

SUSTAINABLE MEDITERRANEAN

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www.hydraproject.net

A bilingual website on the collection, storage & distribution of water in antiquity aiming to link ancient wisdom with modern needs

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Un site web bilingue sur la collection, le stockage et la distribution de l'eau dans l'Antiquité visant à relier la sagesse antique aux besoins modernes

Quarterly newsletter produced by the **Mediterranean Information Office** for the **Environment, Culture and Sustainable Development**, in collaboration with the **European Environmental Bureau** and the **Arab NGO Network for Environment and Development**

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The current issue of Sustainable Mediterranean presents a newly launched bilingual website www.hydraproject.net dedicated to Mediterranean water heritage (fully functional in English and Arabic). The HYDRIA project uses water as a 'vehicle' to unfold the diverse, yet common, tangible and intangible Mediterranean cultural heritage, through reviving some representative ancient water management visions, concepts and techniques of the distant and more recent past.

The website uses Information and Communication Technologies (ICTs), specifically high quality animations and audiovisual material, combined with reference texts, in an attempt to present in an appealing way century old practices of collecting, storing and distributing water in the Mediterranean region.

The website is the result of the work done by a committed team of experts from 6 partner countries (Cyprus, Egypt, Greece, Italy, Jordan and Morocco) in cooperation with a creative web-design team, under the supervision of the MIO-ECSDE/MEDIES Secretariat. The 14 month long project concluded at the end of 2009. MIO-ECSDE is currently (2010) in the process of seeking funds in order to expand HYDRIA with more relevant case studies.

In this issue you will find only a small fraction of the content of www.hydraproject.net. We invite you to browse the website, explore its photographic material and animations. Enjoy your reading!

The "hydria" is a type of ancient Greek pottery used for carrying water. A typical hydria had a large rounded body, a small neck, and three handles. Two horizontal handles on either side of the body were used for lifting and carrying the pot. The third handle, a vertical one, located in the center of the other two handles, was used for pouring water.

Depiction of women at a fountain filling their hydrias and chatting on a ceramic hydria (6th century BC), Louvre Museum © Rostovtzeff, History of the Ancient World, after Perrot and Chipiez



Dans cette publication de Sustainable Mediterranean, on présente un site internet récemment lancé: www.hydraproject.net, dédié à l'héritage méditerranéen concernant l'eau (site totalement fonctionnel en anglais ainsi qu'en arabe). Le projet HYDRIA utilise l'eau comme un «véhicule» pour révéler l'héritage culturel méditerranéen, qui est divers mais en même temps commun, corporel et incorporel, à travers la relance de certaines anciennes visions représentatives de la gestion de l'eau, d'idées et techniques du passé lointain et plus récent.

Le site utilise les Technologies de l'Information et de la Communication (ICTs), spécifiquement d'animations d'haute qualité et de matériel audiovisuel, combinés avec de textes de référence, en essayant de présenter d'une manière émouvante les anciennes pratiques de collection, stockage et distribution de l'eau, dans la région méditerranéenne.

Le site est le résultat de la coopération fructueuse entre une équipe de spécialistes commis origines de 6 pays partenaires (Chypre, Égypte, Grèce, Italie, Jordanie et Maroc) et une équipe créative de web designers, sous la surveillance de MIO-ECSDE / MEDIES Secrétariat. Le projet ayant une durée de 14 mois est terminé à la fin de 2009. MIO-ECSDE se trouve actuellement (2010) dans le processus de collection de fonds, afin d'élargir HYDRIA avec d'études de cas encore plus applicables.

Dans cette publication, veuillez trouver seulement une petite fraction des textes qui se trouvent au site www.hydraproject.net. On vous invite de consulter le site internet, explorer le matériel photographique et jouer avec les animations. Bonne lecture!

Hydrie s'agit d'un type de céramique ancienne grecque qui était utilisée afin de transporter l'eau. Une Hydrie typique, avait le corps gros et rond, le col petit et trois poignées. Les deux poignées horizontales à chaque côté du corps, étaient utilisées pour soulever et transporter le pot. La troisième poignée, verticale, se trouvait au centre des deux autres et a été utilisée pour verser l'eau.

Vue d'une hydrie céramique à figures noires (6^{ème} siècle avant JC) présentant des femmes autour d'une fontaine qui remplissent leurs hydries et bavardent, Musée du Louvre © Rostovtzeff, Histoire du Monde Antique, après Perrot et Chipiez

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INTRODUCTION: WATER MANAGEMENT AND IMPORTANCE

Water is undoubtedly the most widespread substance on earth. It is also one of the most enduring symbols of life, regeneration, purity and hope. Especially for civilizations around the Mediterranean, water represents a very strong link with the sacred, with nature, with social status and expectations, as well as with various aspects of culture. All of these are integral parts of our heritage.

At the same time water is one of the most vulnerable natural resources, anywhere on earth, but this is especially true for the Mediterranean. With just 3% of the world's freshwater resources and more than half the world's 'water poor' population, the Mediterranean region is faced with the vital issue of access to the valuable resource. Today the impacts of climate change, desertification, biodiversity loss, overpopulation and overconsumption, intensive agriculture and mass tourism, result in a complex system of interrelated problems affecting all aspects of everyday life of the Mediterranean peoples.

But how did our ancestors cope with water scarcity in the past?

Since antiquity all sources of water, rivers, lakes, springs, underground resources and rainwater were exploited through sophisticated systems, which were always relevant to and in proportion with the geomorphology, the topography and the local hydrological and climatic conditions. Such wise practices were the evolution of century old methods and knowledge based on observations, continuous experimentation and innovation. They were adapted to the needs of the societies and the environmental conditions and could guarantee an adequate level of water supply to settlements and agriculture for centuries.

Over millennia, the know-how used throughout the region for water collection, storage, distribution and flooding emergency response was transferred from one civilization to another, constantly integrating emerging technological innovations. Remnants of this invaluable collective water related cultural heritage, such as cisterns, wells, canals, small scale dams, pipelines, aque-

ducts, reservoirs for flood protection, etc. are found today scattered around the basin, forming a unique, interlinked mosaic, which has played its role in the shaping of the unique Mediterranean landscape.

Unfortunately, many of these remnants are found today neglected, undermined or destroyed indicating a cultural 'poverty' of the local communities despite the 'wealth' of the past. Subsequently, their potential for becoming motors of local socio-economic development, e.g. through tourism, is often not recognized and remains untapped. Furthermore, people tend to drift away from traditional knowledge, they get isolated from their roots, thereby feeling an increased loss of identity. Important heritage that has survived for centuries is lost to modern technologies.

However, our cultural heritage can be an inexhaustible source of inspiration, techniques and solutions; it can indicate to today's scientists alternative directions for research and modes of operation; it offers fascinating possibilities of forgotten models that existed and functioned extremely well for centuries. To create sustainable solutions for water related problems today and account for the needs of people and nature, we also need to better understand the cultural significance of water (emotional, intellectual, moral, social and spiritual) and its evolution over time and space.

The awareness of both the intrinsic and functional value of our heritage calls for a new paradigm, directed, on the one hand to strengthen the sense of our Mediterranean heritage and, on the other to make sure that past best practices in water management are made known and if necessary adapted accordingly to meet modern needs. Understanding why and how the diverse beliefs of the various cultures have interacted with this natural resource resulting in the evolution of wise water management throughout the region may provide precious lessons for today's urgent need to move on to a sustainable **new water culture**.

ABOUT THE HYDRIA PROJECT

The HYDRIA project uses water as a ‘vehicle’ to unfold the diverse, yet common, tangible and intangible Mediterranean cultural heritage, through reviving some representative ancient water management visions, concepts and techniques of the distant and more recent past.

The project aims to shed light on cases demonstrating the wisdom of our ancestors, which evolved hand-in-hand with the environment, or, on cases when the lack of respect for water (and geo-climatic peculiarities) resulted in catastrophic implications for societies. Moreover, the project aims to demonstrate that this past wisdom in water collection, storage and transfer if properly combined with modern technological innovations can help address today’s needs without imposing on the environment. Influencing peoples’ water consumption behaviour and water management practices and making them more sustainable is an indirect long-term goal of the project.

The project endorses several case studies from Mediterranean countries. These are presented in the bilingual HYDRIA website (www.hydraproject.net English and Arabic) via a series of texts, photographic material, as well as animations to explain the operation of complex water works. The cultural elements that depict how societies evolved around the water resources are also described, as well as the current status of the remnants. References and internet links are proposed for the interested readers.

HYDRIA targets primarily citizens of the Mediterranean countries, particularly young people and the formal and non formal educational community. Through the description of the case studies the project highlights the role of young citizens today, as water consumers and makes them reflect, and why not, adjust the way they use water to more sustainable patterns.

The project was led by the MIO-ECSDE/MEdIES Secretariat. The partners of the project are from 6 Mediterranean countries, as follows:

- CYPRUS: The Municipality of Larnaca
- EGYPT: The Arab Office for Youth & Environment (AOYE)
- GREECE: (1) MONUMENTA (2) The “Minoan Roads” Project (3) MIO-ECSDE / MEdIES
- ITALY: Istituto per l’Ambiente e l’Educazione Scholé Futuro (Scholé)
- JORDAN: Land and Human to Advocate Progress (LHAP)
- MOROCCO: Club Marocain de l’éducation en matière de Population et d’Environnement (CMEPE)

The HYDRIA project lasted from 01/11/2008 to 30/12/2009 and closed with the launching of the website. It was funded by the UNESCO Participation Programme, MIO-ECSDE (through its annual funding from the European Commission - DG ENV) and GWP-Med. In the beginning a scientific team with experts from all partners was set up. This team nominated the case studies or water-sites in their respective countries that were in line with the scope and objectives of HYDRIA, and collected reference material such as texts, photos, videos, etc.

An experts meeting was held in Athens in April 2009 during which these cases were discussed in plenary and the way of presenting them in the website was decided. Following the finalisation of the texts by the experts, the web designer team started to develop the website as well as the animations that explain how certain water works function. Meanwhile all texts were translated into the Arabic language. The English version of the website went online on 31/12/2009, and a few weeks later its Arabic version followed.

The HYDRIA project is in line with the overall policy of MIO-ECSDE and MEdIES and closely linked to other initiatives such as: (i) the “Water in the Mediterranean” educational material prepared in 8 Mediterranean languages and disseminated in various countries; (ii) the “Gift of Rain” project of MIO-ECSDE and GWP-Med that entails construction or repair of rainwater cisterns in public buildings in several of the Cyclades islands, as well as an educational material for Greek students. Read more at www.medies.net.

For more information on HYDRIA please contact the MIO-ECSDE and MEdIES Secretariat: Responsible Programme officer: Ms Iro Alampei (alampei@mio-ecsde.org)

THE PARTNERS OF HYDRIA

CYPRUS, the Municipality of Larnaca

Role in HYDRIA: Responsible for the development of the content of the case study entitled "Aqueducts and water wisdom in the ancient town of Larnaca"

Expert/Author: Mr Alexis Michaelides, Deputy Mayor of Larnaca, writer and independent researcher

The Municipality of Larnaca is among the three oldest local government organizations of Cyprus. Its life started in the middle 19th century towards the end of the Ottoman rule of Cyprus. At the end of the same century the British Colonial Government of Cyprus enacted the first law establishing democratic municipalities in all large urban centers of Cyprus. The Cypriot municipalities were re-established with the 1960 Constitution that founded the Cyprus Republic. Several revision laws of the Cyprus Parliament modernized and enlarged the domain of their responsibilities.

Today, the Municipality of Larnaca is also part of the Larnaca Water Board, responsible for the supply and distribution of potable water to the wider metropolitan area of Larnaca. It is also part of the Larnaca Sewerage Board, responsible for the collection, recycling, purification and re-use of sewage waters. The Larnaca Sewerage Board (LSB) is together with the Municipality, responsible for the drainage of rain water. Currently (2009), the LSB is carrying out a 40 million Euros system expansion to cover the recycling and purification within the municipal boundaries and of 7 nearby villages, which are fast growing into urban areas. In 2008 the 3 km, long drainage system of "Spyros Kyprianou Avenue" was completed at the cost of 30 million Euros (with a 4 lanes road on top of it), freeing the town of the very frequent urban floods.

Contacts: Head offices of the Larnaca Municipality: 46, Athens Avenue, Larnaca, T: 0035724653333; E: municipality@larnaka.com

EGYPT: The Arab Office for Youth & Environment (AOYE)

Role in HYDRIA: Responsible for the Arabic translation
Translator: Mr Essam Nada

AOYE is an NGO working in the field of Environment and Sustainable Developmental on the National, Arab, Mediterranean and International levels. It was established in December 1978 to promote the awareness of environmental issues and active stewardship for the environment in Egypt, the Arab Nations and the world beyond.

Since then it has trained thousands of youths and adults through environmental camps, scientific symposia and special community projects.

AOYE is the Secretariat of the "Arab Network for Environment and Development" (RAED), which involves more than 100 NGOs from Arab countries who share their experiences and exchange information on environmental and developmental issues in the Middle East. As the Secretariat of RAED, AOYE is responsible for publishing and printing a monthly newsletter titled *Montada El-Biah*. AOYE is also a member organisation of MIO-ECSDE.

Contacts: Mr Essam Nada, T: 20-2-5161519 /5161245, F: 20-2-5162961; Masaken Masr Lel-Taameer; E: aoye@link.net, W: www.aoye.org. Address: Zahraa El-Maadi St., Masaken Masr Lel-Taameer, Building # 3 A, Cairo, Egypt

GREECE: MONUMENTA

Role in HYDRIA: Responsible for the development of the content of the case studies entitled "The Peisistratid Aqueduct, Athens"; "The small river Eridanos, Athens"; "The Ancient Agora Hydraulic works, Athens"; "The springs and fountains of the Acropolis hill" and all case studies for Naxos island: "The ancient aqueduct of Flerio", "Water-mills of Naxos"; "Cisterns of Naxos"; "Traditional cisterns of Naxos"; "The contemporary containment dams of Apeiranthos, Naxos"

General Editor: Ms Irini Gratsia, archaeologist

Investigators: Ms Dafni Papadopoulou, civil engineer; Mr Stelios Lekakis, archaeologist; Ms Irini Gratsia, archaeologist

Text: Ms Dafni Papadopoulou, civil engineer

MONUMENTA is a non-profit civil company for the protection of the natural and architectural heritage of Greece and Cyprus, created in 2006 by a team of archaeologists, architects and environmentalists wishing to contribute to the protection and the equitable management of the natural and architectural wealth of the two countries.

Its activities include the publication of the electronic magazine MONUMENTA (www.monumenta.org), programmes for informing the public and students, interventions for the rescue of monuments in danger, organisation of events, publications, etc.

The programme "Local Communities and Monuments", applied in various parts of Greece, aims so that the citizens themselves act for the protection of the natural and man-made environment of their region, and explores the relation between local communities around the world with their cultural and natural heritage.

Contacts: E: info@monumenta.org (Ms Irini Gratsia or Ms Maria Konioti) W: www.monumenta.org

GREECE: The "Minoan Roads" Project

Role in HYDRIA: Responsible for the development of the content of the case study entitled "Water Management in Prehistoric Crete: The case of Choiromandres, Zakros"

General Editor: Dr Stella Chryssoulaki, archaeologist

Text: Ms Christine Katsavou, archaeologist

Minoan Roads is a research project conducted under the Directorate of Prehistoric and Classical Antiquities of the General Directorate of Antiquities and Cultural Heritage of the Hellenic Ministry of Culture and Tourism.

The Minoan Roads Project aims to investigate the overland communications in Minoan Crete, comprising the detection, recording and study of the natural communication axes and the ancient built roads, as well as the sites linked with them. Furthermore, the Project also aims at establishing the settlement patterns and the types of habitation in the rural hinterland of Crete.

Running since 1985, Minoan Roads focuses its research on the easternmost part of Crete, the Prefecture of Lasithi, conducting both surface surveys and excavations at selected sites, while fieldwork has also been carried out in other regions of the island.

The project is directed by Dr Stella Chryssoulaki, archaeologist, Head of the Educational Programs and Communications Department of the Directorate of Museums, Exhibitions and Educational Programs of the Hellenic Ministry of Culture and Tourism. Dr Leonidas Vokotopoulos, archaeologist, is in charge of the surface surveys and studies the finds from the excavated sites.

Contacts: "Minoan Roads" Project

Hellenic Ministry of Culture and Tourism,
General Directorate of Antiquities and Cultural Heritage
Directorate of prehistoric and classical antiquities: 9,
Prytaneiou str., 105 56, Athens, GREECE; T: +30 3251787
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GREECE: MIO-ECSDE / MEDIES

Role in HYDRIA: Project Leader, responsible for the overall implementation, communication, finances, etc.

Responsible officer: Ms Iro Alampeï

The "Mediterranean Information Office for Environment, Culture and Sustainable Development" is a Federation of Mediterranean NGOs for Environment and Development, acting as a technical and political platform for the intervention of Civil Society in the Mediterranean scene. In co-operation with Governments, Intergovernmental and other Organisations and socio-economic partners, MIO-ECSDE plays an active role in the development of policies, the protection of the environment and the promotion of the sustainable development of the Mediterranean countries and of the region as a whole.

Especially in the sector of "Education for Sustainable Development" (ESD) and Intercultural Education, MIO-ECSDE has been coordinating the MEDIES Initiative since 2002 (www.medies.net), through a series of activi-

ties aimed to support the educational community of the Mediterranean, such as preparation of educational material and circulation in various languages, organisation of teachers seminars, organisation of teacher and youth exchanges, etc.

MIO-ECSDE, through MEDIES is the lead organisation of the Hydria project, and will certainly aim to expand this important project to other Mediterranean countries and case studies.

Contacts: MIO-ECSDE / MEDIES: 12, Kyrristou str. 105 56, Athens GREECE; T: + 30 210 3247490; F: +30 210 3317127; E: info@mio-ecsde.org, info@medies.net; W: www.mio-ecsde.org, www.medies.net

ITALY: Istituto per l'Ambiente e l'Educazione Scholé Futuro (Scholé)

Role in HYDRIA: Responsible for the development of the content of the case study entitled "Water management in Ventotene Island"

Expert/ Author: Ms Patrizia Bonelli

The Institute for Environment and Education Scholé Futuro is a non profit cultural association, set in many Italian regions. The Institute was founded in 1982 and its main purpose is to develop environmental preservation through different activities such as research, cultural promotion, planning, training and consulting (focusing mainly on education on environment and sustainable development).

Information dissemination is pursued through the publication of books, CD-Rom and a monthly publication *.eco, Sustainable Education*, the first and only Italian magazine for environmental education.

ScholÉ Futuro is involved in many projects on knowledge and promotion of cultural and environmental patrimony, on cultural and scientific communication, on research related to environmental education and sustainable development. In particular the Institute is part of networks at international and European level and hosts the WEEC - World Environmental Education Congresses - Permanent Secretariat. It is also partner association of the Italian Ministry of Environment in the Task Force on Sustainable Consumption.

Contacts: Scholé, Via Bagny 15, 10122 Torino; T/F: 0114366522; E: schole@schole.it W: www.educazione-sostenibile.it

JORDAN: Land and Human to Advocate Progress (LHAP)

Role in HYDRIA: Responsible for the development of the content of the case study entitled "The Water System of the Qatraneh Site"

Expert/ Author: Mr Ziyad Allawneh

Founded in 2000 as a non-profit making, private organization, the Land and Human to Advocate Progress (LHAP) serves as a consulting and partner organization to influ-

ence, encourage and assist local communities throughout Jordan to ensure a better management on natural resources in a sound and ecologically sustainable manner. LHAP hosts in its office the Mediterranean Ecological Media Network (MedEcomedia), a network designed to enhance the capacity of environmental media in covering and communicating priority information at local, national, and regional level.

LHAP also hosts the "Arab Network for Environment and Development" (RAED) - Jordan Branch, the umbrella for the Arab environment and sustainable development NGOs. LHAP is comprised of bodies that work to fulfil its objectives such as a Network of Experts, Youth for Sustainable Development and Media for Sustainable Development. LHAP is a full member of MIO-ECSDE and a partner of MEDIES.

Contacts: P.O. Box 340636, Amman 11134, JORDAN; E: lhap@cyberia.jo

MOROCCO: Club Marocain de l'éducation en matière de Population et d'Environnement (CMEPE)

Role in HYDRIA: Responsible for the development of the content of the case study entitled "Traditional water management in arid and semi arid areas: Case studies of the Gheris oasis and the Figuig oasis"
Expert/ Author: Mr Mohamed Jamal Eddine

Contacts: B.P 1072 Rabat- Morocco; T: 00212661546594; F: 00212537717513; E: cmepe2000@yahoo.fr

BROWSING OPTIONS IN www.hydraproject.net

Browsing by Place, Type and Time

The site is constructed so that the reader can navigate through the case studies using three criteria, either PLACE, TIME, or TYPE of hydraulic work, with multiple interlinks amongst them. The logic behind the construction of the site allows for its potential future enrichment with more cases that may be in consistency with the ones that are already there.

The template for navigation by PLACE is a google map, where the user may browse in the Mediterranean region and trace all the case studies, using the familiar tools of the google browser. Short texts and characteristic photos are included in each case study.

Another interesting feature is the TIMELINE, depicting all case studies and their evolution by including certain milestones in each. This option gives a holistic picture of how various types of water management systems evolved throughout the Mediterranean starting from 3500 BC to date and gives the user the opportunity to compare the technologies that existed around the Mediterranean in various historic periods.

In browsing by TYPE, the hydraulic works are grouped in two categories, the **large scale works**, where the hydraulic operation is at the level of a settlement, a city or greater (includes the Aqueducts, the Foggaras, River management works, etc.) and the **small scale works** for which the operation is at the level of a house or a complex of buildings (including small dams & terraces, cisterns, wells, watermills, etc.).



The hydridia project homepage in the Arabic language

Presentation of documents

The description of the case studies is done in a uniform way through certain fixed paragraphs (TABS). These may not be applicable for the content of all cases, but

it works for most of them. To support the reader, an **e-glossary** of key-terms has also been developed. The categorisation of the texts in TABs is presented in table 1.

IMPORTANCE	SETTING	WATER WORKS	PEOPLE / CULTURE	PRESENT STATUS	TIMELINE	CREDITS	APPENDIX
This is an introductory paragraph that explains why the particular water work is selected for the HYDRIA website, its relevance and importance. The most characteristic photos or diagrams are shown here	The topographic and geomorphologic setting of the water work is presented, as well as data on the water availability in the particular region, etc. Maps and diagrams are included where relevant	This section describes in detail the hydraulic system, how it was built and maintained, how it used to operate, when and why it ceased to function, etc.	This paragraph presents the social, cultural and economic dimensions of each case study, meaning the way societies evolved around the water sources, how they used, misused or abused them, how water availability determined economic and societal growth, etc.	The current status of the water remnant is described, including useful information for the potential visitor. Whether an archaeological site, a monument or a museum, the contact details of the authority that is responsible for the site today are also given.	The history or evolution of the operation of the water work is presented by means of milestones.	Presents the team of authors for each case study and their contact details, as well as suggested bibliography for further reading.	This paragraph contains any information and data that cannot be categorized in the above-mentioned TABs.

Table 1: Types of information included in the hydria project

The animations

In the hydria project four high quality 2D animations have been developed to explain the function of complex water works. They are complementary to the descriptive texts. The user may play them, or certain parts of them, zoom into them, etc. The animations describe:

- a. The function of a prehistoric dam in the Island of Crete, Greece, that was used to irrigate cultivations through a series of built terraces.
- b. The function of a contemporary watermill in Naxos Island, Greece, used to grind grain that was in use until the 1960s.
- c. The water management system of Ventotene Island in Italy that was built by the Romans in the 1st century BC. The system harvested rainwater by combining an aqueduct and cisterns, thus ensuring water-sufficiency to the small Island.
- d. The ingenious and wise way of construction, operation and maintenance of a typical *foggara* in Morocco (Gheris and Figuig oasis).

CYPRUS: AQUEDUCTS AND WATER WISDOM IN THE ANCIENT TOWN OF LARNACA

Only a part of the case study is presented here. Read the full story with photos, etc. at www.hydraproject.net

Cyprus throughout its history has been known for its frequent and long droughts and low rainfall levels that cause severe water scarcity. This case study examines the water management systems developed in antiquity in Larnaca city, situated on the south coast of Cyprus, an area that has been inhabited since the beginning of the 2nd millennium BC. The site for building the city was selected due to its excellent natural port facilities and because of its proximity to the great civilizations of the Bronze Age. It was certainly not chosen on the premise of water availability, however important a factor this was for the establishment of early settlements. So, although Larnaca soon became the island's major port facilitating all import and export trade, its inhabitants, have always had to deal with water scarcity. Since antiquity and up until today they have constantly needed to find ways to secure water for their ever growing needs.

The city has survived on exactly the same dry site without any interruption for 4000 years. This record is partly due to the excellent water wisdom its local authorities were compelled to develop through the ages.

The early settlement wells: As the early settlements of the 2nd millennium BC started to grow so did the need for water. Due to the absence of any major stream in the area, these early settlers dug their own **wells**, remnants of which can be found today. Such wells seem to have existed in almost every house and public building, some surrounded by sacred gardens and/or crops (signs of intensive cultivation).

In the beginning, water supply from the wells was sufficient to cover the needs of the population. However, overconsumption for agriculture and the ensuing need to dig deeper wells caused a serious problem to the water quality, as these settlements were very near the sea.

The city's population increased by the end of the 2nd millennium BC, while to defend itself from neighbouring powers the local authorities built city walls around the 13th century BC. By the end of the 12th century BC the Mycenaean Greeks took over the city and constructed "cyclopean" walls (so called because of the very large stones used). During Archaic Times (700-480 BC), the city's population kept growing mainly due to the arrival of large numbers of Phoenicians from nearby Sidon. This new demographic reality obliged the population to use a new method of water storage in underground **argil sealed cisterns**. These underground cisterns were fed by rain and nearby wells.

The ancient aqueduct: An inscription on a tomb of the Archaic Period (700-480 BC) found in the Kition cemetery of the same period, refers to the king's "Minister", who

was responsible for the water supply of the kingdom, a title held by his family, according to the inscription, for 6 generations before him! Therefore, organised, efficient and institutionalised management of the city's water resources can be traced even before the Archaic Period.

Severe scarcity of water obliged the kingdom and its water Minister to import the wisdom and experience of nearby civilizations such as transporting water to the walled city from remote sources. During the Persian rule of Cyprus (546-335 BC), the technology of Persian Qanats has been introduced. This sophisticated system brought sufficient quantities of water from sources outside the city walls. The end part of the extensive Persian qanat discovered in the ancient port of classical Larnaca (480-300 BC) is exhibited today.

In the book "Acts of Saint Barnabas" of Evangelist Mark, a detailed account of his visit to Larnaca is included (45 AD) as well as his short rest at the public aqueduct. The city was then densely populated and public aqueducts were a necessity that the Romans and later the Byzantines systematically financed and encouraged.

Local water genius: Archaeological findings of Roman Larnaca show extensive distribution networks made of clay pipes that carried water over small valleys and hills! At least one distribution line was found which transported water from a higher source through a valley and over a hill to the town of Larnaca. Hydraulic wisdom pre-existed Pascal in Larnaca?

In Medieval times, according to the chronicle of "Leontios Machairas" written in the 14th century AD, **grain mills** operated in Larnaca, and Luzinian King Peter I used them to supply his army and fleet with flour. It is assumed that these grain mills worked on the same main Persian qanat, after having been repaired.

This Persian Qanat was still in use during Venetian times (1486-1570 AD) as proven by documents of the Venetian Archives, describing a project for the re-routing of the aqueduct so that it would not end up in the salt-lake. This was necessary as salt production, which was an important source of income, was negatively affected by the incoming water, delaying the drying and evaporation process.

The ottoman aqueduct: In Ottoman times (1571-1878) Larnaca, once again, became the main port and most populated centre of Cyprus. One of the governors at the time was Abu Imbrahim, known as Bekir Pasha (1746-1748), who constructed an aqueduct for Larnaca. It was a 15 km long water supply system (7 km underground and 8 km above ground level). The underground part (survives today) was based on the Persian qanats technology and the above ground arched aqueduct passed over three



The 1st (higher) and the 3rd (lower) series of arches of the old aqueduct of Larnaca

small valleys before reaching the city (all 3 series survive today). The aqueduct powered 2 grain mills along its way and supplied 7 public city fountains with running water, 2 of which exist today. These installations comprise a monument of collective historic water wisdom.

Present status: The aqueduct and the mills were in operation till the early 1950s when pumps and modern water

distribution systems were installed. The ancient water supply systems of Larnaca were permanently destroyed as over-pumping of water at the source of the aqueduct eventually lowered the water table and caused sea water intrusion. Unwise and unsustainable use of modern technology put an end to a reliable water supply system in Larnaca, which was functional for almost 2,500 years!

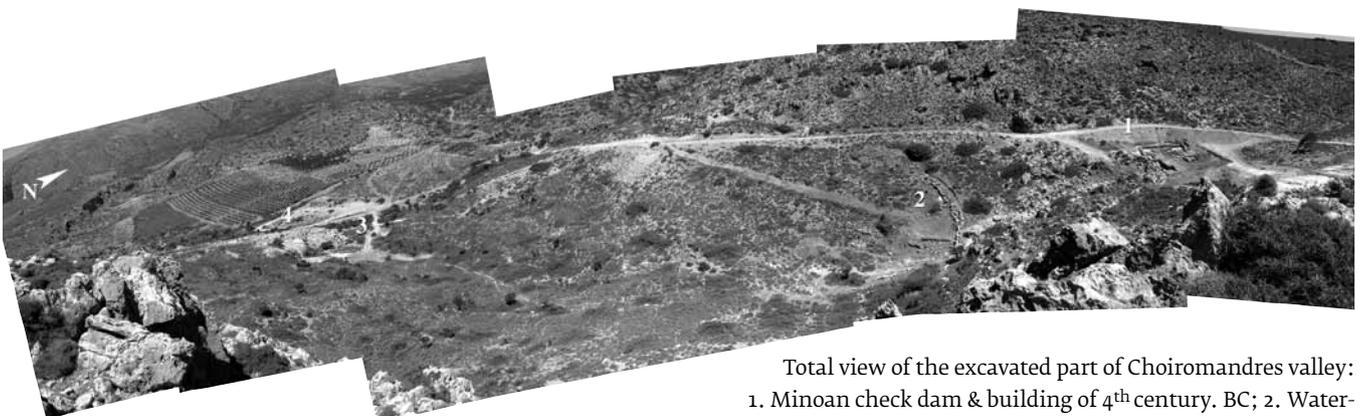
GREECE: WATER MANAGEMENT IN PREHISTORIC CRETE: THE CASE OF CHOIROMANDRES, ZAKROS

Only a part of the case study is presented here. Read the full story with photos, etc. at www.hydraproject.net

Situated at the easternmost part of Crete, the small valley of *Choiromandres* is at the end of the fertile depression of Zakros. The eastern side of the valley takes the form of a rocky ravine with a steep gradient. In winter, rainwater flows down the mountainous terrain, forming a raging torrent that runs along the slope, causing soil erosion, often with devastating consequences.

During the Minoan period, the locals attempted to regulate the rainwater flow by means of a hydraulic land

reclamation system, aimed at protecting arable land from the rush of water, while improving agricultural performance by using rain to water the crops. The excavation and surface survey conducted by the “Minoan Roads” Research Project have revealed the remains of *five ancient buildings*, as well as of *enclosures, terrace walls and two dams*. With the exception of a more recent building (4th century BC), the rest of the above date already from the 2nd millennium BC!



Total view of the excavated part of Choiromandres valley:
1. Minoan check dam & building of 4th century. BC; 2. Water-diverting wall; 3. The lowest end of the water management system; 4. The guard-house.

The water works: In the *Old Palace Period* (1900 – 1700 BC), two walls were erected in the streambed at the upper end of the ravine, in an early attempt to keep the rushing water in check and to protect the sloping surface soil. Today, their remnants are approx. 0.70m high, considerably lower than the initial construction, as their building materials were used to construct another, larger wall at a later stage.

During the *New Palace Period* (1750 – 1450 BC), the subsequent wall was built in curved megalithic masonry. Currently, it has a length of 27m, and a height of 3.10m. As it traverses the streambed, it takes on the form of a check-dam that served to hold back the torrential downpour of rainwater, restrain it and slow it down. The wall is substantially thicker at its base, to ensure stability.

Inside the ravine, small walls were erected between protrusions of the bedrock, set up parallel or perpendicular to the water flow, forming a succession of small **vertical terraces**. These low walls were part of the management system designed to slow down the water and protect the constructions at the lower end of the ravine. It is possible that at periods of mild flow, small-scale manufacturing units exploited the water collected in the small cavities.

At the lower end of the ravine **three megalithic walls** of the New Palace Period were integrated into the complex mountainous hydraulic system that provided irrigation to the terraces in the valley. The most interesting part of the system is a wall, over 200m long and 1,20m high, which encloses an area of about 28.000 m² (W 14). This wall, which formed the lowest boundary of the entire system, crosses the axis of the valley, like the dam at the upper end of the ravine. It was the second line of defense against the swift flowing stream, serving as an interception dam, temporarily trapping rainwater that was slowed down previously by the upper dam. Two more walls possibly joined this great wall, complementing the system of mild water diffusion to the terraces for agricultural produce. Surplus water would seep through these walls to the adjacent **stepped terraces** providing moisture to their soil.



The check dam (W31) and the three megalithic walls (W14, W11 & W18) form part of the Minoan water management system of the valley. Water is represented in blue.

Minoan hydraulic land reclamation constructions were again in use for a short period during the 4th century BC, as indicated by a carefully constructed **rectangular building** erected adjacently to the check-dam.

From an archaeological point of view, the particular water management system is an example of *large-scale public works in the Mediterranean in the Bronze Age*. This work, which served the local needs for many years, is one of the rare examples of Minoan land reclamation that have been brought to light, so far. Advanced land reclamation techniques are mostly documented in the Mycenaean world.

Present status: Oral testimonies of the inhabitants of Choiromandres valley attest to the existence of extensive fertile areas with carob trees (*Ceratonia silica*) up to the mid-20th century. The exploitation of carob trees was an important source of income for the people of Zakros. Carob pods were traditionally used as a natural sweetener and even today as feed for livestock, to produce alcoholic drinks, in the tanning and paper industry, etc. A serious flood in 1949 uprooted all trees in the valley!

Nowadays, in *Choiromandres*, the human factor has turned out to be the main cause of environmental disasters: extensive drilling for irrigation has resulted in severe depletion of the water reserves, while waste effluents from oil-factories contaminate surface and ground waters. Worse still, during the illegal construction of a rural road in 1993, very close to the Minoan check-dam at the upper end of the ravine, the dam was covered with debris, its small basin was filled with soil, and part of it was demolished!

Even so, the technical expertise of the 2nd millennium BC, acquired through the harmonious interaction of man and nature could serve as a prototype or at least an inspiration for contemporary applications, particularly in cases where the natural environment and climate is similar to that of the *Zakros* area (extended summer droughts and devastating winter torrents). Using contemporary materials and advanced techniques suitably adapted to local geomorphological features, and taking into account the needs of the local community, we could obtain results along these lines without recourse to energy intensive options.

The Ministry of Culture and Tourism and the Forest Authority of *Lasithi* are making concerted efforts to protect the area and the distinctive cultural character of the site, aspiring to grant *Choiromandres* the status of a visitable archaeological site open to the public. Environmentally friendly activities geared towards cultural tourism and ecotourism need to be sustained, as they will support the local community and raise awareness of the wider public about the need to preserve our cultural heritage.

GREECE: WATER MANAGEMENT IN ANCIENT ATHENS

Only a part of these case studies is presented here. Read the full story with photos, etc. at www.hydraproject.net

The Ancient Agora of Athens

In ancient Athens, the *Agora* hosted the central administration, justice services and all trading activities. In the pre-classical era, it was the place where the *ekklisia* met. From the 8th up until the 3rd century BC, when it was completely destroyed by the Erouls, the *Agora* was a favourite spot for the Athenians, the place where all social and intellectual relations took place: the heart of the city.



Remnants of the southeast fountain, called *Enneakrounos* (=“of nine spouts”) in the Ancient Agora, dating from the second half of the 6th century BC

During this period various water-works were constructed in the Agora to facilitate the increasing needs of the population, not only for irrigation purposes but also for efficient drainage. These works, namely wells, cisterns, fountains, hydraulic and drainage works, etc. are presented in this case study. Some are described through simulation diagrams, but there are also quite a few photos of their remains, as they can be seen today, 2,500 years later, by the visitor who walks around the archaeological site of the Agora.

The Peisistratid Aqueduct of Athens

The subterranean aqueduct of the tyrant Peisistratos is a typical example of water-supply facilities in Greek cities (i.e. Megara, Syracuse and Samos) during the archaic and classical period. For such semi-arid regions, it was all too natural for every city to ensure its own water supply system, as a basic feature of civilized life.

Yet, because of the continuous wars between ancient Greek cities, aqueducts used to be hidden and subterranean. During the 6th -5th century BC technologies relat-

ing to tunnelling methods improved, especially after the development of precise topographic measuring devices (refer to Eupalinos' aqueduct in Samos). During those centuries the industry of pipes, ceramic, stone and later of lead (in the Hellenistic period) flourished.

In this case study the Peisistratid aqueduct is presented. Because large parts of this aqueduct were discovered during the recent Athens Metro excavation, parts of the aqueduct are displayed today in various Metro stations of Athens.



Clay pipes of the Peisistratid aqueduct, exhibited in Evangelismos Metro Station.

The small river Eridanos of Athens

When the ancient bed of Eridanos River was located in 1993 by a radar sound system investigating Syntagma Square, as part of the Athens Metro works, the inhabitants of Athens were astonished to learn that there is a small river still flowing underneath the heart of the city.

Eridanos was the third river of ancient Athens in terms of water flow. Actually, it was more like a gushing torrent which during the winter months would start from the south slope of Lecabettus hill reaching down to the Kerameikos valley. In this valley, already since prehistoric times, the inhabitants of the nearby settlement buried their dead on its banks and in the surrounding marshy area.

As the river often flooded, because of sudden torrential downpours from the surrounding hills, its riverbed was unstable, changing direction from time to time. This is why the Athenians attempted several times to control its riverbed, by enclosing it into built channels.

Nowadays, Eridanos mainly runs underground, and has the size of a stream. However, its course can be traced in the Kerameikos archaeological site (flowing in open air); in Monastiraki Metro Station (flowing underground) and in Syntagma Metro Station (the cross section of the ancient riverbed is exhibited).



Vaulted chambers from the Roman times, as seen in the Monastiraki Metro station today. By the Roman period the Eridanos river was already a drain channel of Athens.

The Springs and Fountains of the Acropolis Hill

The hill was first inhabited, sometime between 3500 and 3200 BC. The few remains and finds of this period testify that the first settlements were on, or very close to the rocky hill, which was later named Acropolis.

Of course water was the vital prerequisite for selecting the specific site to build the settlement and it was accessed by digging wells. It is estimated that in prehistoric times there existed 21 wells 3-4m deep, testifying to the rich water table. Later on, in the historic era several luxury fountains were built around the Acropolis hill, exploiting these underground streams that provided access to a safe water resource at times of siege, when the Athenians would gather behind the walls of the Acropolis. In this case study the following springs and fountains of the Acropolis are presented:

1. The **Klepsydra spring and fountain house** mentioned by many writers.
2. The **Asklepieion spring house**, which combines a spring and fountain at the healing house of Asklepios.
3. The **Mycenaean spring fountain**, which is linked with a heroic moment of Modern Greek History, when during the Nazi occupation (1941) two Greek students used the cave of the fountain as a secret passageway to reach the upper level of the Acropolis and take down the Nazi flag.

GREECE: WATER MANAGEMENT IN ANCIENT TIMES AND THE RECENT PAST IN NAXOS ISLAND

Only a part of these case studies is presented here. Read the full story with photos, etc. at www.hydraproject.net

The Ancient Aqueduct of Flerio

The *Flerio* region in Naxos Island is, among others, a region of great historical and archaeological importance. Large strata with marble of good quality exist close to the surface. For this reason and since the 8th century BC, an important community of excavation workers developed and flourished, that reached its peak period during the 7th - 6th centuries BC thus promoting Greek architecture and sculpture.

In antiquity, in this region an impressive 11km long aqueduct was constructed in phases, starting from the 6th century BC in order to transfer water from the rich springs of *Flerio* to the capital of Naxos. The aqueduct starts from a river basin carved in the rock and is wisely designed to provide irrigation to the crops before its clay module pipes reach and provide water to the capital.

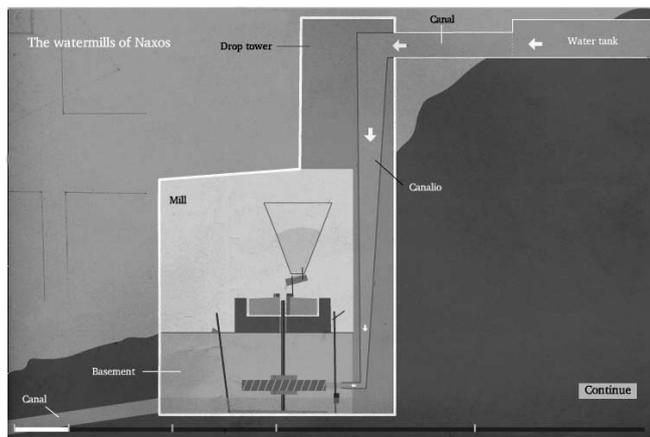
Nowadays, the most important parts of the aqueduct have been restored and are accessible to visitors, thanks to the collaboration between scientists, local authorities, but also thanks to the understanding and cooperation of contemporary land owners of the selected parts of the aqueduct that are exposed.

The Watermills of Naxos

Watermills were widely used in all of the Cyclades islands and although the weather conditions in these islands were fit also for windmills, in regions rich in water watermills were preferred for various reasons. First of

all, their construction was faster and cheaper; there was less risk for damages and corrosion and the maintenance cost was lower. Also, their function was easier and didn't depend on weather conditions, specifically the wind. Lastly, the local inhabitants used to believe that the flour produced from a watermill was of higher quality than the one coming from a windmill.

In various spots of Naxos Island stand the remnants of old traditional watermills, monuments that form an excellent example of sophisticated water exploitation. Also a variety of old documents have been found that provide us today with valuable information concerning subletting, inheriting, donating a watermill or determining the timetable for the water use. The oldest of these documents dates from 1549 (end of the Venetian era) and refers to a watermill that has not been discovered yet. The watermills in Naxos were functional for centuries up till the 1960s.



The 2D animation explaining how the watermills of Naxos function (play it at www.hydraproject.net)

Traditional Cisterns of Naxos

Traditional cisterns were widely used in Naxos Island to store water for domestic and agricultural purposes. There used to be separate cisterns: those collecting water from the terraces of the houses that would be used for drinking purposes and those cisterns that were constructed in the courtyards that collected water for washing and cleaning. Their use in Naxos was abandoned after the 2nd World War, although it is considered to be a very efficient system for specific needs in water. Very few cisterns are preserved nowadays.

Very interesting examples are the cisterns of the byzantine fortress *Kastro Apalirou* and the Venetian castle *Apano Kastro*. These are described in the hydria webpage, for the interested readers and the potential visitors to Naxos that would like to learn more.

The Contemporary Containment Dams of Apeiranthos, Naxos Island

In January of 1987 the Commune of *Apeiranthos* together with the Ministry of Agriculture initiated a programme for the construction of dams in order to reduce the rain-water lost towards the sea and to enrich the underground aquifer. In the period 1987-1989, 46 small scale containment dams were constructed based on the hydro-geological study of the Ministry of Agriculture, Directorate of Geology and Hydrology.

The building of the modern containment dams was inspired by the traditional technique and their construction is very similar in terms of size, form and materials. The dams are concordant with the natural environment, as well as with the traditional architecture of the region.

This is a case study of great importance depicting a success synergy of a visionary and efficient local Authority with an eager Ministry that in a very short time and with a relatively low budget created a substantial project contributing to the sustainable development not only of the area, but of the whole island of Naxos. We hope that similar endeavours will take place in other regions of Greece and of the water scarce Mediterranean countries.



View of the contemporary containment small scale dams of Apeiranthos.

The Fountains and the Wells of Naxos Island

The richness of the island of Naxos in water is obvious from the numerous wells and fountains that appear in the villages, and in the countryside. Many of them can be seen inside the yards and gardens of the houses or in the orchards. They can also be found in places of social importance, such as the central square of the village or attached to important buildings, such as churches.

In this case study some interesting fountains and mechanisms developed by the locals to draw water from wells are presented.

ITALY: WATER MANAGEMENT IN VENTOTENE AND SANTO STEFANO ISLANDS

Only a part of the case study is presented here. Read the full story with photos, etc. at www.hydraproject.net

Human settlements on the isle of *Ventotene* has always been dependent on the collection of rain-water to secure supplies, as natural springs don't exist on the small island. Apparently, during the last decades BC this was not a problem for the Roman engineers that were so accustomed to building aqueducts. This particular case study examines the collection and water management system of *Ventotene* and *Santo Stefano*, two very small isles created by volcanic activity in the Pontine archipelago, located between Rome and Naples.

The water works that ensured the water sufficiency of the islands are described and also some interesting stories regarding the people that lived on the two islands, from antiquity up until today. For example, during the time of Augustus *Ventotene* Island was an exclusive place of exile for prominent members of the Roman aristocracy. *Santo Stefano* Island became famous for its "panopticon" style jail built in the 18th century AD, that in recent history was used for political prisoners, among others one of the fathers of the European Union, Altiero Spinelli.

The water works: Supply of water has always played an important role in roman architecture. Architects always cared about the slope of roofs towards the inside of the houses, applying the principle of **compluvium** (= collecting surface). Water poured both from the gutter and through the rain pipes and was collected in the basin in the middle of the yard or atrium (**impluvium**). Besides being an ornament the *impluvium* was used for the draining of water, as dust and dirt from the roof would deposit at its bottom.

The **cisterns** in *Ventotene* Island: The island, whose inhabited section was around the port, required just a few water collection points in the highest parts to allow an easy distribution to the lower parts. Two huge cavities with pillars, walls and vaults covered with *cocciopesto*, were dug into the tuff bank (volcanic rock) and were the heart of a complex, well constructed aqueduct on the southern end of the island. With this system, every year about 800 m³ of water were collected and distributed for domestic use, manufacture and port needs.

Both cisterns are visitable today and under the supervision of archaeological institutions. Five more cisterns of smaller size are found in *Ventotene* Island, used for decantation purposes. All of them were interconnected by means of an underground aqueduct.

Thanks to the system of collecting, storing, draining and distributing rainwater, Ventotene was able to develop a multi faceted and high standard of living. So much so that emperor Augustus made the isle part of the Imperial patrimony, transforming it into an imperial summer residence. The so-called Villa Julia was already in use by the end of the 1st century BC.



The interior of one of the cisterns of *Ventotene* Island situated close to the huge Imperial Villa Julia of "Punta Eolo". This is a huge reservoir that is carved directly into the tuff about 10m below ground level.

How the cisterns worked: The two huge cisterns were connected with each other by an **underground aqueduct**, which was divided in two branches that reached a) the imperial Villa Julia and the port, and b) the fish pond, respectively, and would meet again to form a closed system. The collection area above the cisterns had a slight incline so as to maximize the rainwater collected in the basin. With a rough estimation, multiplying the feeding basin area by the average rainfall of the isle (700–600 mm/yr), every year this water collecting system could store between 700 to 800 cubic meters!

From the point of natural collection, rainwater was conveyed to tanks dug in volcanic rock, with a series of corridors partly covered by *cocciopesto*. From there, big underground pipes fed water to secondary cisterns. To ensure continuous flow by gravity, the pipelines would gradually reach a depth of about 5-6m underground. Each room had an external containment wall, while the floor and the lower parts of walls were made watertight by use of hydraulic mortar. The rooms were completed by arched vaults.

The floor of the cisterns has a **slant** from west to east dropping from 122cm to 12cm. This tilt assured the movement of water towards the last room allowing for the cistern to periodically empty completely and facilitate cleaning and repairs.

The quality of water: The Latin architect Vitruvio suggested the use of several decantation and drainage cisterns to

improve **water quality**. The different levels of basins ensured constant flow and the arched vaults ensured oxygenation of water. But it was the fact that the cisterns were dug in tuff that ensured the high water quality and also limited evaporation. Moreover, the tuff minerals were gradually diluted along the way in the rainwater, flowing inside the long pipeline, making the water even more potable.

Present status: Even if situated very close to Rome and Naples, Ventotene is not spoiled by unsustainable tourism. Its inhabitants in the past had no option but to collect rainwater for domestic use. Gutters under the roofs conveyed water in pipes and from there in cisterns, mainly placed underground. These were usually bell or drop shaped, or with arched tops, to stand the weight and their inner surfaces were generally lined with hydraulic mortar. Since water tankers were introduced in the '60s, the use of cisterns has decreased and is almost abandoned today. The new buildings are not equipped with cisterns and several of the existing ones have been transformed to cellars or apartments for rent in summer.

Nevertheless, lately, due to repeated water shortages and to an increased environmental awareness, rainwater harvest methods are being revived, mainly for small scale family gardening. This indicates that the reversal of the trend of not using rainwater is possible, with the proper support of administration and the appropriate promotion



Building of a cistern by Vitruvio

to citizens and tourism operators. In particular, builders should be encouraged to use the traditional techniques in building and insulating cisterns, a skill that is on the verge of disappearing. Modern plumbing systems should include double pipelines in buildings, one for rainwater from the cisterns and another one for potable water. It is important to communicate rainwater harvesting through a campaign on the importance of the self-sufficiency of the isle and the decrease in consumption.



Aerial view of the Ventotene and the Santo Stefano isles

JORDAN: THE WATER SYSTEM OF THE QATRANEH SITE

Only a part of the case study is presented here. Read the full story with photos, etc. at www.hydraproject.net.

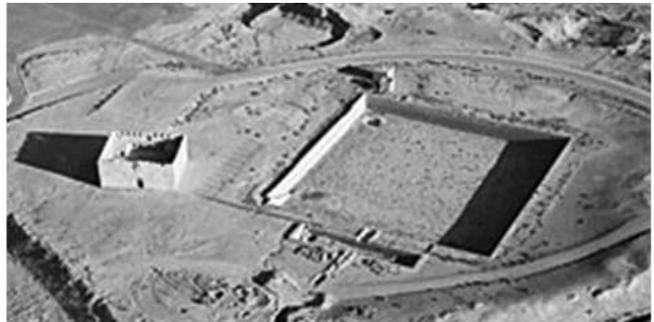
Jordan is a small country with diverse ecosystems but with scarce water resources. Precipitation varies annually from 50mm in the east to 600mm in the west parts of the country, therefore it is considered as an arid or semi arid country. Obviously, all the civilizations that dwelled in Jordan could not have survived, much less prospered, without adjusting to water scarcity. They needed to come up with management systems that would conserve this vital resource, including rainwater harvesting and schemes to reduce evaporation.

This case study examines the water management system at the *Qatraneh* Site, developed to provide water to a castle of the roman era by exploiting a nearby *wadi** and rainwater harvesting. Securing safe water for the residents of the castle, the surrounding settlement and the travellers was of vital importance as the *Qatraneh* site is considered to be part of an ancient sacred pilgrimage route that linked Mecca and Jordan. The site is 90km south of Amman with an elevation of 790 m above sea level.

People of the roman and byzantine eras often transported water over considerable distances to settlements. The efforts conducted by the Department of Antiquities (DAJ) around *Qatraneh* revealed the presence of aqueducts, which link the *el-Hasa wadi* with the nearby *wadis* and the main pool. The *channel*, which is partly preserved, reaches the site of a medium size *settling tank*, and is then directed to the *pool*.

Only few remains of the channels, stone ashlars and foundations have been discovered. The recovered pools

* Wadi is the Arabic term referring to a valley or a dry riverbed that contains water only during times of heavy rain.



In this aerial photo the castle, the settling tank and the square storing pool can be seen, as well as the surrounding wadi.

and cisterns are one of the important discoveries east of the Jordan River and are associated with the local settlement which existed during the roman and also the byzantine and Islamic periods. The castle is 22.20m long and 17.35m wide while its average height is 10.0-10.5m.

The water system that provided the inhabitants with clean water for drinking and irrigation was therefore comprised of an **earth dam**, **two water canals**, a **settling tank** and a **main storing pool** connected to a **well** located inside the castle for easy access. The main pool which is 26m far from the castle has a surface of 70m x 70m with a depth of 5.2m! The settling tank, preceding the pool is 38m by 6.6m with a depth of 2.4m with a dual canal system connecting them. The earth dam is about 75m away from the castle.

MOROCCO: TRADITIONAL WATER MANAGEMENT IN ARID AREAS: CASE STUDIES OF THE GHERIS & THE FIGUIG OASES

Only a part of the case study is presented here. Read the full story with photos, etc. at www.hydraproject.net.

In the desert wealth is not measured by how much property a person owns, but by the water rights attached to one's land.

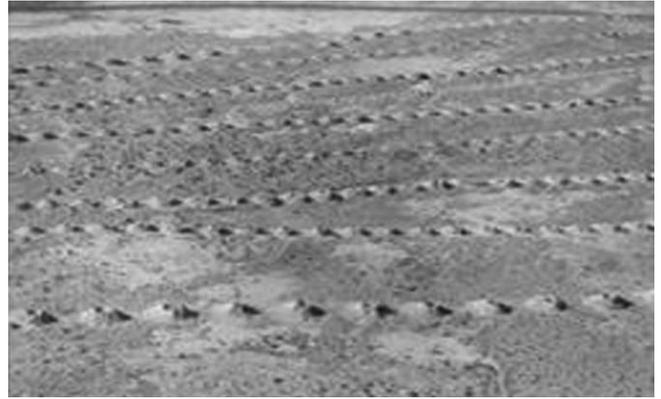
Although water is certainly scarce on the surface of the desert it can be found at the subterranean level. Humans, thousands of years ago, came up with an ingenious system that ensured water for their settlements and for irrigation of their cultivated lands, the oases. The

oases, these green islands in the middle of the desert are not natural, as thought by many, but entirely artificial systems of vegetation. They are the result of hard work and the practical application of techniques suited to the harsh environment; the product of wisdom passed on from generation to generation and from culture to culture.

Obviously, the survival of an oasis depends entirely on water. The *foggara/khettara* system for managing scarce



Curetting of a vertical shaft in a foggara



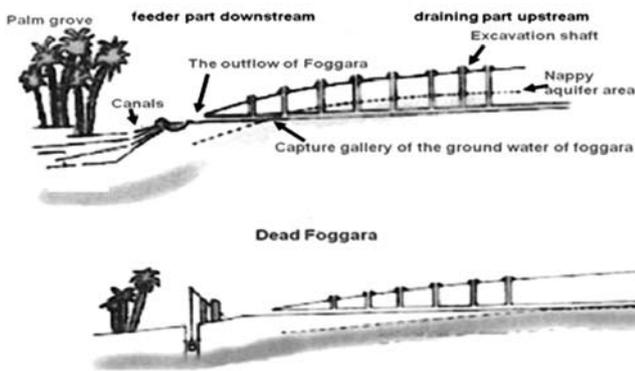
Aerial photo of a series of shafts on the surface can be recognized by their raised edge resulting from the excavation.

underground water sources in the desert is examined in this case study as a characteristic example of traditional wisdom that has survived for millennia. In the case study, focus is given not only to the description of the operation of the system itself, but also to the entire social organisation that developed around it, in Morocco. In fact, the construction and maintenance of a foggara formed special societal bonds and a hierarchy on the basis of which the inhabitants of the oasis would share the privileges and responsibilities for the management of this vital resource in an undisputed, fair manner. Such social configurations survive to our days in Morocco and in other countries where foggaras are in place.

water out of them, but instead they are used for aeration and condensation of atmospheric humidity. As the khet-tara's main tunnel is constructed to have a lower gradient than the terrain under which it lies, the tunnel becomes gradually shallower until it emerges above the ground at a distance of several km far from the first well, which in certain cases can reach a depth of 150m (considering the tunnel is cut under a hill or mountain). The construction may start also from the settlement site inward, usually following an alluvial cone of a river or fossil wadi.

Unlike a feeder canal and the Iranian qanats, the Moroccan foggara do not convey water from springs or underground pools, as their main tunnel does not usually go as deep as groundwater sources. Actually the foggara is fed with water, primarily in the following ways:

- a. Through micro-flows of the sands
- b. Through regular rainfall in the plain above the foggara
- c. Through condensation of atmospheric humidity

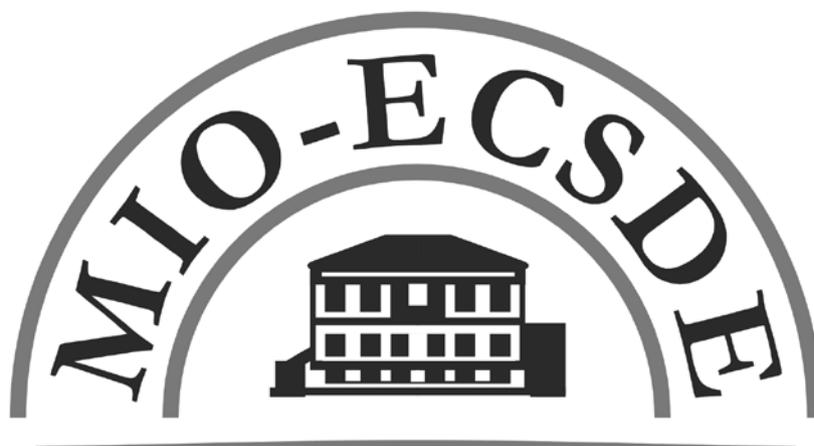


Top: The way a healthy foggara operates is illustrated. Bottom: When the water table drops, due to over drilling, the foggara ceases to operate, and in most cases this is an irreversible change.

Present status: Foggaras are threatened today on the one hand by the increasing demands of population growth, and on the other hand, by the popularity of new water extraction technologies, especially electric pumps that exhaust underground water resources and render the foggaras useless. Perhaps the challenge in this case is how to make best use of cotemporary science and technology in water management, while taking into account the traditional foggara.

The khet-tara system taps the groundwater table by means of a **nearly horizontal tunnel** which is dug over a long distance (normally 4-8km but can reach even 15km!). At regular distances (~10-20m apart), **vertical shafts** are dug which enable access and maintenance of the main tunnel. The function of the well-like shafts is not to pull

The life of a farmer in an oasis: Before starting his daily work, every farmer, alone or with his family or sharecroppers, and the villagers have to unite to ensure water for their community. They need to unblock the spring flows, build basins to increase the water quantity that will flow in the canals to the fields, build and repair dikes or small dams, and expand the foggaras. The canals should provide enough water for upstream palm groves ensuring enough for those downstream, according to the tradition and the water rights prescribed by ancestral contracts.



MIO-ECSDE Profile

The Mediterranean Information Office for Environment, Culture and Sustainable Development, is a Federation of Mediterranean Non-Governmental Organizations (NGOs) for the Environment and Development. MIO-ECSDE acts as a technical and political platform for the intervention of NGOs in the Mediterranean scene. In cooperation with Governments, International Organizations and other socio-economic partners, MIO-ECSDE plays an active role for the protection of the environment and the sustainable development of the Mediterranean Region.

Background

MIO-ECSDE became a federation of Mediterranean NGOs in March 1996. Its roots go back to the early 80s, when the expanding Mediterranean membership of the European Community encouraged the European Environmental Bureau (EEB) to form its Mediterranean Committee supported by Elliniki Etairia (The Hellenic Society for the Protection of the Environment and the Cultural Heritage). The Mediterranean Information Office (MIO) was established in 1990 as a network of NGOs, under a joint project of EEB and Elliniki Etairia and in close collaboration with the Arab Network of Environment and Development (RAED). The continuous expansion of MIO-ECSDE's Mediterranean NGO network and the increasing request for their representation in Mediterranean and International Fora, led to the transformation of MIO-ECSDE to its current NGO Federation status. Today it has a membership of 112 NGOs from 26 Mediterranean countries.

Our Mission

Our mission is to protect the Natural Environment (flora and fauna, biotopes, forests, coasts, natural resources, climate) and the Cultural Heritage (archaeological monuments, and traditional settlements, cities, etc.) of the Mediterranean Region. The ultimate goal of MIO-ECSDE is to promote Sustainable Development in a peaceful Mediterranean.

Major tools and methods

Major tools and methods used by MIO-ECSDE in order to achieve its objectives are the following:

- Promotion of the understanding and collaboration among the people of the Mediterranean, especially through their NGOs, between NGOs and Governments, Parliaments, Local Authorities, International Organizations and socio-economic actors of the Mediterranean Region.
- Assistance for the establishment, strengthening, co-operation and co-ordination of Mediterranean NGOs and facilitation of their efforts by ensuring the flow of information among relevant bodies.
- Promotion of education, research and study on Mediterranean issues, by facilitating collaboration between NGOs and Scientific and Academic Institutions.
- Raising of public awareness on crucial Mediterranean environmental issues, through campaigns, publications, exhibitions, public presentations, etc.

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