Specialist Group on Water and Wastewater in Ancient Civilisations

Newsletter
April 2010

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CONTENTS

Prolegomena 3
A. N. Angelakis, M. Salgot, N. V. Paranychianakis, and G. De Feo
2nd IWA Symposium on Water and Wastewater Technologies in Ancient Civilisations, Bari, Italy, 28-30, 2009: Overview and Conclusions 5
R. Drusiani, P. Laureano, G. De Feo, and Angelakis
Management Committee of the IWA Specialist Group on Water and Wastewater in Ancient Civilization 9
3rd IWA International Symposium on Water and Wastewater Technologies in Ancient Civilisations, 22-24 March 2012, Istanbul, Turkey: 1st Announcement and Call for Papers 11
Ancient Water Technologies, Traditional Knowledge, and Water Resources Sustainability 15
L. W. Mays
Water and Wastewater Technologies in Minoan Crete, Greece 19
A. N. Angelakis
Various 23

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**PROLEGOMENA**

"The Past is the key for the Future"

Humans have spent most of their history as hunting and food gathering beings. Only in the last 9,000 to 10,000 years they discovered how to grow agricultural crops and tame animals. Such revolution probably first took place in the hills to the north of Mesopotamia. From there the agricultural revolution spread to the Nile and Indus Valleys. During this agricultural revolution, permanent villages replaced a wandering existence. About 6,000 to 7,000 years ago, farming villages of the Near East and Middle East became cities. During the Neolithic age (ca. 5700-3200 B.C.), the first successful efforts to control the water flow were driven (such as dams and irrigation systems), due to the food needs and were implemented in Mesopotamia and Egypt. Urban water supply and sanitation systems are dated at a later stage, in the Bronze Age (ca. 3200-1100 B.C.).

The rapid technological progress in the 20th century created a disdain for the past achievements. Past technologies, especially in water and wastewater sectors, were considered to be far behind the present ones; significant major advances achieved in the twentieth century. At the same time, several of unresolved problems, related to the management principles, such as the decentralization of the processes, the durability of the water and wastewater projects, the cost effectiveness, and the sustainability and especially the protection from floods and droughts were gathered. In the developing world, such problems were intensified in an unprecedented degree. Moreover, new problems have arisen such as the contamination of surface and groundwater. In a natural way, intensification of unresolved problems led societies to revisit the past and to reinvestigate the successful past achievements. To their surprise, those who attempted this retrospect, based on archaeological, historical, and technical evidence, and were impressed by two things: the similarity of principles with present ones and the advanced level of management of both water and wastewater.

Today is well documented that most of the technological principles related to water and wastewater are not achievements of present-day, but date back to three to four thousand years ago. These achievements include both water and wastewater constructions (such as dams, wells, cisterns, aqueducts, sewerage and drainage systems, toilets, and even recreational structures). These hydraulic works reflect clearly an advanced scientific knowledge, which for instance allowed the construction of tunnels from two openings and the transportation of water both by open channels and closed conduits under pressure. Certainly, technological developments were driven by the necessity to make efficient use of natural resources, to make civilizations more resistant to hazardous natural elements, and to improve the standards of life. With respect to the latter, certain civilizations developed an advanced, comfortable and hygienic lifestyle, as manifested from public and private bathrooms and flushing toilets, which can only be compared to the modern one, re-established in Europe and North America in the begging of the last century.

The Romans, whose Empire replaced the Greek rule in several parts of the Mediterranean region, inherited the existing technologies and developed them further also changing their application scale from small to large and implementing them to almost every large city. The Greek and Roman water technologies are not only a cultural heritage but are the underpinning of modern achievements in water and wastewater engineering and management practices. Apparent characteristics of technologies and management practices in many ancient civilizations are durability and sustainability. Also, there have been integrated management practices, combining both large-scale and small-scale constructions and measures that have allowed cities to sustain for millennia. The durability of some of the water and wastewater-related constructions that operated up to present times, as well as the support of the technologies and their scientific background by written documents enabled these technologies to pass to present societies despite regressions that have occurred through the centuries (i.e. in the Dark Ages).

IWA Specialist Group on Water and Wastewater in Ancient Civilizations:
April 2010 Newsletter
With the increasing worldwide awareness of the importance of water resources management in the ancient civilizations, the responsibility for organizing the 2nd IWA International Symposium on Water and Wastewater Technologies in Ancient Civilizations was undertaken by the IWA Specialist Group (SG) the October 2006 (during the 1st IWA International Symposium). The Symposium was organized by IWA SG on Water and Wastewater in Ancient Civilizations in collaboration with the Federutility and other national and international agencies, in Bari, Italy, from 28 to 30 May 2009.

April 2010

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CONCLUSIONS OF THE 2ND IWA INTERNATIONAL SYMPOSIUM ON WATER AND WASTEWATER TECHNOLOGIES IN ANCIENT MAY 28-30, 2009, BARI, ITALY

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Organization. The 2nd IWA International Symposium on Water and Wastewater Technologies in Ancient Civilizations, has come to its end after two fruitful conference days and several months of preparation, which demanded substantial efforts from the Organizing Committee and Program Committee and of course from the contributors. The Symposium was organized in Bari, Italy from 28 to 30 May, 2009. The Conference was organized in the following five Sessions:
(a) Introductory themes
(b) Infrastructures: Building, Development, and Management
(c) Technological Aspects and Hydraulic Engineering
(d) Water Culture, Mythology, etc.
(e) Environmental Aspects, Urban development, Health

The aims of the Symposium were:
(a) to reveal the cultural heritage in several regions of the world and to make visible the archaeological remnants of technologies which have contributed to the development of the existing technologies in water, wastewater, and environment management;
(b) to describe and evaluate the old technologies, which on a long term may contribute to water and wastewater management systems and to the development of integrated methodologies; and
(c) to develop small systems based on old technologies using new equipment, which may be of great significance for water, wastewater and environmental management in the future, particularly in developing countries.

It is a joint conviction of all participants that the Symposium succeeded in its objectives. The Organizing committee was impressed by the diverse themes of presentations and the substantial advancement of the several topics. 45 full papers (available in the CD-proceedings) were presented.

The Symposium was an international one, with 35 scientists and professionals from 13 countries (Table 1). Simultaneously, it was an interdisciplinary Conference, with representatives of several scientific and technological disciplines and with additional participation of the industry (Table 2).

Final conclusions. The Organizing Committee (OC) attempted to draw a few general conclusions that summarize the state of the art in the field and the 2nd IWA Symposium contribution. Here is the list of the most important (in the OC opinion) conclusions:
1. Hydraulic structures coming from the past constitute a valuable historical, cultural and environmental heritage. Moreover, a lot of them (i.e. aqueducts, drainage galleries, fountains, etc.) have continued to be in use from ancient times until nowadays; but the fact that they still have practical uses has denied a monumental value for them.
Table 1: Distribution of the contributors and participants of the Symposium by country.

<table>
<thead>
<tr>
<th>Country</th>
<th>no participants</th>
<th>Country</th>
<th>no participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1</td>
<td>Israel</td>
<td>2</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
<td>Italy</td>
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<td>China</td>
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<tr>
<td>Finland</td>
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<td>Sweden</td>
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</tr>
<tr>
<td>Germany</td>
<td>1</td>
<td>Taiwan</td>
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<tr>
<td>Greece</td>
<td>6</td>
<td>United Kingdom</td>
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</tr>
<tr>
<td>Iran</td>
<td>1</td>
<td>Total</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 2: Scientific, technological and professional fields of the contributors and participants of the Symposium.

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>Environment</th>
<th>Public Health</th>
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<tbody>
<tr>
<td>Archaeology</td>
<td>Geo hydrology</td>
<td>Physics</td>
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<tr>
<td>Architecture</td>
<td>Governance</td>
<td>Sanitation</td>
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<tr>
<td>Biology</td>
<td>History</td>
<td>Soil Sciences</td>
</tr>
<tr>
<td>Chemistry</td>
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<td>Tourism</td>
</tr>
<tr>
<td>Economics</td>
<td>Hydraulic</td>
<td>Wastewater management</td>
</tr>
<tr>
<td>Engineering</td>
<td>Life Sciences</td>
<td>Water Resources</td>
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2. The history of water science and technology: is currently not widely known; contains biased, inaccurate or inconsistent bits of information and has a lot of gaps; Then it is important to know this heritage; and the history should be re-written, particularly in those chapters where biases; and inaccuracies have been already located.

3. There is a growing interest on revisiting past water technologies and management practices, which is justified by the understanding: of the diachronic similarity of problems; and the deadlocks and intensification of problems in the current situation. The history of water and wastewater technology is the best teacher for the future (the past is always the key to the future); and it is important that the society becomes aware that ancient civilizations have developed advanced knowledge, wisdom and sustainable practices.

4. History teaches that water management is important for sustaining civilizations and that sightless or insufficient management may result in civilization collapses. Particularly, civilization collapses have been resulted from inability to deal with climate changes, which seem to have been occurred several times in the past (such as persistent, multiyear droughts; destructive and recurrent floods that destroyed hydraulic infrastructures; and negative human impacts on the environment, i.e. deforestation, erosion, and
desertification).
5. History also teaches that many civilizations all over the world have developed magnificent technologies and management practices characterized by: sustainability and durability (operation for millennia, as opposed to today’s design horizons of 20-50 years); safety and security (as opposed to today’s insecure structures); and wise combinations of small-scale and large-scale projects and measures (as opposed to today’s dominance of large- or mega-scale projects).
6. There is a lot to learn from ancient water and wastewater technologies and practices; the current Symposium is a successful step in this direction and the continuation of this research will certainly suggest improved solutions for current and future problems.
7. Technologies coming from the past could furnish “new” and sustainable solutions in order to face the global environmental crisis.
8. The study and the valorization of ancient technologies and infrastructures could reinforce the image, identity, consciousness and role of the Management Enterprises involved in the water sector.
9. For the continuation of this research the Symposium hopes for great efforts from the IWA Specialist Group on Water and Wastewater in Ancient Civilizations. It could be useful the creation of a specific Web Community. Moreover, we would create a strong connection with UNESCO initiatives as well as UN Convention to Combat Desertification (UNCCD).
10. Finally, organization of a 3rd IWA Symposium in Istanbul, Turkey the spring of 2012 has been decided.
The members of the interim Management Committee of IWA SG are:

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3. Prof. Miquel Salgot, Secretary of Management Committee, Unitat d'Edafologia, Facultat de Farmacia, Univ. of Barcelona, Joan XXIII s/n, 08028 Barcelona, Spain, salgot@ub.edu.
4. Prof. G. De Feo, Management Committee member, Dept. of Civil Engineering, University of Salerno, 1, via Ponte don Mellilo, 84084 Fisciano, Italy, g.defeo@unisa.it.
5. Prof. L. Mays, Committee member, Arizona State University, Tempe, Arizona 85287-5306, USA, mays@asu.edu.
6. Prof. D. Koutsoyiannis, Management Committee member, School of Civil Engineering, National Technical University of Athens, 5, Iroon Polytechniou str., 15780 Zographou, Greece, dk@itia.ntua.gr.
7. Dr. Y. Gorokhovich, Management Committee member, Center of International Earth Science Information Network, Columbia University, 61Rt 9W, PO Box 1000 Palisades, NY 10964, USA, ygorokho@ciesin.columbia.edu.
8. Prof. Walter Dragoni, Management Committee member, Dept. di Scienze della Terra, Univ. of Perugia, 06100Perugia, Italy, wd2698@yahoo.com.
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11. Dr. Pietro Laureano, Deputy Chairperson, IPOGEA, Vico Conservatorio s.n., 75100 Matera, Italy, ipogeal@ipogeal.org.
12. Dr. N. Paranychianakis, Management Committee member, Dept. Environmental Engineering, Technical University of Crete, 73100 Kounoupidiana, Chania, Greece, nvpar@her.forthnet.gr.
13. Prof. I. Koyuncu, Management Committee member, Environmental Engineering Dept., Istanbul Technical University, Istanbul, Turkey, koyuncu@itu.edu.tr.
3rd IWA INTERNATIONAL SYMPOSIUM ON WATER AND WASTEWATER TECHNOLOGIES IN ANCIENT CIVILIZATIONS IN ISTANBUL, TURKEY, 22-24 MARCH 2012: 
1ST ANNOUNCEMENT AND CALL FOR PAPERS

Objectives
The principal aims of the 3rd IWA International Symposium are:
(a) To reveal the cultural heritage in several regions of the world and to make visible the archaeological remnants of practices which have contributed to the evolution of the existing technologies in water and wastewater management.
(b) To describe and evaluate the old technologies, which on a long term may contribute to water and wastewater management systems and to the development of integrated methodologies.
(c) To develop small decentralized systems based on old technologies using new equipment, which may be of great significance for water, wastewater, and environment management in the future.
(d) Water and wastewater knowledge related to the water services and juridical/economic aspects.

Topics
Topics of interest include but are not limited to:
(a) Methods, practices, and techniques of water and wastewater resources management.
(b) Urban water use.
(c) Urban wastewater and storm water management technologies.
(d) The evolution of aqueducts and other relevant infrastructure and technologies through the millennia.
(e) Old influence in modern water and wastewater technologies.
(f) Iconographic aspects of water in ancient civilizations.
(g) Sociological and economical issues.
(h) Juridical aspects
(i) The socio-economic role of water throughout the centuries.

Call for Papers
Authors are invited to submit their English written manuscripts of maximum 8 pages, including figures and tables (as MS word file single interspaced) via e-mail to koyuncu@itu.edu.tr no later than November 30, 2011. Manuscript will be accepted based on quality, originality and relevance to the Symposium themes. All accepted manuscripts (papers or posters) will be published as the Symposium Proceedings. Only presented contributions (papers and posters) will also be reviewed, on their quality, originality and relevance to the Symposium themes, by the International Reviewing Committee for publication in a special edition of Water Science and Technology. The Reviewing Committee will be established on the last day of the Symposium.

Registration Fees in € (for the 2 or 3 lectures days )

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<th>Categories</th>
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<td>320.00</td>
<td>380.00</td>
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<td>Non-members</td>
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<td>Students</td>
<td>140.00</td>
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<td>Accompanying persons</td>
<td>80.00</td>
<td>140.00</td>
</tr>
</tbody>
</table>

50.00€ discount will be applied to the fee for authors whose abstracts has been accepted.

Also the IWA International Symposium will include one day tours to old water structures.
of Istanbul. The tour will cost 40.00€.

Participant’s registration fee includes: admittance to all sessions, congress material, proceedings, certificate of attendance; coffee-breaks; lunch on March 22-24. Students’ registration fee includes: admittance to all sessions, congress material, certificate of attendance, coffee-breaks, and lunch on March 22-24.

Don’t miss the chance to expose your company’s experience, brand your products, and trade on the opportunities by becoming an Exhibitor or Sponsor of the 3rd International Symposium on Water and Wastewater Technologies in Ancient Civilizations (WWTAC). If you would like to have more information about sponsoring or exhibiting, please contact Prof Ismail Koyuncu by email (koyuncu@itu.edu.tr).

**Important Dates to Remember**

a) Manuscripts submission (up to 8 pages): November 30, 2011;
b) Notification to authors regarding manuscripts’ acceptance: January 31, 2012; and
c) Registration at a reduced rate: January 31, 2012.

**Organizers**
The main organizers are:

- Istanbul Technical University, Turkey
- Ministry of Environment and Forest, Turkey
- Istanbul Water and Sewerage Administration, Turkey
- Water Foundation of Turkey, Turkey
- DWHG, Germany
- FederUtility, Italy
- Hellenic Water Supply and Sewerage Systems Association (EDEYA), Greece
- IPOGEA, Italy
- Turkey Antiquities Authority, Turkey.

**Organising Committee**

- Prof. Dr. Ismail Koyuncu, Turkey, Chairman
- Prof. Dr. Hasan Z. Sarıkaya, Turkey
- Prof. Henning Fahlbusch, Germany (to be confirmed)
- Representative of the Ministry of Foreign Affairs, Turkey
- Representative of the Ministry of Tourism, Turkey
- Dr. Andreas N. Angelakis, EDEYA, Greece
- Dr. Renato Drusiani, FederUtility, Italy
- Prof. Dr. Cumali Kinaci, Turkey
- Prof. Dr. Izzet Ozturk, Turkey
- Assoc. Prof. Dr. Ali Fuat Aydin, Turkey
- Assoc. Prof. Dr. Mehmet Cakmakci, Turkey
- Assoc. Prof. Dr. Vedat Uyak, Turkey
- Assist. Prof. Dr. Ali Uyumaz, Turkey

**Programme Committee**

- Dr. Ismail Koyuncu, Turkey, Chairman
- Dr. Andreas N. Angelakis, EDEYA, Greece
- Prof. Adin Avner, Israel
- Dr. Mohamed Bazza, FAO, Egypt
- Prof. Giovanni De Feo, Italy
- Dr. Renato Drusiani, FederUtility, Italy
- Prof. Dr. Hasan Z. Sarıkaya, Turkey

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IWA Specialist Group on Water and Wastewater in Ancient Civilizations:
April 2010 Newsletter
• Prof. Dr. Cumali Kinaci, Turkey
• Prof. Walter Dragoni, Italy
• Prof. Chuck Gerba, Arizona, USA
• Dr. Yuri Gorokhovich, Ny, USA
• Prof. Henning Fahlbusch, Germany (to be confirmed)
• Prof. Arie Issar, Israel
• Dr. Blanca Elena Jiménez Cisneros, Mexico
• Prof. Bryan Karney, Canada
• Prof. Dimitris Koutsoyiannis, Greece
• Dr. Pietro Laureano, Italy
• Prof. Larry W. Mays, Arizona, USA
• Prof. Nikolaos Paranychianakis, Greece
• Dr. Alexander Reyes-Knoche, Germany
• Prof. Joan Rose, Michigan, USA
• Prof. Miquel Salgot, Spain
ANCIENT WATER TECHNOLOGY, TRADITIONAL KNOWLEDGE, AND WATER RESOURCES SUSTAINABILITY

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School of Sustainable Engineering and the Built Environment, Arizona State University, Tempe, Arizona 85287-5306, USA, mays@asu.edu

The Link between Traditional Knowledge and Water Resources Sustainability

At the beginning of this new millennium we have a water crisis which threatens human’s existence in many parts of the world. One might ask, how sustainable is it to live in a world where approximately 1.1 billion people lack safe drinking water, approximately 2.6 billion people lack adequate sanitation, and between 2 million and 5 million people die annually from water-related diseases? In the attempt to solve this water crisis we must concern ourselves with the concepts of water resources sustainability. Water resources sustainability is the ability to use water in sufficient quantities and quality from the local to the global scale to meet the needs of humans and ecosystems for the present and the future to sustain life, and to protect humans from the damages brought about by natural and human-caused disasters that affect sustaining life (Mays, 2007). The overall goal of water resources management must be water resources sustainability.

A component of water resources sustainability is the use of traditional knowledge, which constitutes the ancient knowledge of humanity (www.tkwb.org). The United Nations Convention to Combat Desertification (UNCCD) provided the following definition of it: “Traditional knowledge consists of practical (instrumental) and normative knowledge concerning the ecological, socio-economic and cultural environment. Traditional knowledge originates from people and is transmitted to people by recognizable and experienced actors. It is systematic (inter-sector and holistic), experimental (empirical and practical), handed down from generation to generation and culturally enhanced. Such a kind of knowledge supports diversity and enhances and reproduces local resources.”

Where can we implement traditional knowledge to help in water resources sustainability? Because water impacts so many aspects of our existence, there are many facets that must be considered in water resources sustainability. How do we overcome our modern day shortcomings and strive for water resources sustainability? Possibly one way is to study the past. The use of traditional knowledge may play a major role in solving some of the present day and future water resources sustainability issues, especially in developing parts of the world.

Many civilizations, which were great centers of power and culture, were built in locations that could not support the populations that developed. Now we find ourselves in similar situations in many places around the world. One might argue that if the ancient societies had our present day technologies, they would not have failed. I don’t think that even newer technologies are the answer for our present day problems; therefore we will need to rely on traditional knowledge to tackle these problems. What relevance does the failure or collapse of ancient civilizations have upon modern societies? Learning from the past and discovering the reasons for the success and failure of other societies seems very logical. We certainly are a much more advanced society than those of the ancient societies, but will we be able to overcome the obstacles to survival before us? The collapse of some civilizations may have been the result of the very processes that had been responsible for their success (e.g. the Mayans and Romans and others).

What relevance do ancient civilizations have upon modern day water resources sustainability? Or better yet, what can we learn from these ancient civilizations? Diamond (2005) proposed a five-point framework for the collapse of societies: (a) damage that
people inadvertently inflict on their environment, (b) climate change, (c) hostile neighbors, (d) decreased support by friendly neighbors, and (f) society’s responses to its problems. Three of these can relate to water resources sustainability.

Ancient Water Technology

The following paragraphs are only a very brief description of ancient water technology. Various methodologies of ancient water technology are described further in Mays (2008, 2010) and Mays et al. (2007).

Hassan (1998) stated that “the secret of Egyptian civilization was that it never lost sight of the past”; because of the unpredictability of the Nile River floods and the production of grains suggest order and stability. The ancient Egyptians depended upon the Nile not only for their livelihoods, but they also considered the Nile to be a deific force of the universe, to be respected and honored if they wanted it to treat them favorably. Its annual rise and fall were likened to the rise and fall of the sun, each cycle equally important to their lives, though both remaining a mystery. Since the Nile sources were unknown up until the 19th century, the Ancient Egyptians believed it to be a part of the great celestial ocean, or the sea that surrounds the whole world.

The first actual recorded evidence of water management was the mace head of King Scorpion, the last of the Predynastic kings, which has been interpreted as a ceremonial start to breaching the first dyke to allow water to inundate the fields or the ceremonial opening of a new canal.

Mohenjo-Daro was a major urban center of the Indus civilization during the early Bronze Age, located about 400 km north of present-day Karachi, Pakistan. This planned city, built around 2450 B.C. received water from at least 700 wells and had bathrooms in houses and sewers in streets. The Mesopotamians were not far behind. The Sumerians, during the Bronze Age, and other ancients that inhabited Ancient Mesopotamia provided an enormous amount of information about themselves through cuneiform tablets. Water provided by the Euphrates and Tigris Rivers shaped their societies. Elaborate irrigation systems were developed requiring continuous canal maintenance and construction of waterworks. Sedimentation in many canals was such a critical problem, that it was easier to abandon these canals and build new ones. One Sumerian epic indicates that humans were created specifically to dig irrigation ditches. The Sumerian epics also referred to the effect of uncontrolled human activity on the soil and environment, being interpreted as God’s curses, what we now understand as the environmental effects of intense irrigation.

Other great civilizations such as the Minoans, located on modern-day Crete, flourished during the Bronze Age, They had wonderful water systems, such as those found in Knossos, Tylissos, Phaistos, Zakros, and others. These systems included aqueducts, cisterns, filtering systems, sedimentation basins, rainfall-harvesting systems, terracota pipes for water supply and sewage, and drainage channels. All these Bronze Age civilizations had one thing in common, even with the advanced capabilities to provide water supply, these civilizations all collapsed. The interesting question is whether water resources sustainability was a significant component for their failure.

Later other civilizations, such as the Greeks and then the Romans, built on the previous knowledge of hydraulics and water resources, but yet they also failed. The ancient Greeks built the Peisistratean aqueduct for Athens and the aqueduct of Samos (tunnel of Eupalinos).

The Romans used water as a matter of luxury and prestige building mega water projects using aqueducts to transfer water to their public fountains and baths. During this time many of the smaller water projects such as wells and cisterns were also abandoned. This signified a different water management attitude than the classical Greeks. The ancients showed us that it
it was feasible to construct technologically advanced water transportation projects on a large scale. The fall of the Roman Empire extended over a 1000-year transition period called the Dark Ages. During this period, the concepts of science related to water resources probably retrogressed. After the fall of the Roman Empire, water sanitation and public health declined in Europe. Historical accounts tell of incredibly unsanitary conditions - polluted water, human and animal wastes in the streets, and water thrown out of windows onto people in the streets. Various epidemics ravaged Europe. During the same period, Islamic cultures, on the periphery of Europe, had religiously mandated high levels of personal hygiene, along with highly developed water supplies and adequate sanitation systems.

There is no doubt that the ancient societies in Mesoamerica and the Southwestern United States did fail partially from the depletion of natural resources and climate change, at least particularly as related to water (Mays 2007). Many Mesoamerican civilizations developed and failed for various reasons. The period or era from about 150 A.D. to 900 A.D. (called the Classic) was the most remarkable in the development of Mesoamerica. During the Classic Period the people of Mexico and the Maya area built civilizations comparable with advanced civilizations in other parts of the world. In Mesoamerica the ancient urban civilizations developed in arid highlands where irrigation (hydraulic) agriculture allowed high population densities. In the tropical lowlands, however, there was a dependence on slash-and-burn (milpa) agriculture which kept the bulk of the population scattered in small hamlets. The non-urban lowland civilization possibly resulted from responses to pressures set up by the hydraulic, urban civilization. Teotihuacan (City of the Gods) in Mexico is the earliest example of highland urbanism.

Conclusions

Many civilizations, which were great centers of power and culture, were built in locations that could not support the populations that developed. Now we find ourselves in similar situations in many places around the world. How do we balance the mega water projects with the methods of traditional knowledge? Koutsoyuannis, et al. (2008) explored the legacies and lessons on urban water management learned from the ancient Greeks. They summarized the lessons learned as follows:

a) The meaning of sustainability in modern times should be re-evaluated in light of ancient public works and management practices. Technological developments based on sound engineering principles can have extended useful lives.

b) Security, with respect to water, is of critical importance in the sustainability of a population.

c) In water-short areas, development of an effective water resources management program is essential.

The use of traditional knowledge does not directly apply techniques of the past but instead, try “to understand the logic of this model of knowledge” (Laureano, 2007). Traditional knowledge allowed ancient societies to keep ecosystems in balance, carry out outstanding technical, artistic, and architectural work that has been universally admired. The use of traditional knowledge has been able to renew and adapt itself. Traditional knowledge incorporates innovation in a dynamic fashion, subject to the test of a long term, achieving local and environmental sustainability.

The ancients for the most part lived in harmony with nature and their environment. Where those that did not fail. Their actions should be warnings to us, in other words the ancients have warned us. Today we do not live in harmony with nature and the environment.
References


Minoan technological developments in water management principles and practices are not known as well as other achievements of the Minoan civilization, such as poetry, philosophy, sciences, politics, and visual arts. To put in perspective the ancient water aqueducts discussed in this paper, it is important to examine their relevance to modern times and to harvest some lessons learned. The relevance of ancient works will be examined in terms of the evolution of technology, the technological advances, homeland security, and management principles. With a few exceptions, the basis for present day progress in water transfer is clearly not a recent development, but an extension and refinement of the past.

Archaeological and other evidence indicate that, in the Bronze Age in Crete, advanced water management and sanitary techniques were practiced in several settlements. This period was called by the excavator of the “palace” at Knossos, sir A. Evans as Minoan after the legendary king Minos. Thus, Crete became the cradle of one of the most important civilizations of mankind and the first major civilization in Europe (Angelakis and Koutsoyiannis, 2003). One of the major achievements of the Minoans was the advanced water management techniques practiced in Crete at that time. The advanced water distribution and sewerage systems in various Minoan palaces and settlements is remarkable, because there are evidences that several water techniques were unknown before the Minoan era. These techniques include the construction and use of aqueducts, cisterns, wells, and fountains, the water supply systems, the construction and use of bathrooms and other sanitary and purgatory facilities, as well as wastewater and storm sewer systems. The hydraulic and architectural function of the water supply and sewer systems in palaces and cities is regarded as one of the salient characteristics of the Minoan civilization. These systems were so advanced that can be compared with the modern systems, which were established only in the second half of the 19th century in European and American cities (Lyrintzis and Angelakis, 2006). The history of water supply engineering in Crete dates back more than ca.4,500 years. From the early Minoan period (ca. 3200-2300 B.C.) issues related to water supply were considered of great importance and have accordingly developed. Numerous very advanced and wonderful water and wastewater systems, included aqueducts, cisterns, filtering systems, rainfall-harvesting systems, terracotta pipes for water supply, fountains, baths, sewers, and toilets were practiced in several Minoan palaces and other settlements (Angelakis and Spyridakis, 1996).

It should be noted that hydraulic technologies in ancient Greece are not limited to urban water and wastewater systems. The progress in urban water supply was even more admirable, as witnessed by several aqueducts, cisterns, wells, and other water facilities discovered, including the famous Minoan aqueducts of Knossos and Tylissos, the cisterns of Zakros, Archanes, Pyrgos and Tylissos, the wells of Paleokastro, Zakros, and Itanos (e.g., Koutsoyiannis et al., 2008). These advanced Minoan technologies were expanded to the Greek mainland in later periods of the Greek civilizations.

These technologies, although do not give a complete picture of potable water, wastewater and stormwater technologies in ancient Greece, illustrate that such technologies have been used in prehistoric Greece since ca. 3200 B.C. These advanced technologies began in the Minoan Crete and subsequently were expanded to Mycenaean and then the Archaic and Classical Greece. In light of these historical and archaeological evidences, it turns out that the progress of present day in urban water and wastewater technologies as well as in comfortable and hygienic living is not as significant in terms of evolution as we tend to believe (Angelakis et al., 2005).
This technological progress was accompanied with good understanding of the water and wastewater related phenomena. Thus, ca. 600 B.C., Greek philosophers developed the first scientific views on natural hydrological and meteorological phenomena. Later, during the Hellenistic and Roman periods, significant developments were done by Cretans in hydraulics, such as in the construction and operation of aqueducts, cisterns, wells, harbours, water supply systems, baths, toilets, and sewerage and drainage systems. Further improvements were achieved by Cretans during the Byzantine and Venetian periods, when a further development of hydrotechnologies, such as aqueducts, cisterns, and water supply and sewerage systems was achieved. Several sophisticated defense structures, including famous water supply systems were also constructed at those periods.

Urban hydraulic systems first appeared during the Bronze Age, particularly in the mid-third millennium B.C., in an area extending from India to Egypt. In the island of Crete, where the Minoan culture of the Bronze Age flourished, the emergence of the palaces revealed a remarkable development of water management in the urban context. Moreover, during the Middle Minoan and the beginning of the Late Minoan periods (ca. 2000-1500 B.C.) a “cultural explosion”, occurred on the island. A striking indication of this is manifested, inter alia, in the advanced water management techniques practiced in Crete at that time. These included various scientific fields of water resources such as wells and ground-water hydrology, aqueducts, domestic water supply according to local condition in terms of climate and geomorphology. Additionally, the constructions and use of sanitary and purgatory facilities, even the recreational uses of water, signify attitudes of life and taste (Lyrintzis and Angelakis, 2006).

Different techniques were applied to assure the water supply: (a) management of spring runoff water and (b) transportation and storage of water. Moreover, these techniques suggest a sophisticated life style. Different techniques were applied according to local conditions. While the Knossos palace was depending on springs, in the palace of Phaistos the water supply was depending on a surface runoff system, while at the Zakros palace a groundwater system was used. Despite this diversity, common construction mastery seems to have been applied. It can be suggested that a group of people living in prehistoric Crete were aware of the principles of technologies relevant to water (Angelakis and Spyridakis, 1996). This is suggestive of the existence of master craftsmen responsible for constructing and maintaining the water supply system of a community. They were concerned with the solution of some water related problems and were able to provide palaces and settlements with efficient, even sophisticated water supply systems. To accomplish their goals, this group of craftsmen obviously possessed at least a rudimentary understanding of some basic principles, such as flow and friction, of what we call today water and environmental engineering.

References

Selected papers from those presented in the 2nd IWA International Symposium on Water and Wastewater Technologies in Ancient Civilizations in Bari, Italy from 28 to 30 May, 2009 will be soon published under the title: Water and Wastewater Management Technologies in Ancient World in Water Sci. and Techn., Water Supply, Vol. 10 (4), De Feo, G. et all. (Eds.), 2010.

Other relevant meetings, announcement, publications, etc. are:
1. 8th International Conference on the Mesolithic in Europe, MESO2010, 13 - 17 September 2010, Santander, Spain
   Contact: meso2010@afidcongresos.com
2. Google and UNESCO Announce Alliance to Provide Virtual Visits of Several World Heritage sites. Please visit the site:
3. New Publication
   Minoan Architecture: Materials and Techniques, by J.W. Shaw
   More information about the book and other publications of the Centro di Archeologia Cretese are at the following link: http://www.cac.unict.it/pubblicazioni.php
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4. First Minoan Shipwreck. Please visit the site:
   http://www.archaeology.org/1001/abstracts/minoan_shipwreck.html
5. The sea level has been rising and falling over the last 2,500 years. Please visit the site:
6. Italians Study Iran’s Pasargadae. Italian archaeologists have finished their studies on the destructive impacts of the Sivand Dam on the ancient site of Pasargadae in southern Iran. Please visit the site:
7. News, Archaeology: British Film-makers Uncover Trajan’s Hidden Roman Aqueduct. Please visit the site:
8. The Genius Archimedes, 23 Centuries of Influence on Mathematics, Science, and Engineering Conference
   Syracuse (Sicily), Italy, 8-10 June 2010