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Design with Water. Back to the Future

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ABSTRACT

Cities are undergoing severe water shortages. Many actions are underway to counteract this situation which poses a severe threat to the survival and welfare of humankind. The deleterious impacts of water shortage are becoming glaringly evident in all parts of the world and are particularly alarming in developing countries. In the meantime, contemporary architectural design and urban planning are locked in a paradigm that valorizes practices with high costs of construction and maintenance based on the powers of technology to create buildings and urban landscapes that are, with rare exceptions, not in harmony with the environment and with water conservation. As an alternative, urban design with water aims to maximize water supply and conservation, while minimizing any harmful impact on the natural habitat in a manner that optimizes the role of the built environment as a means for an enjoyable life. As a source of inspiration, traditional water management systems from different parts of the world are explored. Sever case studies have been selected in this study to reveal the range and creativity of traditional and historical methods developed in different parts of the world to harvest and store water. These methods allow us to extract principles for urban design that can be used to supplement water supply and increase storage capacity, while in the mean time contributing to the amelioration and integrity of the ecological habitat.

Keywords: Urban Design; Traditional Water Management Systems; Water History; Archaeology Of Water; Water Architecture; Rainkeep Project; Mexico City; Burj Khalifa

1. INTRODUCTION

Humanity is now facing a serious water crisis: the quantity of water available for urban domestic uses, for drinking, washing and irrigating is not sufficient to meet the demands of the already huge water population that continues to grow at an alarming rate (Hunt, 2007). There is also the growing demand for water to cope with developments. The situation is made worse as a result of water pollution and is even worse in developing countries where measures for environmental protection are not in place.

One of the most serious problems, however, is the availability of water in cities all over the world. This is especially the case for the large urban conglomerations where 60% of the world population resides at present. The problem of water scarcity is in the cities is compounded with the need of water for sound ecological systems. In addition, the world is undergoing climatic changes that may in many parts of the world lead to water scarcity, while in others it will change in frequency and seasonality of rainfall. We also have to reflect upon water demands by future generations. Given the gravity of the consequences of water scarcity in all manifestations of life on earth and on humanity, it is important to mobilize all the domains of knowledge to find

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ways to counteract the catastrophic effects of water shortages, architecture included (Colombo, 2003).

Given also that the bulk of humanity live in cities, it is now the time to rethink architecture and town planning in terms of the ongoing depletion of water resources. As a first measure, it is both necessary, and urgent, to find architectural and urban solutions to increase urban water supply of water by promoting the preservation and the efficient use of the water resources. This will require a new approach to urban planning and architectural design.

The research methodology in the current work was based on a comparative analysis of water management in three urban contexts with reference to traditional water management systems for harvesting and water storage. These results were analyzed to provide principles for guiding future urban design approaches with water management as key component of the design.

2. WATER SCARCITY IN MODERN CITIES

Las Vegas, Caracas, New York, Tehran, Sao Paulo, Paris, Lagos, Tokyo, Sydney, Shanghai, all the cities in the world have to face this alarming situation. The fact is that the demands for urban water increase as urban population grow. Together with the grand engineering constructions, there are architectural projects that use devices and technological installations to recover, recycle and reuse water, mostly rain, with high costs of construction and maintenance (Berger, 2009). Confronted with the limits of a tight budget, we need to optimize urban water supply. This is essential for humanity because of increasing poverty and limited resources. One of the possible strategies to face this problem is based on rereading the past to discover cheap and friendly environmental designs.

Figure 1 The image of the city. Ian L. Mcharg, Progettare con la Natura, Franco Muzio Editore, Padova, 2007. p. 24

The relationship between water and architecture may not be clear today, but there has always been a close, intimate link between architecture and water resources. Throughout human history and in all continents, people applied their ingenuity to find solutions to the problems of matching the needs with local water availability: using different forms and

materials, architectural designs included features for harvesting and collecting water. Some of these ancient methods survive as traditional water harvesting and management systems. Traditional knowledge can suggest architectural solutions by stimulating our imagination beyond what is rational for us at this moment. Primarily, we need not to focus our attention on how to recycle, drain, purify, avoid waste and consume less. The biggest challenge for architecture is to design the human environment according with water (Dreiseitl, 2009).

In the past, the human manipulation of the natural environment, aimed to improve water supply in symbiosis with the opportunities and limits water loss. Urban centers were closely tuned to the local environmental and climatic conditions. The characteristics of the environment were taken into consideration in determining the appropriate setting of a house and informed urban networks, residential and public areas as well as the location of public spaces. Knowledge gained was transcribed as Tradition a set of ideas, actions, products and practices accepted by the community for generations in a specific natural environment. Tradition, in relation to water, therefore, can be regarded as the red wire that led the human water supply until Modernity has broken sound water management principles.

Historical knowledge was encoded by practitioners and users in traditional systems of building, planning and thinking. Over centuries, ancient societies with different building methods, materials and designs, as well as urban locations and through generations selected the best practices and rejected those that did not conform to the environment or the local climate.

The approach to urban planning and architectural design changed with the advent of "modernity". Modern architects working under conditions of industrial methods of water supply since the 19th century which made water available in houses, factories, and public places where water might not have been otherwise available, were no longer constrained with local water availability.

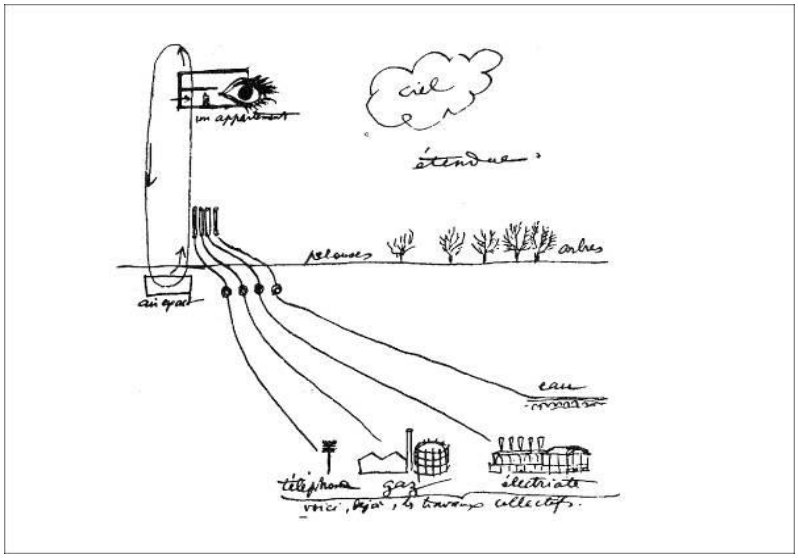

Figure 2 Sketch of Le Corbusier. In modern time, water was not considered a natural element but an urban comfort like gas, telephone and electricity. Leonardo Benevolo, L'architettura delle città nell'Italia contemporanea, Edizioni Laterza, Bari, 1972, p. 127.

Thinking about water, in modern time, is cut off from a consideration of its intimate links to the natural environment, and is considered no more than a service of technology, just like telephone, gas and electricity. The consequences were a sharp rise in water demand which was not met with any methods for water conservation or harvesting. Modernity thus represented a shift from living in symbiosis with nature to an exploitative strategy that did not take into consideration the harmful effects of high levels of water consumptions that can only be met with high cost of water collection, transport, purification and storage. As a consequence of what was considered "progress" we have now come to a point in time where our notions of progress had to be re-examined and our architecture that was a part and parcel of modernity had to be re-invented. The faith in the utopian promises of the modernity has by now evaporated, but modern thinking about water in architecture and urban settlements is ossified in the training strategies that continue to dominate the formulations and designs of architects and planners (Habermas, 1997).

If time, place, purpose, or climate, prohibit replicating traditional designs , this does not prohibit the study and review traditional best practices that have been marginalized, ignored and rejected by modern designers. The principles of eco-anthropological design characteristic of traditional settlements could be used as strategies to alleviate the current urban water crisis and blend them with the recent discoveries allow us to look for a future of continuity and progress (Berardinelli, 2007).

3. LEARNING FROM TRADITION

For thousands of years, in different ways depending on the historical period and specific geographical location, traditional architecture included elements for harvesting and storing water. For example, the design of houses at Alberobello and Matera, Italy, the organization of the settlement with terraces in the Italian region of "Cinque Terre", the underground dwellings in China, the architectural configuration of Maya settlements, the Acropolis in Athens, the step-wells in India, and the torrent streets in Ghardaia reveal how human societies managed to secure water from locally available sources and to store it for later use by integrating water management devices in urban and architectural designs. Today, architectural design can benefit from this traditional knowledge, and to use such knowledge to create a creative blend of contemporary and traditional knowledge and practices (Laureano, 2001).

Three case studies are presented here to illustrate how water management devices were integrated in architectural design and how traditional principles can be used in current architectural and urban design. The three case studies highlight the basic principles of traditional design.

The first case study is the "Rainkeep Project" in Jordan, an area with serious problems of water. This project highlights the importance of recovering social practices for improving current architectural design. This project initiated by Professor Oystein LaBianca, physical anthropologist of Andrews University (Michigan, USA), was conducted with the aim of discovering the best practices for recovery and reuse of old water cisterns in Jordan.

The project showed that some of these old storage devices can be restored at low cost, with beneficial results for the families who actually have begun to restore old cisterns to use them again for collecting rainwater. This had the effect of reducing the pressure on public water supply, and lowering the demand for water to be transported from outside the community by private tank trucks (LaBianca 1964).

Figure 3 Cisterns in Jordan, by Oystein LaBianca

The second case study concerns one of the biggest cities of the planet, Mexico City, and draws attention to the importance of traditional water management systems in conserving and restoring natural habitats. In this case the ancient traditional settlements were located and were integrated in swamps. The great Valley of Mexico, where the city is located today, was in the beginning a large lake, or better, a series of lakes, and Tenochtitlan, the capital of the Aztec empire, was built almost entirely on "chinampas", cultivated rafts from mud and weeds, like floating gardens, anchored to the bottom of the lake. The disappearance of the lake combined with the exploitation of the aquifers underlying the urbanized area, the devastating rains, and the continuous drainage works have led to the sinking of the city. To remedy this situation, a project by architect Alberto Kalach called "México Ciudad Futura. Return to the City of Lakes", is based on previous traditional initiatives. It consists of a plan for environmental rescue based on "rehydrating" one of the urban areas, where conditions are the worst (Spellman, 2003). Unfortuantely, the project has not been realized and Mexico City continues to grow "against sound management with nature".

The third case study deals with the tallest building in the world the Burj Khalifa, in the Emirates, and the potential for harvesting water from one of the important water sources used in the past: water vapor (humidity). After researching "Air Wells, Dew Ponds and Fog Fences, and methods to obtain water from atmospheric humidity through condensation" by Robert A. Nelson, founder of Rex Research, we can begin to visualize how the function and meaning of a building could change if it was designed with water harvesting in mind. Burj Khalifa, 828 meters in height, could probably capture the "atmospheric rivers", a term used for concentrations of humidity in the air, to provide water in an economical and environmentally sound way, and to start a "revolution" in the architectural language (Nelson, 2003).

Figure 4 Burj Khalifa, Dubai (UAE), by Francesca Guerrucci

Given the current situation, the objective of the research focus on recovering and rediscovering traditional architectonic and urban strategies that have over millennia ensured adequate water supply, conserved water and contributed to the enhancement of the integrity of the ecological habitats. Such methods can at present contribute to a better management water systems in cities and towns all over the world. They can become a complementary method for increasing water supply. They can also contribute to reducing the risk of occasional water scarcity, reduce the cost of water supply, maintenance and repairs, and help in planning new urban settlements (Lanz et al., 2006).

It is not the intention in this work to suggest replicating or cloning traditional water management and supply architectural elements in modern settings or in environmental, climatic, or social conditions widely different from those in which traditional methods originated. Instead, the focus is on architectural design and urban planning principles that aim to increase water availability and conserve water resources. Architecture emerges from our current discussion not as just as a project for building a physical shell, but as an activity that mediates between human objectives and environmental opportunities and constraints, and as a human endeavor it cannot be achieved at the risk of destroying its local environment or at a level that cannot be supported by local ecological parameters including water. A harmonization between architectural design, human needs and objectives, as well as environmental parameters is the basis for future attempts to design with water.

4. TOWARD AND ARCHITECTURE WITH WATER

Nothing in the past could be explained well without considering the ecological, cultural context and the availability of water resources (Hassan, 2010). Today, almost all major cities are facing problems of water scarcity. Architectural projects have by now become inseparable from grand engineering constructions and devices that aim to recover, recycle and reuse water. This is done at a high cost of construction and maintenance, but without a serious consideration for how architecture is related to local resource and limited local water availability. To remedy this, we require to introduce water as an integral design element of

architecture and urban planning. The case studies clearly reveal that before the advent of modern times, there was a devoted attention to harvesting and storing water. This was done in a manner that balanced environment, society and resource. An analysis of the relationship between these components is important for understanding the principles needed for the development of future planning strategies.

Clearly, cities and urban places have to be in tune with the available environmental resources. One of these resources is water. Accordingly, it is not fitting to continue to phrase the problem in terms of providing more water to "support" the cities. Instead, it is now important to refer to the concept of "adaptation" (Dubos, 1965). The adaptability is a result of the intimate relationship between architecture and the natural surroundings in a specific context, by which the architecture is tuned both to available resources and human needs in a specific social setting. From an anthropological point of view, socio-cultural aspects have always played an important role

In the past: people were actively involved in maintaining a sound relationship with nature and their environmental surroundings (Moore, 1994). Therefore, it is essential to recover local water management principles and practices from all over the world in order to contribute to a framework for restoring the direct relationship between people and their environment on a global scale. It has also become clear from the examination of traditional case studies that the relationship between architecture and resource must be re-examined. In this case we speak of water, but we could also consider any natural and essential element for life, such as fire, wind, sun and earth. We also can no longer just be preoccupied with the aesthetics of the water in the urban environment, or its expressive and symbolic meanings. It's time to pay attention to the ethics of architecture (Rapaport, 2005). New actions are needed to transform the current condition and to overcome the current scarcities of urban water at limited costs and optimizing water supplies without damaging the environment. This approach is the basis for a "revolution" of design language.

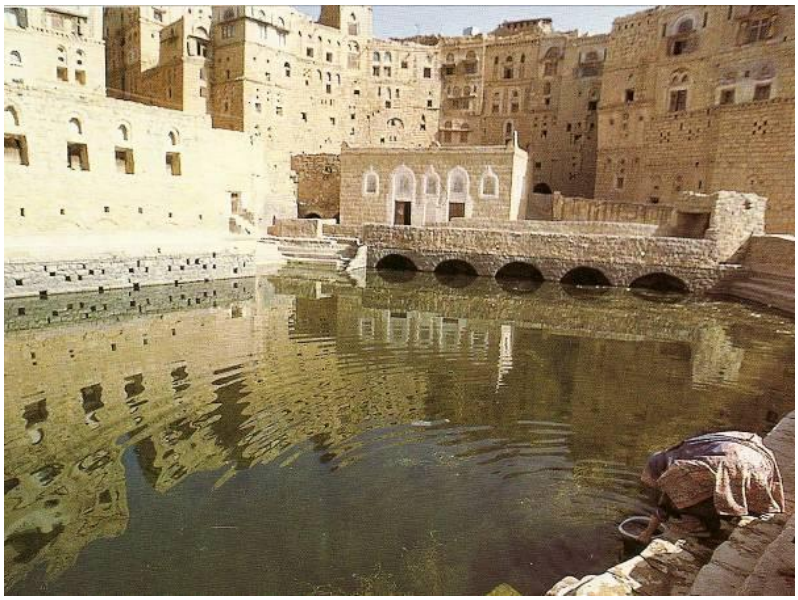

Figure 5 Hababa (Yemen). The public basin. Pietro Laureano . Atlante d'acqua: conoscenze tradizionali per la lotta alla desertificazione, Bollati Boringhieri Editore, Torino, 2001, p. 161.

The design approach that follows the principles of traditional design should not be an exercise of "transplanting" from one context to another. A simple historical analysis of traditional architecture is not enough, if it's not included in a broader framework that identifies the essential features and general principles for designing with water.

Traditional knowledge of water management provides some insights on how to do this, keeping in mind that traditional knowledge should not be considered as relicts worthy only of "museums" (Andriani, 2010). Although some of the traditional methods are rural, this does not mean that they cannot be integrated in urban designs. Our idea against traditional architecture should be overcome in order to extract principles of sound water management practices. Traditional water management also teaches us that human societies have persisted because they adapted to their habitats and developed means for harvesting and storing water that were congruent with local water availability and distribution. The result was a symbiotic design with water.

The main objective of the research elaborated here is not to glorify traditional architecture or turn back to living in traditional dwellings, but to encourage the development of new more appropriate practices, rooted in traditional knowledge, to meet contemporary needs. Our historical analysis of traditional architecture has been done with the aim of extracting lessons of how human societies established their settlement in an adaptive way. In conclusion, then, with the necessary abstractions and generalizations, we are able to introduce the principles necessary for the development of a design approach based on traditional knowledge.

The primary principle consists of an appreciation for building cities with due consideration to water traditions. Other principles in this new approach to water in architecture are: (1) to develop an adaptive architecture in harmony with their hydrological environment, (2) to reconnect local practices related to water management with current practices, and (3) to improve the performance of water in the human habitat.

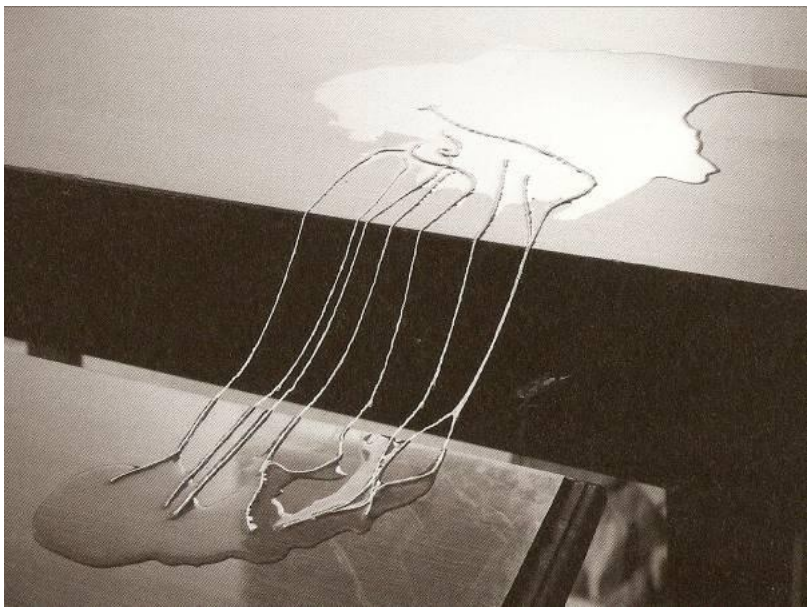

Figure 6 Cohesion forces of the water. Oliver Herwig e Axel Thallemer, Water | Wasser - The Unity of Art and Science, Arnoldsche Verlagsanstalt GmbH. Stuttgard, Germany, 2008, p. 89.

After centuries of neglecting the long history of the relationship of architecture and water, it is now necessary to re-establish a relationship with history as a form of heritage, and to promote a new relationship with ancient architectures not just in terms of form, but also in terms of its anthropological and environmental dimensions.

New architectural strategies can be developed by adopting the traditional architectural principles of traditional water management practices, and they can be integrated in the design of both rural and metropolitan regions in the process of being urbanized, as well as for rehabilitating existing cities ties that suffer from water scarcities. Studying the past is an opportunity to overcome the idea that traditional architecture is a matter of historical "style" or of no use in current designs. The time has come to establish a sound relationship between human settlement and water resources.

The change is important and requires minimization of the impacts of water extraction on the hydrosphere through durable and inexpensive designs to cope with the depletion of our water resources, pollution and degradation of habitats, and to mitigate the threat of global climate change. Experimenting with different design configurations, the first objective will be to design devices able to capture and collect water: taking into account seasonality, amount of rainfall, local groundwater resources, and other environmental factors in order to secure sufficient amounts of water for domestic uses.

At this moment in human history, we need to rethink the meaning, function and form of our urban settlements, buildings and public spaces, and to begin to think of them as potential sources for water capture and storage as a means of increasing water supply in the urban context, and to contribute to the integrity and vitality of ecosystems, and in concordance with acceptable stability of social practices (Mcharg, 2007). Admittedly, the amount of water produced by re-introducing traditional knowledge cannot be initially sufficient for the needs of all humanity. However, it can be, in short time, a valuable additional and complimentary source of valuable water. When architects rediscover this knowledge, we will gain the benefits of a breakthrough in the way architecture interacts with people and nature. This will open new vistas for novel, innovative simple, elegant designs that combine new scientific and technological knowledge, tools, and materials and with deep traditional knowledge with its natural and social benefits.

We must look back even a little, or sideways, to encourage the recovery of precious systems of knowledge developed over the long journey of humanity, and not to commit the mistake of abandoning them and to safeguard the structures and buildings that continue the embodiment of the long Tradition of the relationship between water and architecture (Friedman, 2009).

CONCLUSIONS

Today humanity faces a serious challenge and architecture can help find answers to our current global problem. For this reason, the study of the ancient architecture becomes more than a pure intellectual exercise. The recovery of practices that allowed human societies to work with nature in different environments and at different times can be a source for upgrading architectural designs so that they can be comparable with their habitats. Researchers from all over the world could work together to discover the rich heritage preserved in traditional dwellings and urban structures. The ingenuity of communities in different geographical conditions can be a component in promoting cultural development, and a means to maximize scarce global water resources. The diversity of projects that will be inspired by traditional water management systems are

vital for the emergence of future adaptable architectural designs, especially in times of growing water scarcity, instability and great unpredictability concerning water resources.

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