SOCIETÀ NAZIONALE DI SCIENZE LETTERE E ARTI IN NAPOLI

RENDICONTO
DELL'ACCADEMIA DELLE SCIENZE
FISICHE E MATEMATICHE

SERIE IV - VOL. LXXXVII - ANNO CLIX

(2020)

GIANNINI EDITORE

La pubblicazione è stata resa possibile grazie ai contributi
- della Regione Campania
- della Fondazione Banco di Napoli
- del Ministero per i Beni Culturali
- dell'Associazione "Amici della Società Nazionale di Scienze Lettere e Arti in Napoli"
- del Dipartimento di Matematica e Applicazioni "Renato Caccioppoli"

N. 87 - Dicembre 2020

ISSN 0370-3568

Direttore responsabile: Carlo Sbordone
Volume a cura di Carmine Colella

Prima edizione italiana

Finito di stampare in Italia nel mese di giugno 2021
da Officine Grafiche Francesco Giannini & figli S.p.A. - Napoli

Autorizzazione del Tribunale di Napoli n. 780 del 14/08/1954
ISBN 978-88-6906-189-9

Rend. Acc. Sc. fis. mat. Napoli
Vol. LXXXVII, (2020) pp. 65-78
DOI 10.32092/1027

Water: abundant, but often scarce and precious

Nota di Maurizio Avallone[1]e del socio Maurizio Iaccarino[2]
(Adunanza del 18 dicembre 2020)

Keywords: Demographic increase, water needs, future of humanity

Abstract - At the end of the Neolithic period the development of agriculture was responsible for a spectacular anthropic growth. But the products of agriculture develop only if it is possible to use large quantities of water, necessary at specific times of plant maturation. Water is abundant on the planet, but often is scarce and precious. Lack of water causes diseases, poverty, malnutrition and frequently offends human dignity. In recent millennia man used several mechanisms to overcome water scarcity, including search for plants suitable for the soils to be cultivated; construction of canals to transport water where it is needed; construction of dams and aqueducts, etc. However, the interventions carried out were not sufficient to cover the growing needs of an increasing population. It is necessary therefore to discuss and propose detailed measures to solve the problems caused by water shortage. This requires organizing an active role for the different categories of people involved.

Riassunto - Alla fine del Neolitico lo sviluppo dell'agricoltura fu responsabile di una spettacolare crescita antropica. Ma i prodotti dell'agricoltura si sviluppano solo se è possibile utilizzare grandi quantità di acqua, necessarie in determinati periodi di maturazione delle piante. L'acqua è abbondante sul pianeta, ma spesso è scarsa e preziosa. La mancanza d'acqua causa malattie, povertà, malnutrizione e spesso offende la dignità umana. Negli ultimi millenni l'uomo ha utilizzato diversi meccanismi per superare la scarsità d'acqua, tra cui: ricerca di piante adatte ai terreni da coltivare; costruzione di canali per trasportare l'acqua dove serve; costruzione di dighe e acquedotti, ecc. Tuttavia, gli interventi effettuati non sono stati sufficienti a coprire le crescenti esigenze di una popolazione sempre più numerosa. È necessario quindi discutere e proporre misure dettagliate per risolvere i problemi della scarsità d'acqua. Ciò richiede di organizzare un ruolo attivo per le diverse categorie di persone coinvolte.

[1] Director, R.S.A. Srl (Research and Studies on the Environment), via Caduti di Nassiriya, 1/a, 80124 Napoli; mavallone@libero.it
[2] Scientific Counselor, Permanent Mission of the Order of Malta at UNESCO; iaccarin@gmail.com.

1 – INTRODUCTION

Water is essential for all forms of life and it is crucial for the interaction between human species and different habitats. It promotes soil fertility and has thus enabled the development of agriculture and, as a result, caused a huge increase in the human population. But the growth and maturation of agricultural products need a lot of water, which often becomes a precious commodity (OECD Environment, 2012).

In the past centuries, many attempts have been used to find more water, or to save it, or to make its use more efficient. But in the meantime, the total population of the planet has increased, and the results obtained, although noticeable, have not been sufficient. How to solve the problem? It is certainly necessary to act in an innovative way, involving the commitment and creativity of all sectors of civil society belonging to different cultures and disciplines. Tackling and resolving this problem is challenging and costly, but crucial for the future of humanity.

2 – WATER AND DEMOGRAPHY

Human beings need to drink a few litres of water a day, an amount that varies, even significantly, in relation to environmental factors. In the absence of water, survival times are measured in terms of days, but they are not quantifiable because they are influenced by environmental conditions (in fact, the World Health Organization does not indicate precise values for drinking water needs). The need for water has influenced human behaviour since ancient times and, indeed, the oldest human settlements have been found mainly on the banks of rivers or lakes (Johanson and Wong, 2009). Rivers were used for drinking and refreshment, but they were also places where food could be obtained] by fishing or hunting. The latter was facilitated by the fact that rivers also served as drinking troughs for animals, so hunters could lurk around to kill and eat them.

The hunter-gatherers of the Neolithic period used wide spaces; archaeological findings (McEvedy and Jones,1978; Biraben, 1979; Kremer, 1993), confirmed by studies on genetic diversity (Leonardi *et al*. 2018), suggest that in the Neolithic period the total population of the Earth's globe did not exceed 3-5 million people, and probably did not increase in number, due to lack of resources and high mortality. Hunter-gatherers moved to follow the tracks of animals (Hassan, 2011). The situation changed drastically for those groups of individuals who settled in areas made fertile by frequent floods: they started agricultural activities, which changed the lifestyle of the human species and greatly influenced, although to different degrees, the demographic development of the various peoples. This happened around 10,000 BC in the Middle East (where wheat and barley were cultivated), around 8,000 BC where is now China (with rice and millet), around

6,000 BC in the Indus Valley and Europe (with various cereals) and around 4,000 BC in the Americas (with sunflowers, corn, beans and potatoes) (Hassan, 2011).

Agricultural cultivations had very significant consequences (Iaccarino, 2015). Indeed:

- the cultivation of the above-mentioned plants still continues, thus requiring a lot of water;
- populations have become sedentary, have built houses and have changed habits and social structures;
- the number of individuals has strongly increased, both because of the increase in the birth rate in some areas of the planet and of the lengthening of life;
- the domestication of animals has begun; they help in agricultural work, provide milk or wool, and are also used as food;
- irrigation has made it necessary to build, use and maintain a complex system of small canals, locks and water storage, and this has encouraged the emergence and acceptance of a central authority;
- the high population density has led to the spread of contagious diseases and the consequent spread of the use of hygienic practices, which require significant quantities of water (Iaccarino, 2019).

The use of water for agriculture allowed a more affluent life and led to an increase in the number of inhabitants (Bocquet-Appel, 2011); but the large amounts of water required for irrigation in certain places made this resource insufficient, while emigration to other places became more difficult, due to the need for stable housing. Changed living conditions have led to an increase in the number of individuals, which are now on the planet about 7,700 million and are expected to become 9,800 million in the year 2050, with a 27% increase compared to the current situation (data from the Population Division of the United Nations). At the same time, total water consumption has grown much more than the level of population growth. In fact, once the social transformation was completed, each individual consumed several tens of litres of water per day for cooking and hygienic purposes, while the bulk of consumption was for irrigation (Shiklomanov, 2009). Therefore, the availability of water has caused not only an increase in the number of individuals, but also a greater consumption of water for irrigation, due to an increased need of food, as well as water for personal hygiene. It could happen that a population of a few hunter-gatherers settled in a certain place because they found a great abundance of water; but the optimal conditions caused an increase in the number of individuals and, after a certain number of generations, water became a limiting factor for further growth and well-being. It should be pointed out that a crowded situation facilitates the transmission of contagious diseases and for this reason many epidemics have occurred in the past that have caused a reduction in the rate of increase of individuals (Iaccarino, 2019). Only when people understood the importance of using an appropriate amount of water for personal hygiene the mortality rate decreased and the rate of

increase of individuals started to rise again. But the amount of water needed by each individual also increased. Therefore, water has increasingly become a strategic resource that serves not only to produce food, but also to limit the spread of contagious diseases.

It is appropriate to consider these problems from a global point of view: the water consumption of today's populations is mainly due to irrigation (which requires 70-75% of the water used) and industrial uses (15%), while 10-12% is used for direct human needs (mainly for hygiene and food cooking) (Shiklomanov, 2009); the total water consumption is now estimated at about 3,500 km^3 per year (OECD Environment, 2012). This number should be compared with the amount of rain that falls each year on the planet's emerged lands (107,000 km^3): a part of it (about 60%, known as green water) is retained by the foliar system of existing plants and is absorbed by the soil containing roots; green water quickly returns to the atmosphere through a mechanism called evapotranspiration; the remaining 40% (about 43,000 km^3 of water, called blue water) is available for human use; it flows to the oceans, but along this path it helps to supply rivers (which contain 2,100 km^3 of water), lakes (which contain 91,100 km^3 of water) and aquifers (which contain 10,530,000 km^3 of water) (Boberg, 2005; Falkenmark and Lannerstad, 2005; Gleick, 1993; Shiklomanov, 2009). The aquifers represent a very substantial reservoir and provide almost 20% of the water used by mankind; but their water is located underground, it is often present in places with difficult access and sometimes it cannot be used, due to the presence of toxic substances (Mekonnen and Hoekstra, 2016; W. W. Council/ OECD, 2015). A considerable portion of this water is concentrated in some fossil aquifers that are found at great depths, as for example in Saudi Arabia (Water and Food security, 2015) or in Libya (the Nubian sandstone aquifer located under the Sahara), or in North America (the Ogallala aquifer). Unfortunately, these reserves have a recharge time that often is too slow to compensate the amount of water withdrawn, causing concern about their early depletion.

It is clear, therefore, that plenty of water is present on the planet. But very often it is not sufficient in the places where it is needed for the growth and maturation of plants (Postel *et al.*, 1996): about three quarters of the annual rainfall occurs in specific areas and about 80% of fresh water is found in a few basins, such as the Great Lakes of North America, Lake Tanganyika in Africa and Lake Baikal in Siberia; or in five main river systems: the Amazon River, the Ganges with the Brahmaputra, the Congo, the Yangtze and the Orinoco. In addition, the water that precipitates on the planet can move at very different speeds, depending on the characteristics of the soil: in some cases it stagnates, while in other cases it evaporates very quickly or it flows on the surface without penetrating. For all these reasons there are areas on the planet where water is in excess and so it remains for a good part of the year, while elsewhere there is a more or less serious and extensive water shortage. Often, water is not enough to

cover human needs and the struggles for its hoarding can generate episodes of violence, in some cases of considerable severity.

The water available to humans often comes from rivers, lakes or groundwater aquifers located on the border between States (153 States worldwide use transboundary water). The course of rivers is determined by the characteristics of the terrain, while aquifers collect groundwater with criteria that are not related to the size of the populations that can use it. The competition for water has caused considerable friction between different populations: we have news of thousands of international disputes for the use of transboundary waters, in which usually the subject of the dispute was the water of a river coming from a state located upstream. The contenders refer to the doctrine of Harmon (McCaffrey, 1996), according to which a State is the owner of the water originating in its territory and has no duties towards the States located downstream (Iaccarino, 2015). Instead, downstream States claim that they are entitled to receive the same amount of water as they have received in the past.

Humankind needs to increase the availability of water: in fact, as also mentioned in the World Water Development Report of 2020, about 4,000 million people face water scarcity conditions for at least 1 month a year and about 1,600 million do not have the necessary infrastructure to organize decent ways to use water. The total population of the globe will continue to increase, especially in some areas, and therefore it is necessary to be prepared to increase the availability of water, especially in those places where it is presumed that the expansion will be more pronounced.

One problem that is occurring with an increased frequency is the mixing of polluted water that interferes with available water. This phenomenon, due to population growth and urbanization, has increased over the years and is expected to continue to increase, despite the approval of several legislative measures aiming at water protection. Polluted waters pose a serious threat to both health and livelihoods. More and more people will have difficulty accessing healthy water and as a result we should find new ways to manage the needs that often compete with each other. In fact, the water available, as described in this article, may be sufficient to meet growing needs globally, but only in the face of a radical change in the way this resource is used, managed and shared. The global water crisis is a crisis of governance rather than a crisis of resource availability.

Several mechanisms designed to increase water supplies, or the efficiency of its use have been put in place so far. Some of them are listed below:

- Research projects aiming at the development of widely used plants (such as wheat, barley, chickpeas, lentils, fodder legumes) capable of growing in soils poor in water, or in soils with a high salt content, are conducted at the International Centre for Agricultural Research in Dry Areas, located in Lebanon and funded by the World Bank.

- Drip irrigation consists in administering water slowly and directing it towards the root of the plant, thus reducing not only water consumption, but also the growth of unwanted grasses and pests and the evaporation of water from the soil.
- The water footprint (Hoekstra and Mekonnen, 2012) is the measurement of the volume of water needed to synthesize a product; knowledge of this value may lead to prefer the consumption of products that consume less water than others.
- Water levels may be lifted to make optimal irrigation: (1) the Shaduf, designed in Mesopotamia about two millennia BC, is still used today. It consists of a long pole that has a bucket at one end, balanced by a counterweight at the other end. A single man, handling the pole, can lift up to 3,000 litres of water per day and put it into a canal or a tank; (2) the Saqiya is composed of a wheel (moved by an animal) that, through a special gear, transmits the movement to another wheel placed at right angles: it is considered to be the precursor of more complex machines, such as mills driven by running water.
- Transporting water where it is needed: construction of small canals in order to control the water coming from the flooding of a more important watercourse. Sometimes these canals are of considerable flow and length: the Assur canal, built about 10 centuries BC, 400 km long, connected the Tigris and Euphrates rivers and was dug to rationalize the flows of the marshes between these two rivers. The Great Canal of China, built in the 7th century AD, connects the Yellow River with the Blue River and is 1,800 km long. The Arizona Canal, 540 km long, was built to irrigate 400,000 hectares of land with water from the Colorado River.
- Dams. The oldest ones consisted of dams built on “uadi”, to retain water coming from rainfall, which passes intermittently. Later on, they were built to handle water from the Tigris/Euphrates, or the Nile. Important dams built in modern times are the Hoover Dam on the Colorado River (completed in 1936); the Aswan Dam on the Nile (completed in the 1960s) and the Three Gorges Dam on the Yangtze River in China (completed in 2006). In 1997 there were 800,000 dams worldwide, 40,000 of which were more than 15 meters high.
- Aqueducts serve to bring water from a spring to the place of use. The Qanats (or Kariz) are underground tunnels that use water from the aquifers; the flow of water is continuous because it moves on an inclined plane and therefore there is no need for pumps. The Qanats have been crucial for the development of the agricultural practices in the Iranian plateau since the first millennium BC, and then spread as a means of water supply throughout the Middle East, the Mediterranean basin and Central and South Asia. In the Roman Empire there were about 600 aqueducts whose main function was to provide drinking water. The Ostrogoths destroyed the aqueducts that arrived to Rome in 537 A.D., in order to prevent the supply of water to the city. The development of aqueducts on a large scale resumed only around the 19th century to feed the rapidly growing cities. In modern aqueducts, the water is subjected to potabilization processes (flocculation, flotation, filtration, disinfection) and is made colourless, tasteless,

odourless, clear, fresh and free of pathogenic germs. Before distribution, water is analysed to exclude the presence of microorganisms or toxic substances, in accordance with the legislative provisions of the State where the aqueduct is located. Water networks are generally public property and often their sale to private subjects is prohibited; however, their management is sometimes entrusted to private subjects. A serious problem, present in many aqueducts (especially in large cities), is that of the lack, insufficiency or obsolescence of transport networks and infrastructures, too often ancient and inadequate, that cause the waste of enormous quantities of water, depleting the resource and exposing these territories to chronic inefficiencies.

- Water recycling allows to obtain water suitable for new uses and in this way to save water in areas affected by shortage. In Windhoek, the capital of Namibia, recycled water has been used as drinking water for about 50 years. Water is also recycled elsewhere, such as in the town of Cuxhaven in Germany and in the International Space Station.
- Desalination plants generally use reverse osmosis: polymeric membranes block the passage of salts and other inorganic impurities. In 2019 there were about 16,000 desalination plants, half of them being located in the Middle East and North Africa, producing 95 million m^3 of fresh water per day (Jones *et al*., 2019). Efforts are underway to increase the efficiency of these plants through the use of membranes that may be more permeable to water due to the presence of aquaporins (cell membrane proteins that allow water permeability) (Ye Li *et al*. 2019).

The activities described above are common, but the need for water has led people to imagine other mechanisms not described here. For example, the transfer of icebergs to places where their water can be used; the filling of ships with water from river estuaries; the production of rain obtained by bombarding clouds with silver iodide; etc.

In conclusion, there is enough water on the planet to meet the needs of the current population, but it should be available in the right place and time. For the solution of the shortage problems several mechanisms have been tested. As useful as they may be, they have not been sufficient and for this reason in recent years people are beginning to think in a different and global way. There is a need for a new civil conscience; water must be an utmost priority.

Important efforts have been made in the past to increase water availability, but the results have not been satisfactory: the investments needed to increase water reserves have generally followed the needs instead of anticipating them and no thought has been given to the fact that water scarcity causes an increase in costs to make it available. As discussed in the next chapter, it is necessary to recognize the importance to have enough water for personal use, but also for irrigation and industrial use. This implies to organize requests to governments or to international organizations; the requests should be persisting, and the

governmental actions should be long lasting. Pressure should be exercised also at an international level and in the appropriate UN panels, using arguments valid from the environmental, economic and industrial point of view. Finally, it should be borne in mind that discussions on water needs must necessarily involve experts from different disciplines.

In the next chapter, we discuss the factors necessary to shake governments out of the torpor that they demonstrate in their actions dedicated to the availability of water.

3 – HOW TO SOLVE THE PROBLEM

Problems caused by the lack of water, such as poverty, malnutrition, diseases, difficulties in interpersonal relationships, violence perpetrated between individuals belonging to different social classes, are hardly ever taken into account when discussing the reasons that should lead governments to plan investments in infrastructures. The consequences of water scarcity are aggravated by the fact that quite frequently different States share the use of rivers, lakes or aquifers (see above). This situation increases the difficulties of interaction and sometimes causes wars between peoples of neighbouring States.

We pointed out that, although water is abundant on the planet it could be badly needed in specific places: in fact, as also mentioned in the World Water Development Report of 2020 (see above), about 4 billion people have to cope with water shortages for at least 1 month a year and about 1.6 billion do not have the necessary infrastructure to use water in a decent way. The investments made in recent years to obtain more water for populations needing it have been effective, but insufficient: in fact, the world population has increased in the meantime; and the outlook will probably worsen, not only because of further population growth, but also because of climate change and urbanization.

Lack of water is often due to the needs caused by the disproportionate growth of a population that had chosen a specific location where water was abundant, but later on, the demographic increase was not accompanied by an increase in the water resource. Other times water is scarce because there has been a decrease due to climate change, or because a river or groundwater table has been polluted, or because of the impoverishment of the water sources, due to the fact that other people appropriated them. Lack of water makes it difficult to irrigate the fields and reduces crop yields; moreover, in regions with high population density it is also important to have water for hygienic practices, in order to prevent the onset of contagious diseases, as already mentioned. The problems to face are the most varied, such as: (1) the preservation of the quality of water (from rivers, lakes or sea) through the design and construction of purification plants; (2) the mitigation of the risk of river flooding, with interventions of consolidation of the banks of water courses; (3) the proper management of water resources, with the

construction and operation of dams, canals, artificial lakes, etc.. (4) the rationalization of resources, with urban planning and means of transport; (5) the development of the necessary infrastructures; (6) the mitigation of landslide risk, with slope stabilization interventions; (7) the water flow regulation, both in order to minimize the possibility of triggering erosive processes, and to regulate the outflow of excess water mass; (8) the recovery of polluted sites, through remediation and safety interventions.

A problem that is often encountered is related to the fact that not always the commissioning State has the experts able to prepare a project and a tender specification to be submitted; moreover, often has difficulties in judging the countless "variants in progress" suggested by the concessionaire. For this reason, the States often make use of multinational companies that have the necessary skills to study solutions to solve technical and structural problems related to the management of water resources. Sometimes these companies are seen with favour, due to the expectation that the private sector would bring in more investments, improve technology, enhance efficiency and provide access to the excluded. Therefore, they are supposed to be able to propose the accomplishment of a package of solutions suitable for the local structures. However, often they do not have sufficient knowledge of the specific problems of the region and of the populations that are destined to take advantage of the works to be performed and they do not seem to understand the goal of realizing the human rights to water and sanitation (see in the Ref. the UN document on the human rights and safe drinking). Moreover, these companies are often considered unreliable because they are suspected of not having a vision of the problem that takes into account the interests of the population involved, giving priority to their business interests. As a consequence, between 2000 and 2019 in at least 300 cases the management returned to the private state. A compromise that has sometimes been reached consists in entrusting these companies with the execution of complex works, the management of which, after a defined time, passes to the commissioning State.

As mentioned above, 7.7 billion people live on the planet today and it is expected that they will become 9.8 billion in 2050, with a 27% increase. The interventions to be carried out to solve water problems must take into account not only the expected increase in population size, but also the forecasts of increasing urbanization and the intensification of climate change. These are problems that last over time and must be treated bearing in mind that they will not be resolved in the short term. Finally, it is necessary that problems related to water supply are dealt with by professionals having experience in all the necessary disciplines.

The problems of water availability were discussed when the UN member States, in September 2015, concluded that the numerous attempts to find a solution to the problems of poverty eradication had all failed. On that occasion the UN member States discussed and approved the Agenda for Sustainable Development and committed themselves to achieving it by the year 2030. All

States committed themselves to contribute to the realization of the various aspects of a program that aims to eradicate poverty, in all the ways it manifests itself. And all States have promised to cooperate, within the limits of their possibilities, to achieve the ultimate goal, namely that all the inhabitants of the planet must have the same possibilities, disregarding differences in census or education. The approved Action Plan includes 17 Sustainable Development Goals (SDG), one of which, SDG6, concerns water and sanitation, which are recognized as an inalienable right of humanity. The document highlights the fact that as many as 3 billion people live in houses that are not equipped with hand washing facilities and recommends that the people concerned show a determined and constant commitment, which must be translated into appropriate political action. Governments are committed to incorporating these demands into national development programs. The implementation of these programs will be facilitated by the fact that they will be consistent with those of other UN member States and for this reason the achievement of the goals of the program should be easily monitored. In addition, the 17 Sustainable Development Goals should serve as an incentive to consider water and sanitation (SDG6) as a major problem to be solved. The purpose of the investments planned in the past was to provide for the needs, as described at the time, without considering a possible increase in the number of individuals and their needs: as a consequence, once the purpose had been achieved, the needs had increased and it was necessary to start upgrading. It is reasonable to hope that future needs will not be overlooked in the programs now in the pipeline. In fact, one criticism that is made of the decisions approved in the UN assemblies is that often the delegations represent governments that do not intend to commit themselves and therefore, even if they approve, they will not be collaborative.

4 – A PROPOSAL FOR A GLOBAL SOLUTION

We have highlighted in this article that in order to save water resources, various mechanisms have been put in place: for example, to increase the efficiency of irrigation, or to transport water from places where it is abundant; or to purify the polluted water in order to be able to partially reuse it. These interventions have proven to be effective and they helped to alleviate the shortcomings found. Obviously, the procurement of water could be more effective if States addressed supply problems in a cooperative and systematic way, with a long-term program that takes into account the need for appropriate facilities and is aimed at meeting the needs of the users. Unfortunately, for reasons discussed below, water management is severely neglected in much of the planet and the planned programs are not part of a coordinated and long-term vision; a vision that should be formulated with the participation of technicians of various specializations, but also with humanists, sociologists and economists who

have the relevant and necessary cultural skills for the development of institutions dedicated to improving water efficiency and sustainability. However, the prevailing attitude of political leaders and ruling classes is to postpone the search for a solution to the problem, perhaps because their mandate is generally too short-term to achieve meaningful results. But also because they do not understand, or do not want to understand, that the problems to be discussed should primarily be dealt with and deepened by a group of experts who have all the necessary knowledge to propose a remedy: only after the conclusions have been formulated at the technical and managerial level can politicians be involved again, in order to harmonize the proposals of the specialists with the needs of the nation. The mandate of this panel of experts should be broad and the discussion of each problem must inspire the interaction of experts of different disciplines. There is a need for experts that are knowledgeable in the most disparate fields, as for example engineering, geology, agronomy, biology, medical sciences, sociology, economy and so on, because the water resource characterizes the existence and the set of natural functions of living organisms on our planet. Only infrastructures aiming at reducing the risk of water scarcity and at the management of water-related disasters can make a country's development efforts more sustainable, reducing its vulnerability and/or strengthening the resilience of economies to extreme events. This should be done bearing in mind not only the ultimate goal, i.e. the distribution of healthy water, but also infrastructural deficiencies and economic, socio-political, environmental and good governance factors.

On the other hand, we are witnessing the fact that many States, although they have the necessary economic resources and the possibility to access water, are not organized and lack efficient structures to solve the problem of water supply in areas where it is lacking. Sometimes this situation is due to difficulties in understanding that often occur in discussions between specialists from different disciplines, or to a disorganized demand from users. The associations active in this field are increasing in number and effectiveness in all continents. In short, problems related to sufficient and stable water supply should include separate discussions, following a logical plan: (1) citizen surveys; (2) representatives of politicians; (3) interdisciplinary experts. When these results are achieved new discussions by politicians should take place in order to formulate the planning of activities and structures required for the solution of problems; at this point administrators can prepare the planning and the beginning of the work.

It should also be borne in mind that the problems related to the lack of water must be addressed by experts who know the local needs well, since the proposed solutions will have to be managed by the users. It is therefore important to define the technical/professional figures necessary and useful to rationalize the needs of the population and then design and implement what is really advantageous and essential in terms of water resources. It must be kept in mind that the required

skills must concern the use of water, its enhancement and especially the preservation of these characteristics over time. Progress in this field has been made in most developed countries with the creation of university courses in sanitary/environmental engineering; courses usually included in interdisciplinary schools for environment and territory. These professionals must be aware of the fact that they contribute to the safeguarding of a service of public utility and that part of their decisions have an ethical relevance that, at times, leads to overshadow economic considerations. Therefore, in conceiving and deciding on the planning of activities, and in planning the processes of control, maintenance, surveillance and verification of works and interventions involving water resources and related infrastructure, they must give priority to the efficiency and reliability of infrastructures and facilities; and at the same time comply with current laws and regulations. Therefore, they must be aware of all the problems related to the protection of water resources, the operating techniques of water supply and capture plants, purification plants, sewerage and water networks, methods and techniques of remote sensing, remote control and telemetering, as well as the use of software and information systems in the sector. It is relevant to emphasize that the management of the activities must include at least one expert specialist in the skills listed above, but the topics discussed need the participation, active and passive, of all members of the management commission: the responsibility for decisions must be taken by each member of the commission, but anyway it must also be collective in its multi-disciplinarity. Finally, it is important that these specialists are assisted by qualified technicians, the so-called Integrated Water Resources Cycle Management Technicians. Several countries have given attention to this requirement and have trained technicians that have proven to be very useful in controlling the processes of management, maintenance, surveillance and verification.

The description of the problems encountered in trying to optimize the water supply shows that it is necessary to proceed with a more concrete approach than the one used until now. A panel of experts should be available to examine the needs and analyse the feasibility of the proposals made. Water problems frequently have transboundary aspects and often different States have different financial possibilities. For this reason, it should be envisaged to organize that groups of States sharing similar interests are encouraged to collaborate to solve problems dealing with water that are of common interest. However, the protection of water resources, as well as of the environment, could require interventions coordinated by an International Organization that must intervene to protect safety in the areas most "at risk". Since poor countries do not have the resources, it could be necessary that the more developed nations do it on their behalf and at their own expense: the question concerns the vitality of the planet and not who should and cannot do it. It is therefore necessary to intervene on international regulations, verification and control procedures also to act against those who do not comply.

The members of this International Organization must adopt an environmental management model of territorial self-sufficiency of their own, without emulation of "Best Practices" of large companies, or other large emancipated or developing countries, through Solutions Based on Nature (NBS) using or imitating natural processes with the aim of contributing to better water management (WWAP, 2018).

It is essential to understand what is needed to provide water to the families and to the farmers; one possibility is to set up a Committee that expresses ideas in an official way. These proposals should be analysed by a Committee representing the political authorities. This Committee must constantly take into account the needs of the country, be aware of the needs of its citizens and be aware of the resources required. One possibility is to appoint a group of people to hold an annual meeting where the results obtained are explained and the programs proposed, as well as their feasibility, are discussed. Those proposals that are considered interesting should be discussed by a panel of experts carefully chosen to represent the different disciplines (economists, engineers, sociologists, etc.). This panel will present a book of considerations on the country's needs at the annual meeting described above; this book should contain a description of the activities carried out and one or more proposals for future activities. At this point a Governmental Commission, on the basis of the information obtained from the participants in the above-mentioned panels, recommends priorities at national level, taking into account any initiative that may be put in place by neighbouring countries.

5 – REFERENCES

Biraben J-N. (1979) Essai sur l'évolution du nombre des hommes. *Population*, **34**,13-25.

Boberg J. (2005) Liquid assets. Rand Labor and Population, Santa Monica, California, USA, 2-15.

Bocquet-Appel J-P. (2011) When the world's population took off: the springboard of the Neolithic Demographic Transition. *Science*, **333**, 560-561.

Falkenmark M., Lannerstad M. (2005) Consumptive water use to feed humanity – curing a blind spot. *Hydrol Earth Syst Sci, **9***, 15-28.

Gleick P.H. (1993) Water in Crisis: A Guide to the World's Fresh Water Resources**,** Oxford University Press, New York, 504 pp.

Hassan F. (2011) Water History for our times. IHP essays on water History, Vol. 2, Paris, UNESCO Publish., 1-122. http://unesdoc.unesco.org/images/0021/002108/210879e.pdf.

Hoekstra, A. Y. Mekonnen, M. M. (2012**)** The Water footprint of Humanity. *Proc Natl Acad Sci USA*, **109**, 3232-3237.

Iaccarino M. (2015) Un Mondo Assetato, Editoriale Scientifica, Napoli, 164 pp.

Iaccarino M. (2019) Water, population growth and contagious diseases. *Water*, **11**(2), 386-400.

Johanson D.C., Wong K. (2009) Lucy's Legacy: The Quest for Human Origins, Harmony Books, N.Y., 309 pp.

Jones E., Qadir M., van Vliet M. T. H., Smakhtin V., Kang S. (2019) The state of desalination and brine production: A global outlook. *Science of the total environment.***657**, 1343-1356.

Kremer M. (1993) Population Growth and Technological Change: One Million B.C. to 1990. *Quarterly Journal of Economics*, **108**, 681-716.

Leonardi M., Barbujani G., Manica A. (2018) An earlier revolution: genetic and genomic analyses reveal pre-existing cultural differences leading to Neolithization. *Sci. Rep.,* **9,** 682-683.

McEvedy C., Jones R. (1978) Atlas of World Population History, London Penguin, 368 pp.

Mekonnen M.M., Hoekstra A.Y. (2016) Four billion people facing severe water scarcity. *Science Advances*, **2**(2), 6 pp.

McCaffrey, S.C. (1996) The Harmon Doctrine one hundred years later: buried, not praised. *Nat. Resources J.,***36**, 965-1007.

OECD Environment: The Water Challenge: Sharing a Precious Commodity (2012), http://www.oecd.org/environment/environmentthewaterchallengesharingapreciousc ommodity.htm.

Postel S. L., Daily G. C., Ehrlich P. R. (1996) Science, Human appropriation of renewable fresh water. *Science.* **271**, 785-788.

Shiklomanov I. A. (2009) Appraisal and Assessment of World Water Resources, *Water International*, **25**, 11-32.

UN document on the human rights to safe drinking water and sanitation. UNGA https://www.ohchr.org/en/issues/waterandsanitation/srwater/pages/srwaterindex.aspx

Water and Food Security (2015) La falda acquifera di Disi. Una risorsa condivisa tra Giordania e Arabia Saudita. https://www.waterandfoodsecurity.org/scheda.php?id=110).

WWAP (United Nations World Water Assessment Programme)/UN-Water (2018) The United Nations World Water Development Report 2018: Nature-Based Solutions for Water. Paris, UNESCO.

World Water Council/OECD (2015) Report of the high-level panel on financing infrastructure for a water-secure world https://www.worldwatercouncil.org/sites/ default/files/Thematics/WWC_OECD_Water_fit_to_finance_Report.pdf.

World Water Development Report 2020: Water and Climate Change, Paris, UNESCO.

Ye Li, Saren Qi, Miao T., Wentalia W., Rong W. (2019) Fabrication of aquaporin-based biomimetic membrane for seawater desalination. *Desalination.* **467**, 103-112.

ISSN: 1121-9270

ISBN-13: 978-88-6906-189-9