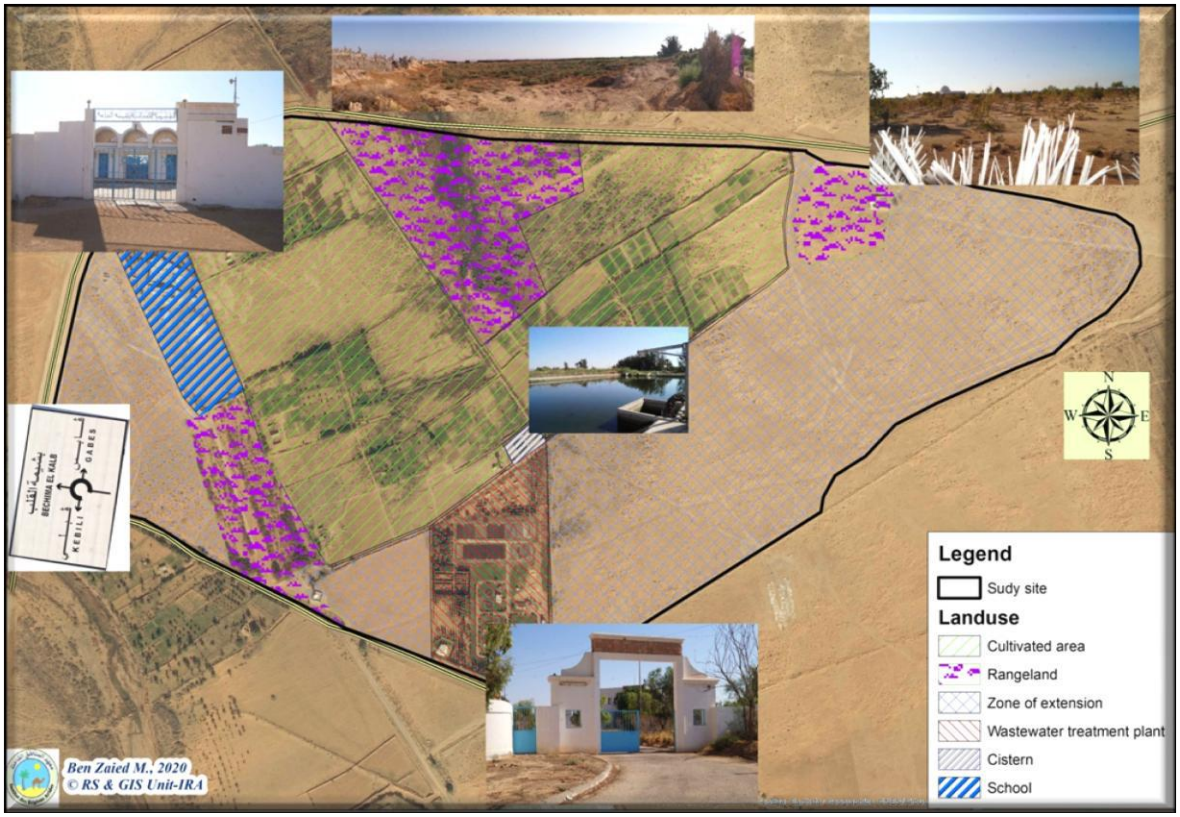


Fig. 19b – Mediss project, pilot area in Tunisia

According to Tunisia administrative boundaries, the area is part of the Gabès Governorate. The El Hamma district is the largest of the Governorate (Fig.20), covering 32,5 % of the total surface (2,319 km²). The specificity of the geographical conditions of the South-East region has generated particular modes of occupation of space, characterized by their diversity. With over three-quarters of the population living in urban centers, urbanization is one of the characteristics of the south-eastern region (Table 20-23).

Table 20. – Distribution of the population by sex (in thousands), El Hamma Delegation

Year	Total	F	M
2018	80,684	-	-
2014	73,512	37,122	36,390
2004	62,390	32,506	29,884

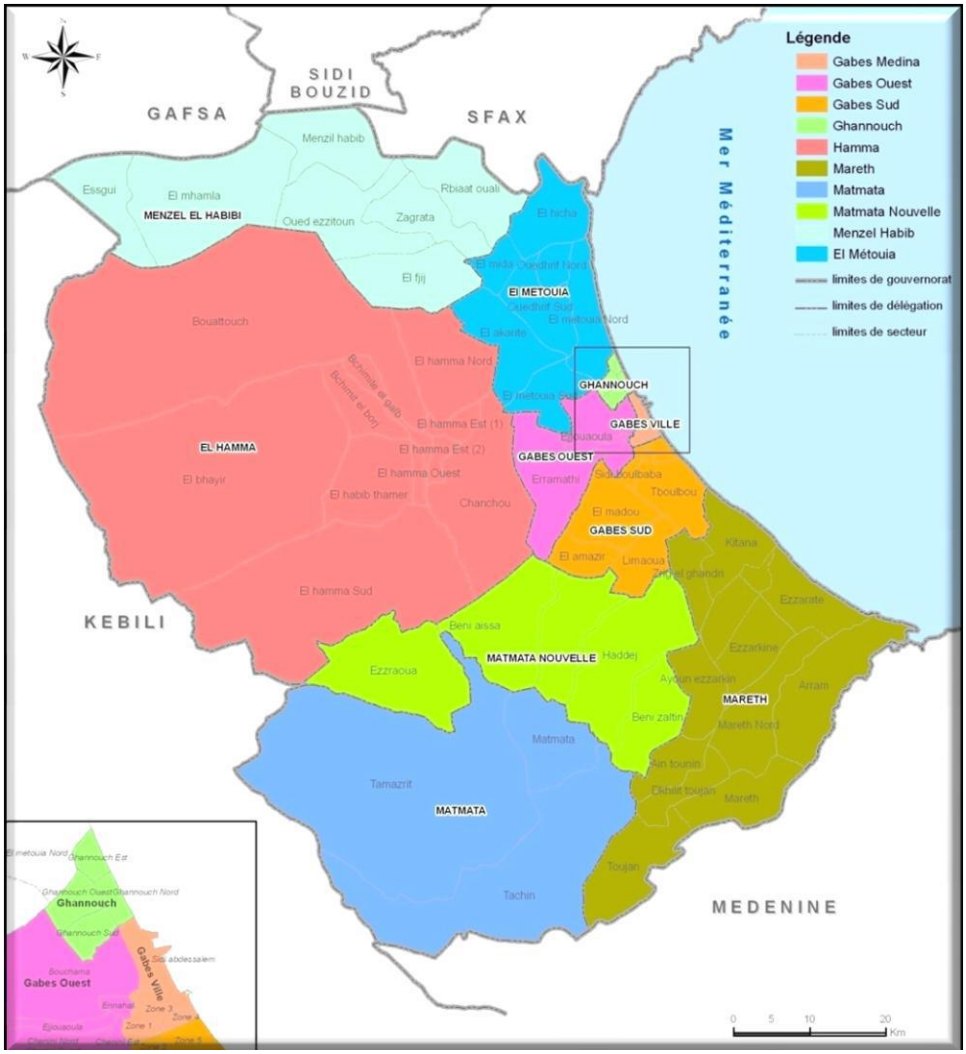


*Fig. 20 – Gabès Governatorate*21*, districts*

It has taken place with rapid growth at the coastal level due to the depopulation of rural areas. The Gabès pole encompasses the city and the municipalities located within a radius of 30 km, in particular, Mareth and El Hamma. The Gabès agglomeration stands out clearly as the regional capital. The second level of city groups

[21] Republique Tunisienne, Ministere de L'equipement, de L'habitat et de L'amenagement du Territoire, Direction Générale de l'Aménagement du Territoire, *Atlas du Gouvernorat De Gabes*, 2011.

together municipalities with very diverse profiles such as Zarzis, Houmt Souk, Medenine, Tataouine, Ben Guerdene, Midoun. The third level of urban centers includes Municipalities like El Hamma, Ajim, and Ghannouche. El Hamma is positioned on the RN16 itinerary, a relevant axis linking the South-East region and the South-West region.

Table 21. – Distribution of the population (in thousands), El Hamma municipality

Year	Number of households	Number of dwellings	Population
2018	-	-	59,479
2014	8,711	10,939	41,607
2004	6,612	7,333	34,835

Table 22. – Distribution of dwellings and households, El Hamma Delegation

Year	Number of households	Number of dwellings
2014	14,661	17,993
2004	11,615	13,111
1994	9,762	10,326

Table 23. – Housing characteristics, El Hamma Delegation, 2014

Informal housing	Apartments	Villa or villa floor	Semi-detached accommodation or semi-detached accommodation floor	Traditional house	Number of houses
0,4	0,7	14,1	50,2	34,7	17,993

Economic and social conditions

Since the 1960s, the central authorities have decided to focus on the modernization of Gabes' region economy. The establishment of an industrial development pole boosted the economy of the city and the entire South-East. The industrial-port complex of Gabès - Ghannouch, based on the transformation of phosphates, has contributed to shifting the region's economy from an economy based primarily on oasis agriculture to an economy where industry and services have come to strengthen the traditional activities.

As a consequence of the centralized and mono-sectoral vision of development, the regional potential for sectoral diversification was underestimated. Gabès region specialization obscured the importance of diversifying development sectors and creating a real local and regional economy. This orientation resulted in a new distribution of the occupied population over the last three decades. The sectors of activity and the main trends of the economic dynamics in the governorate evolved, leading to a halving of the employees in the agriculture and fishing sectors in three decades[22]. Starting from the 80s, the industrial and manufacturing sectors, concentrated in a single area, experienced a decline in employment despite the industrial character of the governorate.

In addition to rising unemployment rates, the Gabes region is currently facing emerging environmental challenges generated by the different forms of pollution (atmospheric, liquid, and solid) from the chemical industries in Gabes. Environmental pollution endangers the longevity of the industrial sector and the development of other activities. Gabes's natural resources are severely under strain due to the increasing pressures exerted on them by their overexploitation and continued degradation by the chemical industry. More generally, it seems that the expected increased attractiveness of the regional business sector failed, being a low proportion of companies located in the governorate of Gabes. A continuous reduction of productive activities emerges in the region since the end of the 1990s. The same results become visible from the number of businesses per capita and the Gabes regional development index, both experiencing a reduction in the last decades. The El Hamma delegation follows the trend described above. Development indicators can be useful tools to monitor and

[22] République Tunisienne, Ministère du Développement,de l'Investissement et de la Coopération Internationale, Office de Développement du Sud, *Gouvernorat de Gabès en chiffres 2018*, 2019.

assess socio-economic development. A multidimensional index, for instance, can describe development' levels and disparities between governorate' delegations. In a recent study [23], the multidimensional poverty index adopted three different indices (employment, knowledge, and living conditions).
A synthetic indicator of territorial development is the simple average of 13 variables. The data, provided by the Southern Development Office (ODS) are related to 2014. Selected indicators reflect mainly social variables and the living standard of the population in the different delegations. Results ranked Gabès governorate delegations as follows (table 24-48):

Delegation	**Multidimensional Poverty Index value**	**Position**
Ghannouch	0,66	1
Gabes sud	0,59	2
Gabes Medina	0,57	3
Gabes ouest	0,50	4
Métouia	0,44	5
Manzel Habib	0.41	6
El Hamma	0,39	7
Mareth	0,34	8
Matmata nouvelle	0,20	9
Matamata	0,14	10

Another form of describing the state well being of local communities is the Human Development Indicator, HDI, adopted by a recent study on Tunisia[24].

Table 25. – Synthetic HDI values, Gabès' governorate delegations, 2014

Delegation	**Synthetic HDI values**	**Position**
Gabes sud	697	1
Gabes Medina	662	2
Métouia	608	3
Gabes ouest	586	4
Ghannouch	573	5
El Hamma	515	6
Mareth	445	7
Matamata	389	8
Matmata nouvelle	384	9
Manzel Habib	374	10
Total Governorate	**567**	**-**
Total Tunisie	**609**	**-**

Table 24. – Multidimensional Poverty Index values (between 0 and 1), Gabès' governorate delegations, 2014

The HDI is an indicator which measures the evolution of socioeconomic indices and reflects the progress made, in particular in human development. This classic HDI represents the arithmetic mean of three components: the economic index or standard of living (represented by GDP per capita in terms of purchasing power parity), the education index (measured by an average weighted at two-thirds of the adult literacy rate and one-third of the school enrollment rate at all levels) and the longevity index (measured by life expectancy). A synthetic HDI takes into account the multifaceted aspect of development and integrates the different phenomena (economic, social, infrastructures). The study adopts seven indices: two relating to employment and unemployment, two relating to education, and three indices relating to infrastructure and equipment (connection of housing to the drinking

[23] Riadh Bechir, *La pauvreté et les disparités régionales et locales en Tunisie, une analyse statistique*, Documents de Recherche de l'Observatoire de la Francophonie Économique – DROFE, Université de Montréal, no. 5, 2019.

[24] Bousnina Adel*, Le développement local en Tunisie. Essai sur la Tunisie périphérique oubliée*, L'Harmattan, Collection

Histoire et perspectives méditerranéennes, Paris, 2019.

water network (SONEDE), connection to the sanitation network (ONAS) and the proportion of households connected to the Internet).

At the governorate level, the study shows the impacts of the chemical industry on the environment and on pollution endangering the unique coastal oasis system and its specific biodiversity heritage. Tunisian Chemical Group (GCT) activities, a public company operating phosphate mines, dump phosphogypsum into the sea and phosphoric acid into the air. The pollution problem in Gabes is combined with unemployment among graduates because of the exhaustion of the industrial sector and the weakness of opportunities in other sectors. In fact, after the revolution, the chemical industry experienced a considerable drop in phosphate production (-54% between 2010 and 2016) and productive capacity (- 60/70% between January 2011 and September 2017).

The unemployment rate of higher education graduates is very high: 40% or more in Menzel El Habib, Matmata, and Mareth. In the El Hamma district, it exceeds 45% of the total number of higher education graduates. The last available socio-economic data on the El Hamma delegation confirm the scenario described. Concerning employment and sectors of activity, services, buildings, and public works are the ones employing most of the workers in the delegation.

Table 26. – Employed population by sector of activity - 15 years and over, El Hamma Delegation, 2014

Total	Not declared	Services	Buildings and public works	Mines and energy	Manufacturing industries	Agriculture and fishing	Activity rate %	Employed
				total				
18,161	19	8,290	5,702	220	1,992	1,939	43,1	24,195
				total m				
14,832	8	6,421	5,622	200	0	1,254	64,2	17,644
				total f				
3,329	11	1,869	80	20	6,64	685	22,8	6,551

Table 27. – Unemployement, 15 and over, El Hamma Delegation, 2014

Unemployement %		Unemployed aged 15 and over by level of education					
Graduates	Total	Total	Higher education	Secondary education	Primary education	Illiterate	Employed
				total			
44,6	24,9	6,034	2,383	2,148	1,237	266	24,195
				total m			
23,4	15,9	2,812	630	1,286	776	120	17,644
				total f			
63	49,2	3,222	1,753	862	461	146	6,551

Table 28. – Employement, El Hamma Delegation, 2018

Job applications			
Others		Managerial staff	
F.	Total	F.	Total
234	463	269	331
Job offer			
Qualified		Worker	
F.	Total	F.	Total
386	432	17	20
Unfulfilled requests			
Others		Managerial staff	
F.	Total	F.	Total
-	-	785	991
Placements			
Others		Managerial staff	
F.	Total	F.	Total
280	326	47	60

Inside the Gabès Governorate, internal migrants are attracted traditionally by the capital city and particularly by the suburbs of Gabès Sud. Other attractive Delegations are Ghannouch and El Métouia being part of the Grand Gabès agglomeration. The Delegations showing negative migratory balances are located mainly to the west of the Governorate, firstly Matmata. The Governorate shows a reduced attractiveness for surrounding regions as a result of the crisis of the industrialization process.

Table 29. – Indicators on inter-delegation migration, El Hamma Delegation, 2009-2014

Reasons for leaving (%)						Migration rate	Out	In
Other	Education	Family support	Marriage	Housing	Work			
				total				
2,1	8,4	22,8	29,3	7,5	29,9	-400	2,304	1,904
				total m				
1,8	8,8	25,4	18,9	8,8	46,3	-286	1,170	884
				total f				
2,5	7,9	30,5	39,9	6,2	13	-114	1,134	1,020

External migrations involve the same Delegations both within the country and abroad. Delegations showing higher population concentration such as Mareth, El Hamma, Gabès Ville, Gabès Ouest, and Matmata are the main emigration areas. El Hamma's Delegation comes only after Mareth for the percentage of emigrants over the total population.

Table 30. – Immigration indicators, El Hamma delegation, 2009-2014

Reasons for leaving (%)						Migration rate	Out	In
Other	Education	Family support	Marriage	Housing	Work			
				total				
0	9,3	0,9	6,6	0,7	82,6	-357	453	96
				total m				
0	8,8	0,2	3,8	0,7	86,5	-362	422	0
				total f				
0	16,1	9,7	45,2	0	29	5	31	36

The first and second education cycle establishments are generally easily accessible also at the local level. First cycle schools outside the main centers face the dispersion of the population in rural areas. Their concentration is higher in the most populous delegations such as Gabès-Ghannouch, Mareth, and El Hamma.

Table 31. – Educational characteristics, El Hamma Delegation, 2014

Illiteracy		Population aged 10 and over by level of education (%)					Higher	Scolarisation
Rate	10 years and over	Higher education	Secondary education	Primary education	Illiterate	10 years and over	education 19-24	6-14
				total				
22,4 %	13671	11,2 %	34,5 %	31,7 %	22,5 %	61141	44,15 %	97,17 %
				total m				
15,1 %	4537	10,1 %	38,8 %	35,9 %	15,2 %	30047	32,8 %	96,8 %
				total f				
29,4 %	9132	12,3 %	30,4 %	27,7 %	29,6 %	31094	55,2 %	97,5 %

Table 32. – Private education: 1st cycle, global data, El Hamma delegation, 2018

	Teachers	Students	Students	Schools

Students/ classroom	Students/ teachers	Total	F.	M.	Total	F.	M.	classes	
13	6	21	18	3	132	48	84	10	2

Table 33. – Public education: 1st cycle, preparatory year, El Hamma delegation, 2018

Students/ group	Students/ teachers	Students/ school	Teachers			Students			Groups	Schools
			Total	F.	M.	T	F.	M.		
23	23	34	25	10	15	577	272	305	25	17

Table 34. – Public education: 1st cycle, El Hamma delegation, 2018

			Teachers			Students		
Students/ classroom	Students/ teachers	Classrooms	Total	F.	M.	Total	F.	M.
25	16	318	482	247	235	7,800	3,794	4,006

Table 35. – Public education: 1st cycle, Success Rate, El Hamma delegation, 2018

6th degree - June 2018

Success Rate (%)			Admitted			Candidated		
Total	F.	M.	Total	F.	M.	Total	F.	M.
95,8	95,6	96,1	1,013	475	538	1,057	497	560

Table 36. – Public education: 2nd cycle, El Hamma delegation, 2018

Students/ classroom	Students/ teachers	Classrooms	Teachers			Students		
			T.	F.	M.	Total	F.	M.
24	11	214	492	213	279	5,226	3,098	2,128

Table 37. – Public education: 2nd cycle, Success Rate, El Hamma delegation, 2018

9th degree - June 2018

Success Rate (%)			Admitted			Candidated		
Total	F.	M.	Total	F.	M.	Total	F.	M.
21,1	28,89	11,27	34	26	8	161	90	71

Table 38. – Public education: 2nd cycle, Success Rate, El Hamma delegation, 2018

Baccalauréat - June 2018

Success Rate (%)			Admitted			Candidated		
Total	F.	M.	Total	F.	M.	Total	F.	M.
37,9	40,2	32,2	244	186	58	643	463	180

Table 39. – Public education: 2nd cycle, Dropout Rate, El Hamma delegation, 2018

Dropout Rate %

Secondary			2nd base cycle		
Total	F.	M.	Total	F.	M.
2,24	1,16	4,35	1,13	0,67	2,03

Table 40. – Public education: 2nd cycle, base and secondary according to specialization, El Hamma delegation, 2018

Experimental Sciences	Success Rate %	Total	54,6	Computer Sciences	Success Rate %	Total	24,2
		F.	57,7			F.	19,4
		M.	40,6			M.	35,7
	Admitted	Total	95		Admitted	Total	11
		F.	82			F.	6
		M.	13			M.	5
	Candidated	Total	174		Candidated	Total	45
		F.	142			F.	31
		M.	32			M.	14

Mathematics	Success Rate %	Total	52,6	Letters	Success Rate %	Total	26,0
		F.	56,5			F.	27,0
		M.	46,7			M.	20,0
	Admitted	Total	20		Admitted	Total	38
		F.	13			F.	34
		M.	7			M.	4
	Candidated	Total	38		Candidated	Total	146
		F.	23			F.	126
		M.	15			M.	20
Techniques	Success Rate %	Total	33,9	Total	Success Rate %	Total	37,9
		F.	44,2			F.	40,2
		M.	27,3			M.	32,2
	Admitted	Total	37		Admitted	Total	244
		F.	19			F.	186
		M.	18			M.	58
	Candidated	Total	109		Candidated	Total	643
		F.	43			F.	463
		M.	66			M.	180
Economics and Management	Success Rate %	Total	32,8	Sport	Success Rate %	Total	0
		F.	32,7			F.	0
		M.	33,3			M.	0
	Admitted	Total	43		Admitted	Total	0
		F.	32			F.	0
		M.	11			M.	0
	Candidated	Total	131		Candidated	Total	0
		F.	98			F.	0
		M.	33			M.	0

Data on infrastructures show that El Hamma is ranked just behind the Gabès agglomeration for infrastructures and access to services.

Table 41. – Electricity consumption by sector, Medium voltage (Gigawatt/h), El Hamma delegation, 2018

Total	Other	Tourism	Industry	Agriculture
44,3	4,6	-	32,5	7,1

Table 42. – Electrification and drinking water, Number of beneficiaries, El Hamma delegation, 2017

	Total	Communal	Non communal
Electrification	20,059	15,551	4,508
Drinking water	17,994	14,690	3,304

Table 43. – Photovoltaic energy

Installed power (KWC)	Number of Photovoltaic installations
114,5	15

Table 44. – Drinking water, Consumption by beneficiary (thousand m³)

Total	Tourism	Industry	Agriculture	Domestic consumption
1,720.9	0.0	2.4	-	1,718.5

Table 45. – Road Network (km), El Hamma delegation, 2018

	Total	Rural roads	Local roads	Regional roads	National roads	Numbered roads
Not asphalted	166.4	149.9	16.5	0.0	0.0	16.5
Asphalted	280.2	219.5	0.0	0.0	60.7	60.7

Table 46. – Health infrastructure in the public sector, El Hamma delegation, 2018

Mother and child care centers	Beds	Laboratories	Basic health centers	Local hospitals	Regional hospitals
1	50	1	12	1	-

Table 47. – Health infrastructure in the private sector, El Hamma delegation, 2018

Infirmary	Dialysis clinics	Laboratories	Pharmacies	Clinics
-	-	-	8	-

Table 48. – Health indicators, El Hamma delegation, 2018

Assisted deliveries %	Women using contraceptives	Number of postnatal acts	Number of prenatal procedures	Social workers	Family planning centers
-	-	1,254	7,234	6	1

Water related data

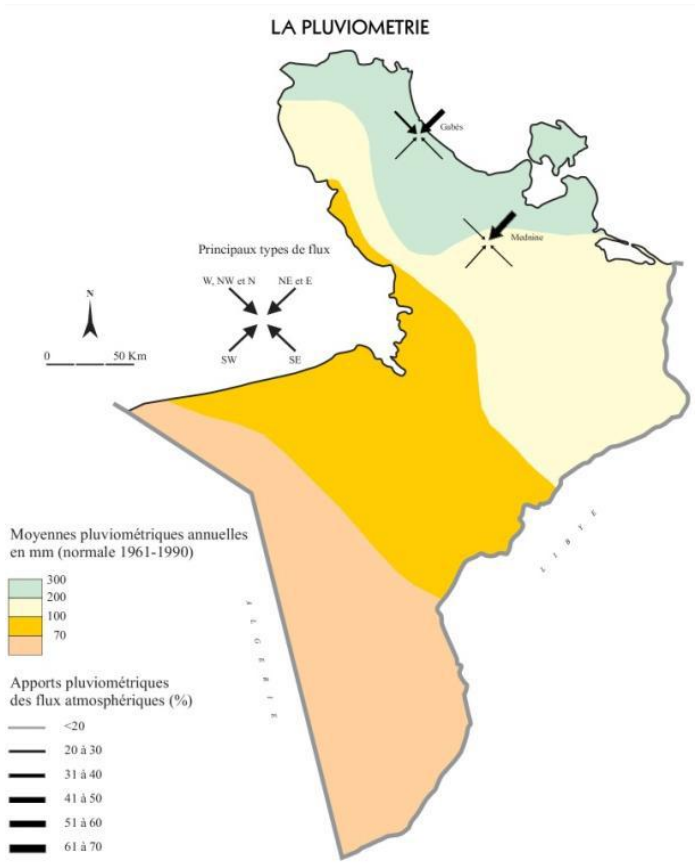
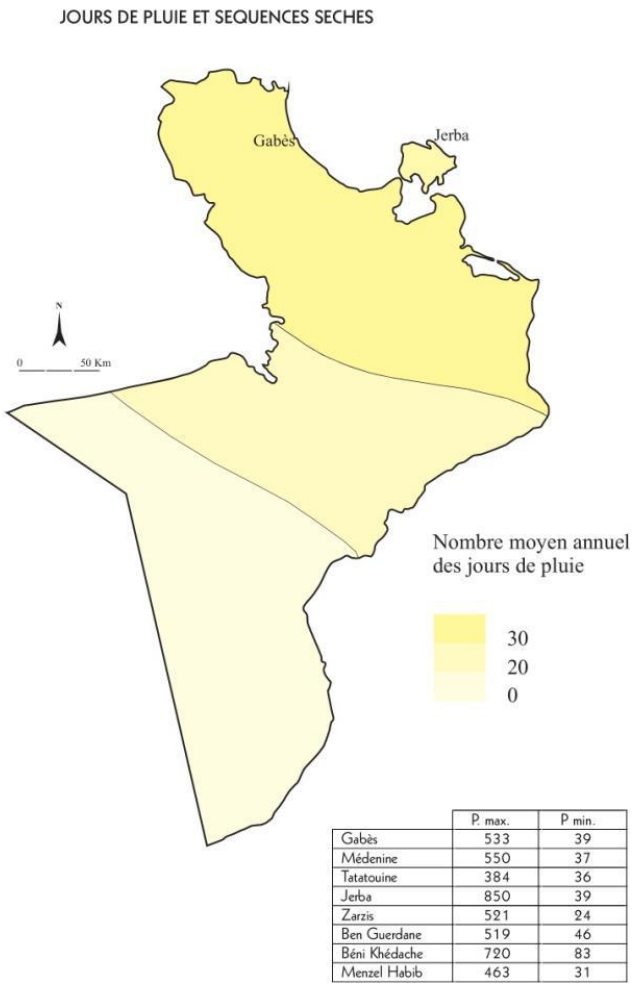


Fig. 27 – Tunisia, South East region, Rainfall



	P. max.	P min.
Gabès	533	39
Médenine	550	37
Tatatouine	384	36
Jerba	850	39
Zarzis	521	24
Ben Guerdane	519	46
Béni Khédache	720	83
Menzel Habib	463	31

Fig. 28 – Tunisia, South East region, Rainy days and dry periods

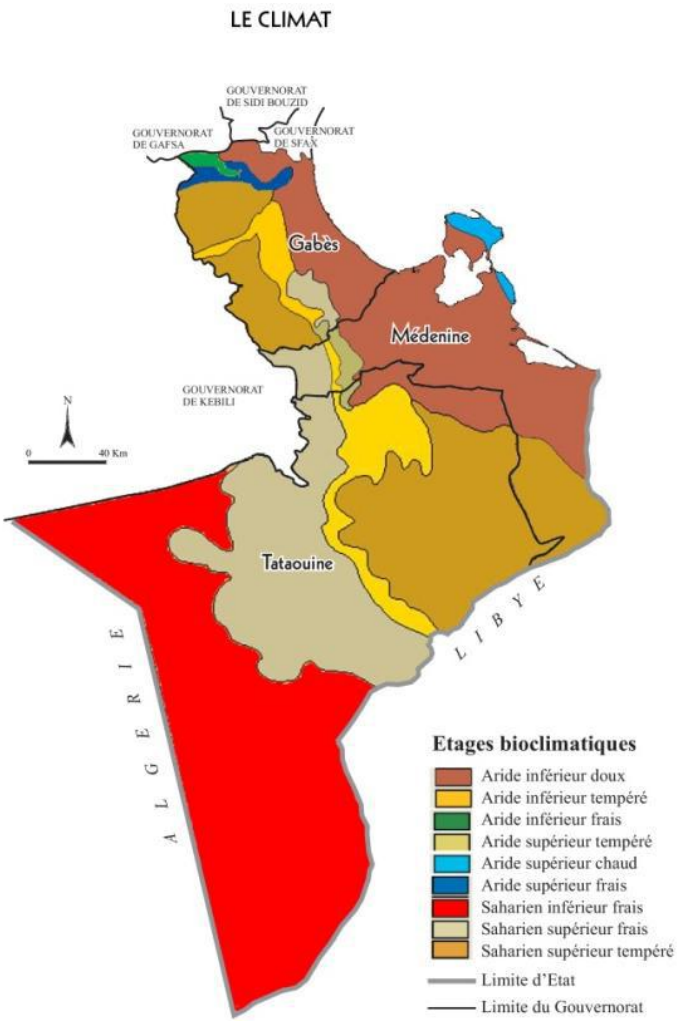


Fig. 29 – Tunisia, South East region, Climatic areas

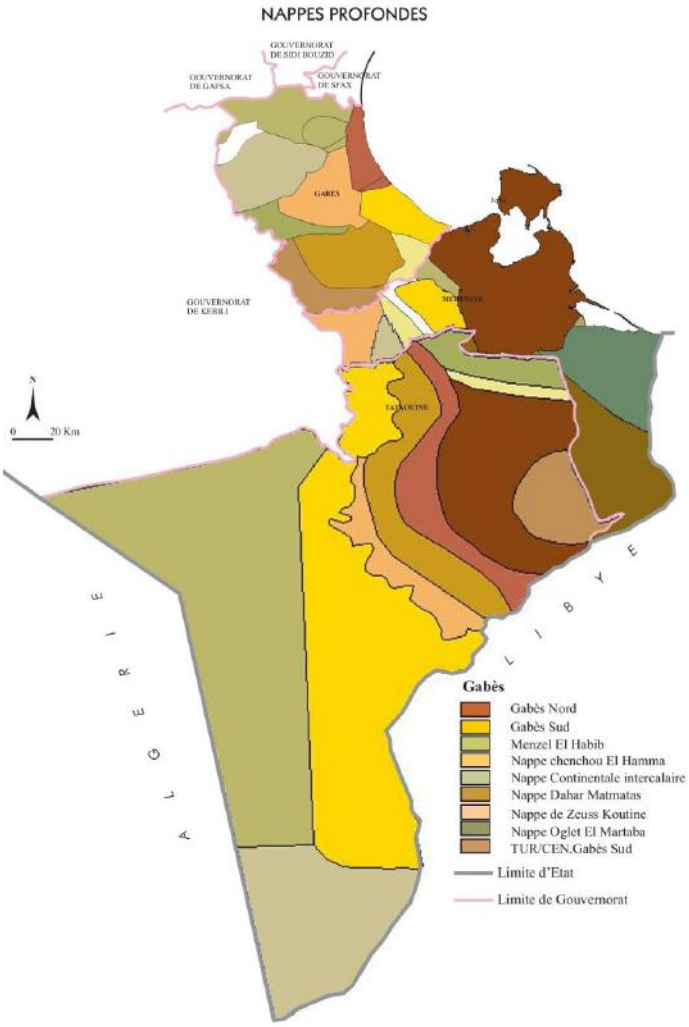


Fig. 30– Tunisia, South East region, groundwater reservoirs

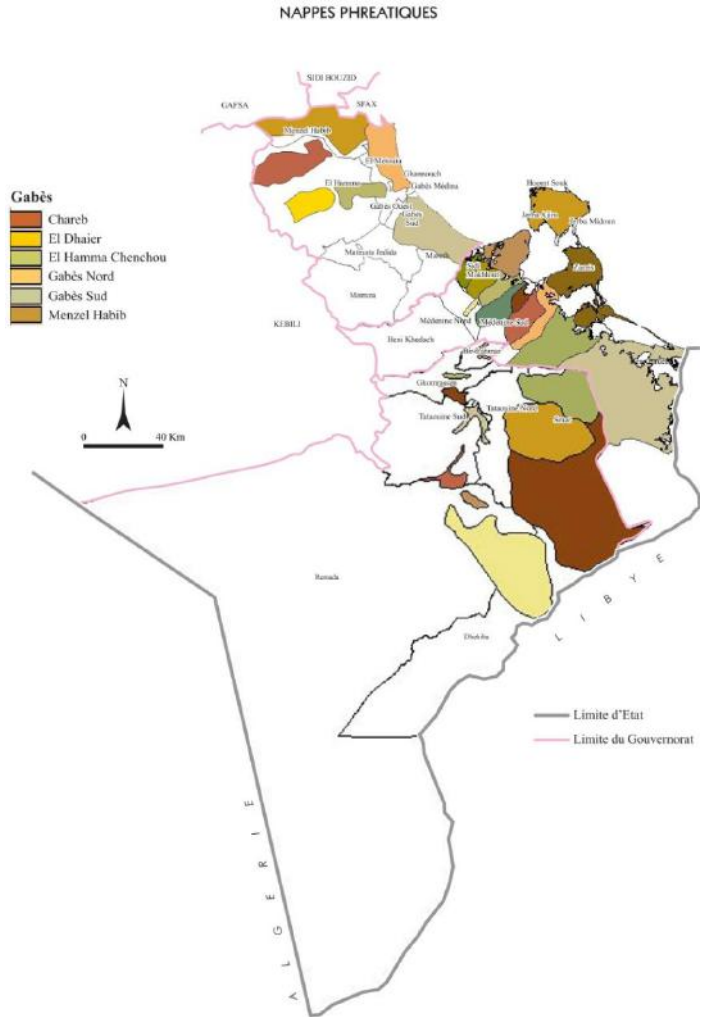


Fig. 31– Tunisia, South East region, groundwater tables

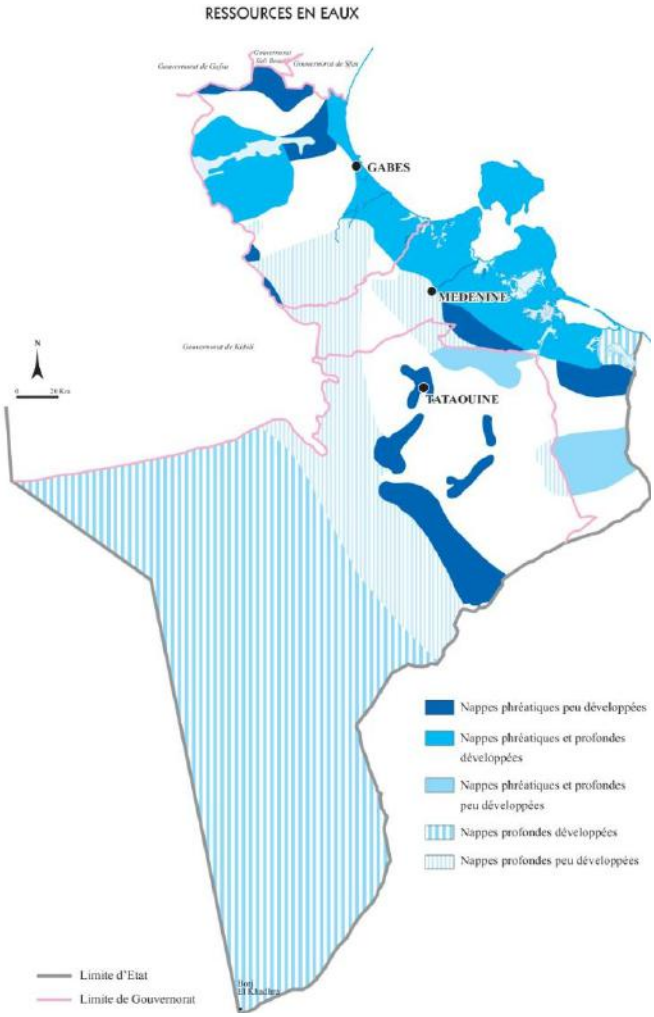


Fig. 32– Tunisia, South East region, water ressources

The previous maps[25] (Fig.27-32) (describe the scenario of water resources in the Southeast region of Tunisia. More in detail, the water resources scenario in the El Hamma delegation can be summarised as follows Table :

Table 49. – Characteristics of waters, water tables and groundwaters, El Hamma Delegation, 2010 -2018

El Hamma – Chanchou Water Table							
	Number of equipe wells	Number of wells	Withdrawn Mm^3/year	Resources available Mm^3/year	Salinity (g/l)	Depth (m)	Exploitation rate %
2018	863	1083	8,96	4,4	3-7	-	-
2010	822	881	7,8	4,4	-	-	177 %
Jeffara El Hamma groundwater reservoir							
	Number of equipe wells	Number of wells	Withdrawn Mm^3/year	Resources available Mm^3/year	Salinity (g/l)	Depth (m)	
2018	-	33	13,68	28,5	-	-	-

[25] Source: Republique Tunisienne, Ministere de L'equipement, de L'habitat et de L'amenagement du Territoire, Direction Générale de l'Aménagement du Territoire, *Atlas Cartographique, Schéma Directeur d'Aménagement de la Région Economique du Sud-Est*, 2010.

The El Hamma treatment plant was built in 2004 with a budget of 600 thousand TND. It had a processing capacity of 4,060 m^3/day, for a unit cost of 0,9 TND/m^3 per day. The state of water treatment infrastructures in El Hamma in 2012 and 2018 is summarized in the following tables (table 49-61):

Table 50. – State of operation and construction cost of WWTP, BOD levels, El Hamma Delegation, 2012

Name	Treatment capacity (m3 / day)	Current average treatment rate (m3/day)	Level of Charge
	4,061	4,210	104%
El	Maximum load of BOD5 (kg/day)	Current charge (kg/j)	Level of Charge
Hamma	2,030	1,554	77%

Table 51. – Water treatment, general data, El Hamma Delegation, 2018

Connection rate %	Number of houses connected	Number of pumping stations	Sewage network (m)		Treatment plants			
			Rainwater drainage	ONAS network length	Treated water (m^3/Day)	Capacity (m^3/Day)	Number of subscribers	Number
94	9,400	5	-	106,000	4,490	4,060	10,462	1

Table 52. – Water consumption according to users, El Hamma Delegation, 2018

y	Tourism	Industry	Agriculture	Domestic use
1,720.9	0,0	2,4	-	1,718.5

Table 53. – Drinking water, beneficiaries, El Hamma Delegation, 2018

Total	Non communal	Communal
17,994	3,304	14,690

El Hamma center is a semi-continental oasis characterized by hot water resources (40 to 70 ° C) and by the production of the date palm of the Kenta variety, of significant commercial value. Small farms are generally low income and have poor access to the market. Traditionally forage crops are cultivated in association with palm trees, and most farmers look for other extra-agricultural activities. The oases hosting small farms are often at risk of abandonment. Medium-sized farms are more differentiated integrating arboriculture (especially pomegranate but also other fruit trees), market gardening in small plots, and goat sheep farming (together with alfalfa cultivations). Nevertheless, farmers get low farm incomes. Large farms practice more and more market gardening and fodder in association with palm and pomegranate, which generates adequate earnings.
A recent summary characterization of Tunisian oases[26], described the main characteristics of the traditional oasis. The identification of traditional oases was done by respecting well-defined criteria and was based on the use of water, the characteristics of the subunits according to geomorphology, geography, natural limits, territorial units, road banks. In summary, the main characteristics of traditional oases can be resumed as follow: Reduced size and fragmentation of farm property; A high density of palm trees (greater than 200 plants/ha); The predominance of commonly used varieties; "Khemmassat"[27] production relations; Soil irrigation system; A high density of fruit trees and a great diversity of species; The dominance of self-consumption and little openness to socio-economic environment.

[26] Republique Tunisienne, Ministère de l'Environnement Et du Développement Durable, Direction Générale de l'Environnement et de la Qualité de la Vie, *Projet «Elaboration d'une Monographie Complete des Oasis en Tunisie»*, Document 1 : Identification des oasis traditionnelles, 2015.

[27] A formal association contract at the end of which the sharecropper (khammes) contributes his labor power, the owner providing seeds, land, and often the working animals.

Table 54 . – Characteristics of the oases in the El Hamma Delegation, 2015

N°	Oasis	Typology	Surface (ha)	Parcels	Farmers
1	Bechima 1	Traditional	224	11	898
2	Bechima 2	Traditional	194	561	600
3	Ben Ghilouf	Traditional	220	484	403
4	El Adaouna	Traditional	75	353	420
5	El Khbayet	Traditional	100	150	177
6	Glib Dokhane	Traditional	70	158	177
7	Jroudou	Traditional	101	140	107
8	Mzira Hamma	Traditional	110	527	645
9	Oasis El Hamma	Traditional	505	2,461	2,109
10	Oued Enakhla	Traditional	30	28	30
11	Oued Ennour	Traditional	204	250	221
12	Ouled Amara	Traditional	62	200	210
13	Tkouri	Traditional	47	136	248

More generally, agriculture sector characteristics in El Hamma delegation are as follows:

Table 55 . – Land tenure (ha), El Hamma delegation, 2018

Total	State property	Common lands	Private lands
195,495	11,500	117,332	0

To implement treated waters use in agricolture, a project funded by GIZ (0,3 M€) under the *Promotion de l'Agriculture et du Développement Rural* (PAD) action, was held in the 2014 -2016 period in El Hamma.

Table 56 . – Irrigated perimeters, El Hamma delegation, 2018

Private irrigated perimeters		Public irrigated perimeters	
Surface (ha)	Number	Surface (ha)	Number
871	-	3,761	26

Several geothermal projects are ongoing around the oases of El Hamma. These have played a relevant role in the evolution of agricultural production systems. The governorate is well known for its large geothermal plantations, with international exporting companies operating in the segment of early produced non-organic fruits and vegetables.

Cultivation of tomato in the El Hamma region was boosted recently by the use of geothermal water as a new source of energy for heating greenhouse crops. In fact, despite a consolidated experience in Tunisia, the heating of greenhouses in the El Hamma region intensified only during the last decade. The geothermal resources in the area are relevant in terms of flow and temperature, ranking it between the most promising producing sites at the national level. Crops growing in heated greenhouse shelters require very high technicality, especially for the presence of highly saline waters. Tomatoes cultivated in El Hamma are distributed successfully in the European market for the quality of the product. At the moment, local production is increasingly specialized even so the limited extension of cultivated areas can restrain future expansion of the sector with respect to product demand. A productive cluster is already at work in the area to properly develop all the components of the sector, by supporting co-operative relationships.

Table 57 . – Distribution of cultivable land (ha), El Hamma delegation, 2018

Arboriculture	Legumes	Vegetables	Fodder	Cereals
-	420	1,258	1,425	4,202

Table 58 . – Annual crops, El Hamma delegation, 2018

Legumes		Vegetables		Fodder		Cereals	
Production (T)	Surface (ha)	Production (T)	Surface (ha)	Production (T)	Surface (ha)	Production (T)	Surface (ha)
208	420	50,742	1,258	73,664	1,425	2,111	4,202

Table 59 . – Breeding, livestock distribution (units), El Hamma delegation, 2018

Rabbits	Rabbits farming	Chickens	Beehives	Camels	Goats	Sheeps	Cattle
500	6	26,740	370	1,180	33,000	72,000	394

Table 60 . – Breeding - Production (tons), El Hamma delegation, 2018

Others				Meet						Milk
Leather	Wool	Honey	Eggs (thousands)	Rabbits	Poultry	Camels	Goats	Sheep	Cattle	Cattle
17	73	3	10,800	3	88	84	99	296	60	2,000

Table 61 . – Agricultural investments, projects, El Hamma delegation, 2018

Finalised projects			Approved projects			Planned projects		
Jobs	Investment (thousand DT)	Number	Jobs	Investment (thousand DT)	Number	Jobs	Investment (thousand DT)	Number
320	29	2	473	28,861	51	1,968	15,329	68

Projects

In El Hamma, hot water resources were traditionally used by hammams hosting more than one million bathers per year. A project for a modern thermal destination is on the horizon in Khabayet, 12 km west of the municipality of El Hamma. The initiative involves 137 ha, and it will focus on the integrated development of hydrotherapy and tourism. In 2004, the Office of Thermalism launched a feasibility study to boost thermal activity throughout the region of El Hamma. The drilling, with a significant flow rate, has already been completed. The project brings together the spas, the hammams, hotel and congress facilities, and a new residential area, including a golf course and gardens (Table 62-63).

Table 62 . – Tourism indicators, El Hamma delegation, 2018

Tourist restaurants	Travel agencies	Bed capacity	Hotels by category						
			Total	Other	1*	2*	3*	4*	5*
-	5	42	1	-	-	1	-	-	-

Table 63 . – Tourism indicators, El Hamma delegation, 2018

Occupancy rate (%)	Direct jobs		Average stay (days)	Overnight stays						Arrivals
	F	Total		Total	Other	1*	2*	3*	4*	5*	
10,8	-	-	1,6	1,660	-	-	1,660	-	-	-	1,013

TEST SITE - JERICO (PALESTINE)

By TIMESIS

Socio-economic Analysis

Date palm cultivation

In 2019, the production of dates from the city of Jericho area and its surroundings reached 6,000 tons, which represents about 55% of the total production of the Jordan Valley. In the Jericho area there are about 118,000 bearing trees, and the Madjool variety represents 98% of the entire palm orchard. In addition, there are 34,000 new trees which were planted in the last 3 to 4 years (Tab. 64). In the target study area, the number of trees is 76,000, which is 64% of the palms planted in Jericho. Usually farmers cultivate dates (Madjool variety) with 9 x 8 meters spacing, namely about 14 trees in one dunum (Fig.34-36).

Tab. 64 Date palm trees and production, year 2019 in the Jordan Valley

Variety	No of bearing trees (productive)	No of young trees	Tons
Madjool	211,146	80,473	10,175.3
Bari	3,103	660	437.7
Baladi	2,200	300	300
Dejletnoor	200	0	21
Total	216,649	81,433	10,934

Fig. 34 Irrigated palm orchard.

Fig. 35 Harvest of dates

Fig.36 Map of Jericho's plantations of date palms

The ownership structure of the farms

The total area involved in the WADISS project is about 17,000 dunums (Fig.37). It is limited by Road 90 from north and east, and by Jericho city from west. The land of the Arab Development Project Society (ADPS – see next paragraph) ends just to the wadi Quilt, then the Al Waqf land starts. Husaniyeh lands are located at the south-west of Jericho city.

The leasing land systems present in the area are described in the following: a) leasing for which farmers pay yearly leasing fees. The fees amount can vary along the leasing contract period; b) leasing fee based on percentage of production. This depends on the type of crops and if the land owner provides the farmers with land only, or land with water for irrigation; c) leasing as a partnership that both farmer and land owner share 50/50 the cost of production and share the profit by 50% each.

Most of the contracts are based on the farmers' willingness to provide management and labour for agriculture activities. The land owner leases the field to farmers and companies which use the land mostly to cultivate date palms, while very few of them prefer to grow other crops, like vegetables and fodder crops.

In the following, the main farming organisations, active in the study area, are described.

The Arab Development Project Society

The land of the Arab Development Project Society is located to the east side of Jericho. The land is shown in Figure 12, inside the green boundary. Road 90 is highlighted in blue. This road is an Israeli road, and it was built prior to the Oslo agreement. It serves the Israeli vehicles crossing along the Jordan Valley. For the Palestinian farmers it is prohibited to cultivate the land on the other side of Road 90, even if they own that land and it is located in Area C.

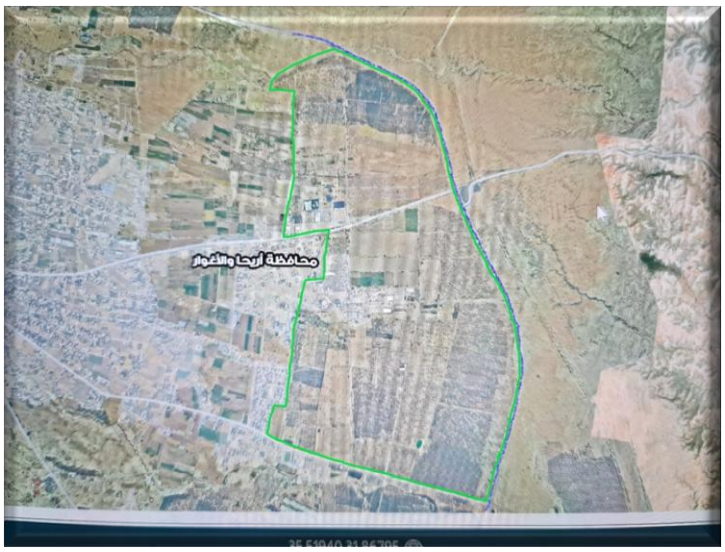


Fig.37 The land of the Arab Development Project Society (inside the green border)

The Arab Development project society (ADPS) has more than 9,000 dunums. Out of this area, 3,000 dunums are not cultivated due to the restriction of the Israeli measures, which prohibits cultivation of lands east of the Road 90. The remaining 6,000 dunums are cultivated directly by ADPS, or they are leased in part to other farmers. Soil and irrigation water available in the ADPS's area are characterised by high salinity. In particular, salinity of water is considered as "severe" because it reaches 7.6 mS/cm-1. This degree of water salinity limits the crop typologies which can grow in the area, especially date palms and fodder crops. Some tenant farmers grow watermelon, melon and melokhya, but

the production of these vegetables is unsatisfactory, both in quantity and quality. Date quality is also affected by salinity: plants show poor vegetative growth and fruits remain of small size. The leasing rate for land is considerably high (150-200 JD - Jordan dinar). The ADPS does not provide water resource and the tenant has to drill its own borehole well to get water for irrigation.

Al Waqf Lands

The Islamic Waqf lands are spread mostly in the areas of the Jordan Valley and Jerusalem. In the study area the Islamic Waqf owns 5,400 dunums (see Figure 13, inside the yellow boundary). East of the property, there is Road 90 (in blue). The Waqf lands are leased to farmers and companies performing agriculture and some industrial activities. At present, there are 30 different tenants. Among these, 5 companies and 25 individual farmers grow date palms. The contract with Islamic Waqf has a growing rate by years, as following:

1 - 5 years the rate is 75 JD/dunum
5 - 15 years the rate is 125 JD/ dunum
15 - 25 years the rate is 200JD/ dunum
25 - 35 years the rate is 250 JD/ dunum.

The Islamic Waqf allows farmers to drill water boreholes to get water, many unplanned boreholes have been drilled in the area, the quality of water is saline and in some times can reach 13ms/cm.

Fig. 13 Alwaqf land in the study area

Al Husaniyeh Lands

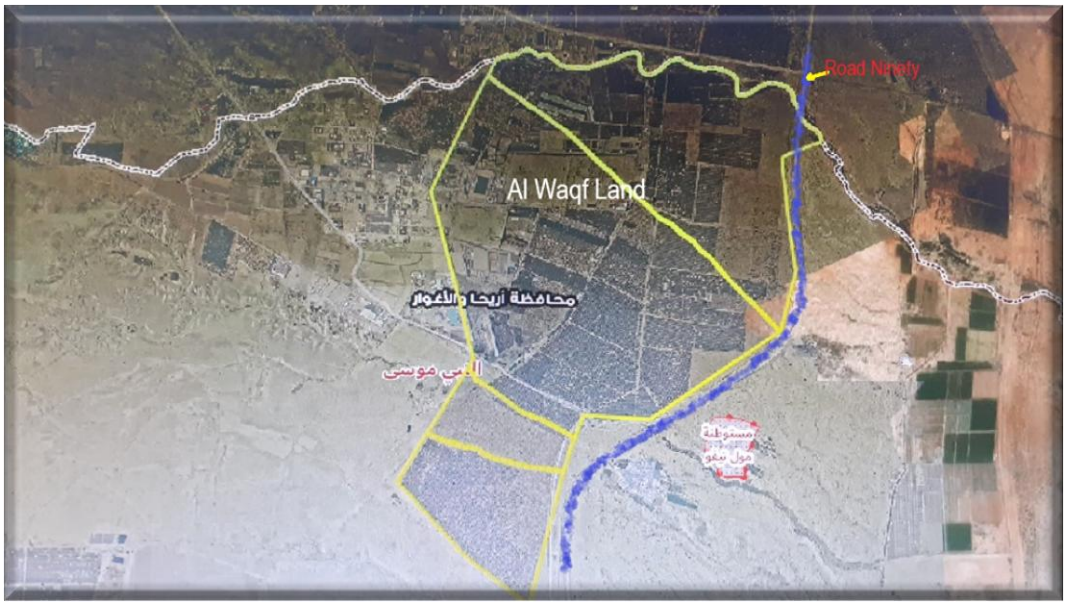
The Al Husaniyeh Family is one of the biggest land owners in the area. The total land is about 25,000 dunums. In the study area, they leased 5,000 dunums for dates cultivations. The leasing terms are based on production. The land owner gets 15% for the land and another 10% of production in case it provides water resources. The water in the area is moderately saline; mainly dates can be cultivated in that land.

Main constraints to farm productivity

As mentioned earlier, the most represented crop in the area is the date palm. Constraints to productivity relate to limited availability of certain inputs (fertilisers, specific pesticides, etc.) and to the lack of technical skills by most of the farmers on modern date palms cultivation. But main problems are represented by limited availability of water and its quality, as discussed below.

Water availability and water quality

There is misconception between the notion of salinity tolerance and drought tolerance of date palm trees. Recently, research on water salinity effect on date palm growth and productivity showed that water with EC of 4 mS/cm and above can severely limit the plant growth, reduce production and affect the quality of the fruits. Generally, plants are not able to uptake more than 35% of the available soil moisture. The average quantity of water available for each mature and fully productive date palm, in the study area, is at maximum 60 m3 per year. But according to the farmers, an amount of 100 m3 per year would increase production by more than 30%.



In order to save water, all farmers use the drip irrigation system. The flow rate of drippers in most farms is 8 litres/hour. Farmers however do not use pressure-compensated drippers, which would guarantee high uniformity of water distribution, because the poor quality of the water would clog it. It is therefore recommended to install filters to decrease the suspended dirt and microorganisms' particles.

Water resources

In the target area, sample of wells water has been tested recently and showed high salinity. In certain wells EC can reach even 13mS/cm. Water abstracted from the majority of wells has an average EC of 7.6 mS/cm. This urges the farmers and companies to look for other water alternatives. An option is to buy water from other wells, located some 14 km away from farms, which however requires high investments and makes the operation expensive. Farmers drill wells at different depth to try to get more water and of better quality. On the other hand, many wells have been dried off by excessive abstraction, or because the water table went too deep.

Well boreholes

In the Jericho area there are about 100 operational wells. The water depth in most wells reaches 80-120 meters and the average discharge is about 40 m3/hour. In general, farmers never declare how much water or how many wells they have, because of the political situation and regulations that prohibit drilling any well in the area.

Stormwater harvesting

Farmers having land close to the wadi Al Qilt built stormwater harvesting ponds. They collect water in winter and pump it to their farms and store it for irrigation. This source of water is not however guaranteed because it depends on the rainy season, every year. The quality of this water is good and farmers use it to wash the salts accumulated along the soil profile.

Jericho Effluent treatment Plant

The effluent plant was built in 2014. It has a maximum capacity of 9,800 m3 daily, but the average quantity of treated effluent water is 6,600 m3, every day. Currently, however, the effluent plant is producing just 1,300 m3 daily. Since 2016, farmers have been applying treated water in their orchards. Today, there are 7 farmers using effluent water for irrigation. Other farmers requested this water and are waiting for the approval from the authorities. The current capacity of storage of the treatment plant is 1,000 m3 of treated effluent water. When authorised, farmers sign an agreement with the Municipality of Jericho, which describes the required water quantity and the fees to be paid yearly, in advance. The farmers can get their quota daily and the municipality guarantees to supply the agreed quantity. In case of any technical problem or unexpected change in effluent water quality, which happened few times during the past, the effluent plant management diverts water to the wadi and compensate the farmers later on with the balance quantity when the problem is solved. Chemical and biological characteristics of the effluent are shown in Annex 1.

To receive the effluent, the farmers have to install all necessary pipes, pumps and all accessories required. The effluent treatment plant offers room to install the pumps inside its premises, including an electricity connection point. The farmers are charged 0.5 ILS per m3 of treated water in addition to the electricity charges of treated water pumping to their farms.

The General Directorate of agriculture of Jericho receives periodical reports on the quality of the treated effluent. Nevertheless, the survey highlights that, after approving the use of treated water in agricultural fields, nor the competent authority nor private and public researchers show interest on assessing the effects of using such water in irrigation for dates. However, farmers show general satisfaction because they can mix the treated water (characterised by low EC) with the (saline) water of their wells, thus obtaining an irrigation water of acceptable quality. Furthermore, the effluent contains nutrients which are useful for the date palms.

Agriculture inputs availability

In terms of inputs availability, fertilisers like urea, potassium (well known as Ashlaghan) and compound fertilisers 20.20.20 and 30.9.18. are strictly prohibited by Israel in the Palestinian territories. This ban raises the price of the other (low quality) fertilisers, ranging from 500 to 900 USD/ton.

Knowhow and technical extension shortage

There is need of trained technical extension and technical expertise. This is particularly true for date palm cultivation. Experienced experts are required especially for training small farmers and supervise their work. In addition, technical skills of workers in the date packing houses need to be improved.

Pest control

The most harmful pest in the world for date palm orchards is the Red Palm weevil, which causes huge economic damage. In the project area, adults of this pest were recently caught and a few trees show symptoms of damage. It is necessary to set up, as soon as possible, a comprehensive integrated protocol for monitoring and early warning of the incidence of the weevil, before an outbreak starts.

Overall production costs of date palm

The date palm cultivation requires high investment. The required investment to establish one dunum and the cost for the first year is about 3,000 USD. The yearly operation and maintenance costs are estimated as 1,300 USD/dun. Harvest starts 4 years after planting, yielding 30% of the potential yearly production. The breakeven year to cover the cost of operation can be achieved in the fifth year and the plantation will return its investment on the ninth year. In the Tab. 65, different types of operation costs for 100 dunums and expected income are shown. The productivity depends on the availability of adequate quantities of good quality water for irrigation. The harvesting months and the expected production of dates of 100 dunums are shown in Tab. 66. The cost of water per cubic meter reflects the actual cost of drilling the well and its operation, also considering its expected total water discharge during its lifespan.

Tab. 65 Yearly operation costs and income for 100 dunums of date palm

items	Unit	Yearly Amount 2021	Yearly Amount 2022	Yearly Amount 2023	Yearly Amount 2024	Yearly Amount 2025	Yearly Amount 2026	Yearly Amount 2027	Yearly Amount 2028	Yearly Amount 2029
Yield and Value in ILS										
Qty of Dates production	Ton	0.00	0.00	0.00	33.60	56.00	78.40	112.00	112.00	112.00
Value of Dates produced	ILS	0.00	0.00	0.00	141,120.00	235,200.00	329,280.00	470,400.00	470,400.00	470,400.00
Costs										
installation cost	Total	19,200	0	0	0	0	0	0	0	0
Cost of Irrigation 10%	Cost Dep10%	1,450	1,450	1,450	1,450	1,450	1,450	1,450	1,450	1,450
Manure and Plant transplant	Total	162,500	0	0	0	0	0	0	0	0
Managemnt and consumables	Total	85,080	90,080	95,080	105,080	115,080	115,080	115,080	115,080	115,080
Irrigation	0.6USD/M3	21,600	43,200	75,600	91,800	108,000	108,000	108,000	108,000	108,000
Machinery	Lump	2,000.00	3,000.00	3,000.00	4,000.00	4,000.00	5,000.00	5,000.00	5,000.00	5,000.00
Total Cost / Year USD	USD	291,830	137,730	175,130	202,330	228,530	229,530	229,530	229,530	229,530
Total Income	USD	0	0	0	141,120	235,200	329,280	470,400	470,400	470,400
Cost/Profit	USD	-291,830	-137,730	-175,130	-61,210	6,670	99,750	240,870	240,870	240,870
Increment cash flow Not discounted	USD	-291,830	-429,560	-604,690	-665,900	-659,230	-559,480	-318,610	-77,740	163,130

Tab. 66 Expected production of 100 dunums for 9 years

Production of Dates		Farm Area in Ha		10		Unit Price USD/ton		4200			USD
		Kg/ Dates tree		80 kg				4200/ton			
	Month	2021	2022	2023	2024 (30%)	2025 (50%)	2026 (70%)	2027 (100%)	2028 (100%)	2029 (100%)	Monthly%
1	January	-	0	0	0	0	0	0	0	0	0%
2	February	-	0	0	0	0	0	0	0	0	0%
3	March	-	0	0	0	0	0	0	0	0	0%
4	April	-	0	0	0	0	0	0	0	0	0%
5	May	-	0	0	0	0	0	0	0	0	0%
6	June	-	0	0	0	0	0	0	0	0	0%
7	July	-	0	0	0	0	0	0	0	0	0%
8	August	-	0	0	0.218	0.364	0.510	0.728	0.728	0.728	65%
9	September	-	0	0	0.118	0.196	0.274	0.392	0.392	0.392	35%
10	October	-	0	0	0	0	0	0	0	0	0%
11	November	0	0	0	0	0	0	0	0	0	0%
12	December	0	0	0	0	0	0	0	0	0	0%
	Total Per Dunom (Ton)	0	0	0	0.336	0.560	0.784	1.120	1.120	1.120	100%
	Total Per Farm Production	0	0	0	33.600	56.000	78.400	112.000	112.000	112.000	
	Incremint Production	0	0	0	33.600	89.600	168.000	280.000	392.000	504.000	
	Expected price/year (USD/Ton)	4200	4200	4200	4200	4200	4200	4200	4200	4200	
	Value of production /year	0	0	0	141,120	235,200	329,280	470,400	470,400	470,400	
	Average production /du	1.120	at 80 kg/ tree at year 7 onward								

Processing and marketing of dates

The existing market and crop prices

Despite the interruption of marketing channels during year 2020 due the epidemic Covid19, the Palestinian dates are highly demanded locally and by the international markets. There are about 22 destination countries for all grades of dates. The prices depend on grades and range between 2.9 – 10 USD/kg. Typically, in the project's area, 75% of production is characterised by premium choice grades while 15% of production is Jamboo and Superjamboo grades.

However, the export of dates out of the Palestinian territories is hampered by the controls carried out by Israeli authorities. All cross borders commodities in and out Palestine must get the approval of the Israeli customs. The control measures always delay the shipments before and during the crossing borders movement (Fig.38). All

Fig. 38 Preparation of one shipment of dates at the packing house

these measures make the shipping expensive and not secured to reach on time to ports or airports. At local market level, it was observed that Israel dumps their previous seasons dates with very low quality in the Palestinian market.

Post-harvest facilities

In the Jericho area there are 10 packaging and sorting plants (see Tab. 67). These companies have in general good management and packaging plants are well equipped. These facilities have an automatic cleaning system which makes the quality control operations compatible with international standards. Some other medium size farms are performing pre-sorting and cleaning activities before sending to final packaging and cold storage. Besides the packaging plants, in the area of Jericho there are 7 cold storage facilities with capacity of about 4,000 tons, which however does not cover the current production.

Tab.67 List of dates companies in Jericho area

	Name of packing houses and cold storage facilities	Establishment year
1	PADECO Holding - Nakheel Palestine	2010
2	Al Awael Company	2012
3	Palestine Dates Company	2017
4	Al Sultan Dates Company	2011
5	Al Zaruon Al Arab Company	2013
6	Qetaf Company	2017
7	Al Rowad Company	2010
8	Sinokrot Holding, Agriculture PAL Garden company	2009
9	Date Palm Association cold storage	2019
10	Al Reef Company	2010

Processing facilities

There are several kinds of by-products, deriving from the date palm cultivation and processing, which can be reused in the production cycle. In the Jericho area there are factories which are specialised in these recycling activities. One is the production of organic fertiliser (compost) from the palm leaves. The compost is used as fertiliser and like a mulching material, to be placed around the trunk. In Jericho there are 3 factories of compost fertiliser. Another recycling activity consists in processing together waste of fruits, dates stones, rejected quality dates fruits and palm leaves to produce silage feeding for animals (sheep, cows, camels, horses).

One sugar factory is under construction in Jericho. It will use as raw materials the low quality and rejected dates fruits to produce sugar.

There is also a carton paper factory, which produces eggs trays. As raw materials, the factory uses the leaves and the fronds of date palms.

Finally, there are several factories which produce molasses and dates paste from dates fruits.

Gender division of labour in irrigated agricultural production

As previously mentioned, in the target area, the majority of farms are managed by big farmers and companies, and the land is mainly cultivated with date palms. There are about 120 dunums cultivated with fodder crops and another 250 dunums cultivated with vegetables, like watermelons and sweet melons. It was observed that no women work in the field, as field work is usually restricted to men because it requires specific skills and strength. Instead, women are highly involved in pre-sorting and sorting, cleaning and packaging the dates: So, they are employed in the pack houses. It is clarified that 80% of the workers are women, counting about 1,000 women in the high season and 200 women employed full time.

The locally available Agricultural Extension and Research Services and availability of specialised private advisory services

In the Jericho district there are many public and private institutions which provide services to the agriculture sector. The General Directorate of Agriculture (GDA) and the National Agriculture Research Centre (NARC) are the representatives of the Ministry of Agriculture in the area. The GDA is responsible mainly for the dissemination to the farmers of good agricultural practices. GDA supervises the implementation of the projects foreseen by the agriculture development plan, which is supported by donors and the government of Palestinian Authority. In addition to that, the GDA has regulatory tasks, like for example assisting the traders and companies to get the permits to transport the produce locally and to export it internationally.

The GDA is organised in several thematic divisions such as field crops, protected vegetables, open field crops, livestock, beekeeping and palm dates. The extensionists are in charge of providing specialised technical advice and training to the farmers. The GDA's staff are in continuous contact with farmers in the concerned field of speciality. In the course of field visits, the extensionist collects information from the farmers on issues arose from the cultivated areas and crops. Then, the extensionist liaises with relevant institutions for the identification of suitable technical solutions for the problems raised by the farmers. It is noted that the big companies growing date palms have their own technical staff and do not usually ask advice to the GDA (Fig.38-40).

Fig. 38, 39 Interviewing an extensionist of the GDA (left) and a palm date farmer (right)

Fig. 40 Interviewing a trader at the central market of Jericho

Agriculture research in Jericho is mainly carried out by the NARC. The organisation has its own experimental stations in the centre of Jericho city. The Agriculture Faculty of Al QUDS open University carries out research activities as well. However, both the institutions have limited activities and weak impact on the agriculture sector due to shortage of funds.
Other opportunities of technical advice for the farmers are offered by private companies. In the area of Jericho, two main companies (Al Sharabati Co. and Sabie Co.) provide technical support to farmers principally on the proper choice and use of fertilisers and pesticides. Nevertheless, farmers need more specialised assistance on specific aspects of the production cycle, such as irrigation based on unconventional water resources, drip irrigation with modern technology, use of salt-resistant varieties, organic manuring, etc.

Farmers raised issues and recommendations for the agricultural development in the target area

Establishing date palm plantations requires important and long-term investments (see above). Therefore, for the farmers the availability of financial resources (also in the shape of bank loan) sometimes represents an obstacle. In addition to the financial problems, the interviewed farmers emphasised the main issues which presently undermine the agricultural sector in the Jericho area.
The main problem facing agriculture in Jordan valley is water availability and water quality. Despite the Palestinian rights on surface and underground water, Israeli authorities are controlling all kind of water resources in the area. Even water springs in different locations, like Jericho, Duok, Al Nweimeh, Ouja, Fasayyel and others, which are located in the so-called Area A, the Israeli water authorities drills boreholes on the underground channels or streams of these springs, so affecting the flow rate. The Joint Water Committee (JWC) has been formed from the Israeli and the Palestinian water authorities for respecting the Oslo agreement, which provides that no new tube well can be drilled or conveyance water pipes installed unless authorised by this committee. But the mainly achievement of the JWC was obtaining few permits to drill wells and extract water for the municipalities and not for agriculture use. For the last 30 years, the demand of fresh water for domestic use has continuously increased. As a consequence, the authorities drastically reduced the flow of fresh water to agriculture and diverted it to domestic use. Farmers therefore had to use water of poor quality, for irrigation. Brackish water is available from the wells but it is not suitable for most of the crops. Date palm trees can withstand moderate salinity, but vegetative growth and productivity are weak.
Palestinians are also facing a huge problem of housing, especially in major cities and mainly in Jerusalem. People from Jerusalem come to Jericho to buy land and construct their houses there. As result, land originally used for farming was converted to resident areas, and the farmers had to move to land with problems of salinity and sodic soils.

Recommendations from the farmers

Farmers raised important recommendations to be handled and supported by agricultural institutions for the development of the date palm sector in the Jordan Valley. They are briefly listed below:

- Introduce innovative irrigation management technologies in order to efficiently use the available water resources;
- Introduction of computerised irrigation and fertigation management systems;
- Support and introduce new irrigation pressure compensate drippers and filtration systems;
- Introduce electromagnetic technologies to reduce the effects of salinity of water and soil;
- Introduce monitoring technologies for irrigation scheduling and nutrients testing in soil and plant;
- Palm cultivation projects should be supported with facilities and protection by the Authority, enabling positive environment to allow private sector to invest in agriculture;
- Approval of the Agricultural Insurance Fund;
- Protection by arbitrary occupation measures by Israeli authorities.

Looking forward

All the entities that own vast agricultural lands, such as the Islamic Waqf, the Husseini family, the Arab Development Project Society, the senior landowners of Auja, Fasayel and Jefllik localities should follow up on the process of registering their lands in Area C as quickly as possible and not leave arguments for occupation to control them, in cooperation with the Palestinian Authority, especially the Tabo department (land registration authority), the Ministry of Justice and Islamic Endowments. These areas should be soon planted with palm trees

to protect them from occupation. However, acceptable water quality and quantity should be ensured by local authorities, compatible with the requirements of the palm.
Private and government institutions should pay attention to the dates sector. There is a strong need of building capacity of the stakeholders and to establish a research platform about dates production and processing, including training courses for the actors and establishment of laboratories.
Financial institutions and banks should be encouraged to support financially this sector and take advantage from the financing opportunities offered by EU loans and Japanese programs, as the business risk in this sector is very low compared to other agricultural sectors.

Foreseen activities

The Association of palm tree growers of Jericho is building a large system of water distribution, to extend irrigation to a vast area of the Jordan Valley, including as well uncultivated fields where new palm orchards can be planted.
The MEDISS project will test the best combination of 3 diverse sources of water, which are currently available to feed the new water distribution system:
a) rainwater, which is seasonally collected by a nearby water stream
b) treated wastewater, from the WWTP of Jericho
c) salty/brackish water, as abstracted by the local wells (already in use to irrigate the palm trees).
Thirteen voluntary farmers will test the effect of the water on the growth and production of their palm orchards.
The trial will start as soon the foreseen project's works will be completed, tentatively by end of January 2022. The experiment will last until the end of the project. The consultant will visit the project area and design a detailed action plan together with local project staff and the 13 farmers. Furthermore, he will provide technical monitoring all along the duration of the trial.

Annex - List of interviewed farmers in Jericho

Name	Occupation	Organization	Location
Eng. Ahmad Al Fares	Head of Department of Agriculture Jericho and JV	MoA	Jericho
Eng. Omer Sawaftah	Agriculture control Head of Division	MoA	Jericho
Eng. Amin Daraghmeh	Extension Protected Vegetables Head of Division	MoA	Jericho
Awad Daraghmeh	Extension Date Palm Head of Division	MoA	Jericho
Eng. RaieK Bsharat	Plant protection Head of Division	MoA	Jericho
Eng. Ibrahim Seibah	Jericho effluent water treatment plant Manager	MoJ	Jericho
Mr. Judeh Iseed	Palestinian Paysants Union Head of Jericho branch	PPU	Jericho
Ayman Al Taweel	Farmer- date Palm	Private	Jer- Target area
Ismael Daik	Farmer- date Palm	Private	Jer- Target area
Jamal Jarrar	Farmer- date Palm	Private	Jer- Target area
Omer Bsharat	Arab Development Project Society GM	ADPS	Jer- Target area
Ramadan Hmaidat	farmer- vegetables and date Palm	Private	Jericho
Harb Farhan	Farmer dates	Private	Jer- Target area
Imran Al Walagi	Farm Manager- ADPS	ADPS	Jer- Target area
Faisal Abu Sakker	Farmer dates and watermelon	Private	Jer- Target area
Belal Eseed	Farmer dates	Private	Jer- Target area

Eisa Eisawi	Farmer dates	Private	Jer- Target area
Mosaab Ameereh	Farmer dates	Private	Jer- Target area

4 Project have implemented by members of BoE in concert with Capitalization plan:

TUNISIE

Study of the vulnerability and risks of contamination of the water table in the region of Wadi Echerka Bachima (south-eastern Tunisia).
Proposal for intervention methodology: aspect risks of contamination of the Wadi Echerka Bachima aquifer
Cost: Euro 150.000

ITALY

Regione Autonoma della Sardegna (RAS)	
E.Wa.S. Soluzioni per l'Ambiente e per l'Acqua	
E.Wa.S. Environmental and Water Solutions	
Nome: Uganda - Codice: |2|8|5|	
Africa, Uganda, West Nile, Distretti di Adjumani, Moyo e Obongi.	
Nome Completo	Natura Giuridica (*per le OSC, specificare altresì se iscritte all'Elenco AICS di cui all'art.26, c.3 della L. n. 125/2014*)
Adjumani District Local Government (controparte)	Autorità locale (Uganda)
Ente Acque della Sardegna ENAS (partner)	Ente regionale (Italia)
Muni University (partner)	Università pubblica (Uganda)
Regione Piemonte	Ente regionale (Italia)
Comune di Oristano (partner)	Ente territoriale (Italia)
ACAV - Associazione Centro Aiuti Volontari (partner)	OSC iscritta all'elenco AICS (Italia)
DREO - Associazione Deborah Ricciu Espandere Orizzonti (partner)	OSC NON iscritta all'elenco AICS (Italia)
Università di Sassari (partner)	Ente pubblico nazionale (Italia)
24 mesi	

€ 1.100.004,20

JORDAN

Project name: - Sea water Mobile Desalination plant on truck capacity of 100 m3/hr
Project Description: - This project will include complete Sea Water Desalination plant to treat the Sea water from the Red Sea to provide the local community with treated Sea water suitable drinking water. All the desalination components are pre-assembled in 1 to 2 containers, including the piping and control systems, which considerably reduces the on-site installation workload and time required for effective fresh water production
Project Objectives: - In case of emergency this project will provide the community with drinking water, and this produced water will be another source for human use in the case of water shortage
Benefit: Minimal site preparation required for Mobile Water Treatment Plants including civil works, electrical trenching, pipe trenching concrete slabs etc are mostly avoided • No expensive purpose built building required • No expensive onsite installation • Systems are often prebuilt allowing faster delivery • Equipment is mobile and can be moved from site to site • Infrastructure of lighting, safety showers, electrical distribution, emergency lighting, climate control are all inclusive with the container and do not require separate building services
Project cost: - The estimated cost of this project approximately 450,000.00 Euros

JERICO

Strategic Initiatives for the Treatment and Sustainable Reuse of Non-Conventional Water in Mediterranean Agriculture – SIWaMA ENI CBC MED Strategic

B.4 Environmental protection, climate change adaptation and mitigation

B.4.1: Water management - Support sustainable initiatives targeting innovative and technological solutions to increase water efficiency

Partnership (max 10) to be confirmed:

1. IAMB (INT)
2. NRD-UNISS (IT)
3. IEMed (ES)
4. CENTA (ES)
5. Lisode (FR)
6. Lebanese Agriculture Research Institute LARI (LB) + (Litani River Authority, Ministry of Agriculture, Bekaa Water Establishment) as associated
7. Union Arab Banks (INT)
8. Palestinian Wastewater Engineers Group PWEG (PS) + Associated PWA + Associated Municipality
9. Royal Scientific Society + Associated Al-Karak Municipality (JO)

The planned duration of a project must be between 24 and 30 months.

The project will contribute to the development of new public policies and policy-relevant innovations. Its effects will be long-lasting and far-reaching, fostering significant change through the achievement of sustainable, tangible and replicable results that last beyond the end of the Programme financial support, and the transferability of good practices. In terms of participation, it will bring together key public and private actors at all levels (national, regional and local) with extensive experience and competencies to foster impact, change and policy innovation.

General objective

Support national and regional learning alliances to address the challenges of non- conventional water treatment and reuse in agriculture in the Mediterranean Region.

Specific objective

Improving water management at a regional scale focusing on the agricultural sector by governing the use of treated wastewater in irrigated agriculture and increasing water-use efficiency, while reducing the negative environmental impact.
Upgrading and upscaling of sustainable solutions in treatment and reuse
Developing national strategic plans to support new public policies to make the next policy steps.
Initiating science-policy dialogue and engaging and connecting across the Mediterranean key stakeholders to accelerate the replication of viable solutions

Project management (WP1)

Output: Kick off (KOM) and 1st Steering Committee (SCM) meetings
Activity: Project start-up

Output: Coordination and management documents
Activity 1: Project management (communication and support)

Activity 2: Project management (monitoring and evaluation)

Output: Administrative and financial management documents
Activity: Administrative and financial management

Project communication (WP2)

Output: Communication/dissemination plan
Activity: Communication and dissemination strategies

Output: Dissemination events
Activity: Realization of dissemination events for visibility, capitalizing the Lessons Learnt, Good Practices and Success Stories

Adaptation of best technological solutions and practices to improve water efficiency (WP3)

Output: Technical report
Activity: Assessment of plants and identification of weakness points

Output: Post treatment and reuse technical reports (water quality and water use efficiency)
Activity: Upgrading of best technological solutions to improve water quality

Activity: Upgrading of best technological solutions to reuse NCW in agriculture

Peer-to-Peer Experience Sharing and Dialogue (WP4)

Output: Interchange of experiences (web platform, field visits)

Activity 1: Cross border exchanges (technicians, farmers, civil society organizations and relevant stakeholders)

Activity 2: Facilitate exchange with and among the standard projects funded under the First Call for proposal ENI CBC MED 2014-2020 B.4.1 to promote promising innovations in treatment and reuse at regional level.

Activity 3: Initiate web communication/experience sharing sessions among water experts, practitioners and Mediterranean Youth Water Networks.

Output: Tailored training events on water use efficiency and non-conventional water addressed to farmers' associations, practitioners, public institutions and other relevant stakeholders

Activity 1: Transfer of water mgnt solutions and to improve use efficiency and quality and use of NCW in agriculture addressed to farmers' association;

Activity 2: Capacity building activity on water mgnt solution and quality standards focusing in particular on technological solutions for treatment and reuse addressed to technician, practitioners and public authorities

Output: Economic model of management solutions and technologies

Activity 1: Economic evaluation of proposed technological solutions

Activity 2: Initiatives to promote the mgnt solutions and technologies to private sectors and public authorities

Output: Water management and local governance plans

Activity 1: Definition/update of quality standards for treatment and reuse in agriculture (LB, JO);

Activity 2: Preparation of decentralized wastewater management strategy for WW management (PL) with public authorities;

Activity 3: Initiate a dialogue at national level and among the different project partner countries with concerted stakeholders.

Policies (WP5)

Output: Comparative assessment report

Activity 1: Comparative assessment of national development plans on the use of water in agriculture in the MPC (Mediterranean Partner countries);

Output: Cross-border alliances on water in agriculture involving relevant stakeholders to compile, disseminate and further develop technological solutions and stakeholder dialogue and water governance approaches.

Activity 1: Mapping of relevant stakeholders;

Activity 2: Implementation of multi-thematic roundtables of key stakeholders (inside and outside the water domain) supported by a multidisciplinary workforce (science policy dialogue);

Activity 3: Creation of strategic alliances aiming at resolving past management bottlenecks including cultural barriers, institutional fragmentation, inappropriate regulations and lack of financial models for cost recovery (YOUTH network).

Output: Initiatives to up-scale and attract investments

Activity 1: Promotion of the innovative technologies through dedicated events addressed to private sector with view of their commercialisation.

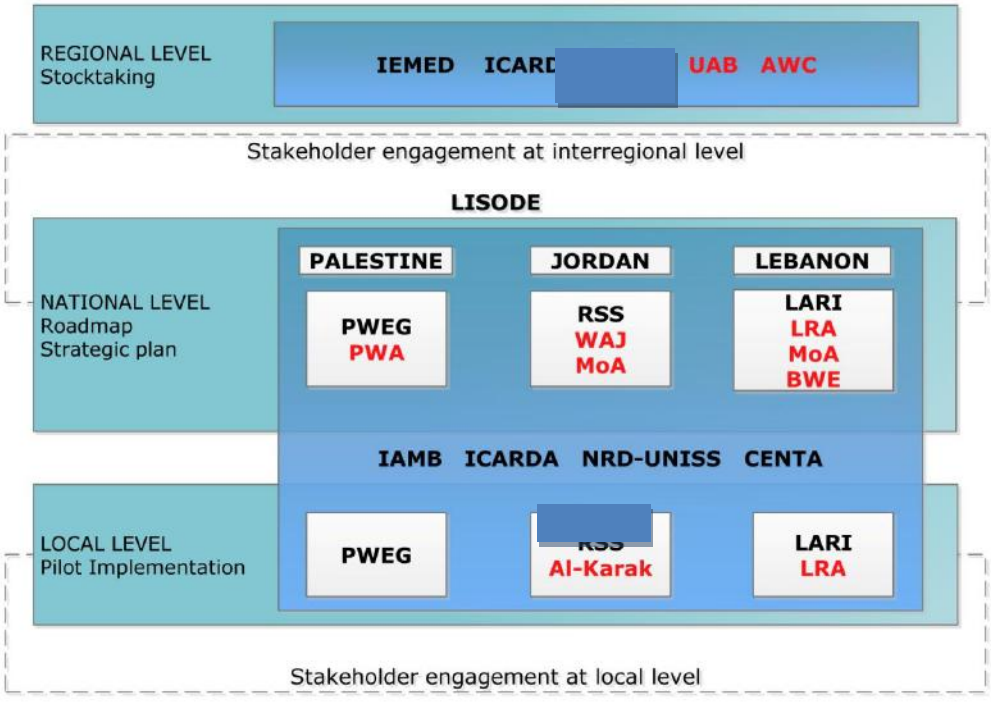
Activity 2: Organization of events addressed to financing Institutions and public authorities to anchor potential investment lines and incentives for up-scaling and replication of the innovative technologies.

Output: White papers and policy recommendations.

Activity 1: Contribute to enhance policies, encourage investments, upgrade governance and implement best practices to sustainably increase water and land productivity, providing tools for strategic planning of optimal and sustainable allocation of scarce water resources.

Palestinian Water Authority (PWA) will be associated partner to the SIWaMA project proposal for the following reasons **(Proposed by PWEG):**

1. Palestinian Water Authority is the institution to regulate the water and wastewater sector all over the Palestinian Territories;
2. One of its functions is to develop plans (long term, medium and short term) for the best management and protection of water resources;
3. Wastewater management is considered one of the top priorities within its strategy;
4. Wastewater treatment and reuse are the key elements in the protection of environment and a substantial nonconventional resources for agriculture and industrial uses;
5. Since the area is suffering from water shortages, Treated Wastewater is a potential source to be used is agriculture and therefore alleviate the burden in the use of fresh water which is very important to reduce the huge gap between demand and supply for agricultural use;
6. Officials and technicians of PWA are considered an important target group for the project and they will be involved in capacity building activities such as training sessions, south-south exchange experiences to share ideas and best practices;
7. PWA will be involved in interregional roundtables where disseminate and further develop technological solutions aiming at improving water governance and policies.



IEMed can:

lead the interaction/dialogue with policy makers and stakeholders in the Mediterranean region through a wide variety of formats;

manage easily activities related to the communication, edition and production of publications, dissemination and outreach;

generate different kinds of synergies with the networks we coordinate: EuroMeSCo, Medthink5 + 5, Euro Mediterranean Women Foundation, Anna Lindh Foundation's Spanish Network, MedConfederation.

Notes:

In Lebanon, the project will have synergies with Re-water and will build on the experience of ACLIMAS (SWIM-demo project). (treatment, reuse, irrigation best practices Codice per l'uso acqua in agricoltura.). With a pilot in kherbet kanafar-west bekaa, upper litany.

Joub Jannine (1 WWTP and 1 artificial wetland)

General information

This site combines two treatment facilities: the Joub Jannine (JJ) Water Treatment Plant and the Joub Jannine constructed wetland.

Joub Jannine WTP

JJ WWTP is one of the biggest treatment plants of the Bekaa. It was built around 10 years ago by the CDR (Center for Development and Reconstruction) and is now managed by the BWE (Bekaa Water Establishment) through a private company, Nazih Breidy. It is located on the right bank of the Litani River, just upstream to the Litani River Authority Rural Development Center. It is surrounded by large agricultural lands, relying mainly on private wells for irrigation.

It uses activated sludge as a treatment technique. It has a maximum treatment capacity of10,000 m^3/day. The current volume treated is between 5 and 6,000 m^3/day. It is equipped to provide tertiary treatment but the latter is not operational. The effluent goes to the Litani River where it is mixed with highly polluted water. It is indirectly reused by some farmers pumping from the Litani River downstream. 2 Tons of sludge are produced daily. They are disposed in a big field located next to the plant. Farmers of neighboring lands come to take some sludge to use it as a fertilizer, without paying any cost to the BWE.

Joub Jannine Artificial wetland

There is an artificial wet land (2.5 ha in size) just downstream to the WTP, also located at the right Bank on the Litani River. It was implemented by a USAID project (2009-2014) to provide improved water quality downstream and to serve as a pilot to develop more natural treatment techniques along the Litani (LRBMS, 2012). Scientific information was recently produced regarding the quantitative and qualitative performance of this wet-land (Abi-Saab et al, 2018).

Management

The two facilities are managed by two different institutions and are operated independently. To our knowledge no collaboration exists between these two institutions.

Joub Jannine WWTP

Joub Jannine WWTP was built around 10 years ago by the CDR and was operated under the responsibility of this institution until 1.5 years ago, when it was transferred to the BWE. By mandate, the BWE is in charge of the operation of water and wastewater facilities in its area of jurisdiction (the Bekaa Mohafaza).

The BWE manages JJ WWTP through a private company (Nazih Breidy). Since JJ was transferred to the BWE, there was a decision to improve its operation. For this, the BWE has established an office at the JJ water treatment plan with staff directly participating in the operation of the WWTP. Moreover, staff from the central level (of BWE) performs regular visits to the plant to supervise the work. It was mentioned that the BWE decided to make the proper investments, in terms of budget and staff, to improve the treatment process of J.J. It would then serve as "pilot" for the operation of other stations.

Joub Jannine Artificial Wetland

The Wetland belongs to the Litani River Authority, a public organization responsible for implementing and operating irrigation and hydroelectric infrastructures on the Litani River Basin.[28] It was designed and implemented by a USAID project and is located on lands that belong to the Litani River Authority. It is specifically part of the Rural Development Center of the LRA. According to Dr. Abi Saab (LARI), the wetland's current management is deficient.

Agriculture

These two facilities are located in a large agricultural area. The major crops are wheat, potato as well as other vegetables (onion, garlic, tomato, beans). There are also fruit trees and grapes but to a less extent. Agriculture is intensive but farmers practice crop rotation to preserve the land. Plots are usually divided in two parts: one part is cultivated with wheat and left fallow after the harvest (June). The other one is cultivated with vegetables (two or three seasons). The following year, the land that was left fallow is planted with vegetables and the other one is planted with wheat (Nassif, 2016[29]).

Irrigation

Irrigation mostly relies on groundwater. The underlying aquifer in this area is a Karstic one (Eocene aquifer) and thus wells are prolific (30-50 l/s). There are different types of collective arrangements around well-use which should be well understood if one wants to implement a collective network supplied by a new water source. The cost of irrigation from wells is between 100 and 200 USD/dunum[30] (depending on well depth, and well-use arrangement).

[28] As per law 221, the BWE is also responsible for managing irrigation works on the Litani River Basin. The latter is divided in two parts: below Damascus road is the responsibility of the LRA and above this road is the responsibility of the BWE. However, it is important to keep in mind that concretely, irrigation is practiced privately in the Bekaa. The only scheme that was implemented by the LRA in the Bekaa (Canal 900) has now stopped being operational. As for the BWEs, it does not operate or supervise any irrigation works at the present time.

[29] Check this report for a detailed description of agriculture in Central Bekaa. Joub Jannine is located in West-Bekaa but similar agricultural practices are also observed in this region.

[30] 1 dunum (du)= 0,1 ha.

It is important to mention that a state irrigation network (Canal 900) exists in this area. It is located downstream to the two facilities but stopped being operational since 2014. It was previously supplemented by pumping from Karaoun reservoir located downstream. The distribution networks of the system extend on 2,000 ha in 5 main villages (Joub Jannine, Kamed El Loz, Lala, Baaloul, Karaoun). They are composed of underground pipes which deliver water on plots through hydrants to which farmers connect their irrigation material. One could study the possibility of connecting the reuse system to these networks.

Potential of implementing reuse

Both of these two facilities have a good potential to be used as a pilot site to study a re-use model. They are located upstream to a large agricultural area relying on groundwater, where farmers could benefit from a cheaper access to water. Distance from agricultural areas is reasonable and a public irrigation network (underground pipes) is already in place and could be connected to one, or both of the treatment facilities. Our recommendation is to assess the possibility to include both of the facilities in the pilot.

Access to information regarding these two sites is good. Some of the information is already available (technical design of the wetland, assessment of agriculture and irrigation in the area). Furthermore, we have already liaised with a number of informants.

In **Palestine**, the project will concentrate more on TWW management and recharge.

PWEG can contributes with preparation of decentralized wastewater management strategy for Palestinian rural areas which are two thirds of the Palestinian Territories, this will be adopted and enforced by Palestinian Water Authority (PWA), these rural areas don't have proper wastewater management scheme.

PWEG will present a show case of existing decentralized WW management scheme covering an entire Palestinian Village in the Jordan Valley, visits and to the site and presentation of sustainable governances stratifies and actions will be presented to project partners.

PWEG will facilitate the exchange with Mediterranenan Integrated System for Water Supply (MEDISS) a project which PWEG leads under the standard projects funded under the First Call for proposal ENI CBC MED 2014-2020 B.4.1 to promote promising innovations in treatment and reuse at regional level. Visits to sites where saline agriculture water is blended with treated wastewater as well as brackish water used in irrigation will be made to the partners over the duration of the project.

In **Jordan** we are still negotiating with many potential partners.

PWEG will Present one of the above mentioned MEDISS actions in south Jordan under the standard projects funded under the First Call for proposal ENI CBC MED 2014-2020 B.4.1 and shown to the partners, this consists of low cost and high efficient desalination of non-conventional water to be used in irrigation in Al Risha Village in Aqaba region.