Water Management

Fondazione Barilla
il tuo cibo, la tua terra

people, environment, science, economy

Executive Summary

Although renewable, water is a scarce resource. As the World Bank has noted, we can contain it, divert it, collect it, purify it, package it, transport it and transform it, but we cannot "produce it". This simple observation leads to a complex truth: handling and managing the resource, water, and its use represents one of the greatest challenges that society faces today on a global scale

SCENARIO

- Overall, our planet has available approximately 1.4 billion km^3 of water. However, it is estimated that only 9-14 thousand km^3 of water, equal to approximately **0.001% of the total, are economically available for human use**. Freshwater resources are distributed unevenly among the regions of our planet. In addition, allocation of water resources is skewed towards the **agricultural sector** with 70% consumption of freshwater, while 22% involves industry and the remaining 8% is for domestic use[1].

- **More than one of every six people in the world do not have access to the minimum level** indicated by the UN of 20-50 liters of freshwater required daily per capita to assure basic nutritional and hygienic needs.

- **The scenario for 2025 regarding scarcity of water would appear to be dramatically worse** than the current situation. The areas characterized by a high-level use of available resources (over 20%) will increase substantially, spreading within the **United States, Continental Europe** and **southern Asia**, while worsening from a percentage standpoint in extended areas of **Africa** and the **Indian subcontinent**[2].

- It is estimated that an amount **between 15% and 35% of current water usage for irrigation will not be sustainable in the future**[3], due to demographic growth, persistence of inefficient irrigation methods and growing competition among users.

ASSUMPTIONS

- The **virtual water**[4] content of a product (commodity, good or service) is the volume of freshwater used to produce it. It refers to the sum of the water used in the various steps of the production chain. The virtual water content of a product consists of three components: green virtual water, which is the volume of rain water evaporated during the production process; blue virtual water, which is the volume of surface or ground water evaporated as a result of the production of the product; and grey virtual water, which is the volume of water that becomes polluted during the production process.
  - Comparison of the virtual water content (expressed in cubic meters per ton) of some agricultural products in some countries of the world reveals **significant differences** both comparing the various products amongst themselves and taking into consideration where they were produced. In particular, **animal husbandry products** (meat, eggs, milk and derivatives) **have a much higher virtual water content than cultivated prod-**

1 *"Water at a glance"*, FAO Water, 2006
2 *"Business in the world of water. WCCSD Water Scenarios to 2025"*, WBCSD, 2006
3 *"Facts and Trends - Water"*, World Business Council for Sustainable Development (WBCSD), 2006
4 The concept of virtual water was created in 1993 by professor John Anthony Allan of King's College, London and School of Oriental and African Studies, for which we was awarded the Stockholm Water Prize in March 2008

ucts given the fact that before being transformed into food products, animals which are raised consume for a number of years a tremendous amount of products cultivated as feed. In addition, the content of virtual water in the same product can vary significantly from place to place, depending on factors such as climate, agricultural techniques employed, crop yield, etc.

- Various nutritional practices also imply a greater or lesser consumption of water resources. In fact, an individual utilizes on average 2 to 5 liters of water per day for drinking, while the daily consumption of virtual water for eating purposes is approximately 1,500-2,600 liters for a vegetarian diet and approximately 4,000-5,400 liters for a meat-rich diet[5].

- The *Water Footprint* represents a new indicator of water use[6]. It measures water use in terms of volume (expressed in m^3) of evaporated and/or polluted water and may be calculated not only for each product or activity, but also for each well-defined group of consumers (an individual, family, inhabitants of a town or an entire nation) or producers (private companies, public entities, economic sectors). It does not simply indicate the volume of water consumed, but also refers to the quality of the water and *where* and *when* it is consumed.
  - The global *Water Footprint* amounts to 7,452 billion m^3 of freshwater per year, equal to 1,243 m^3 per year per capita. Taking into consideration the *Water Footprint* as an absolute value, the country which consumes the greatest volume is India (987 billion m^3), followed by China (883 billion m^3) and the United States (696 billion m^3). If per capita values are taken into consideration, on the other hand, citizens of the United States have an average *Water Footprint* of 2,483 m^3 per year, followed by Italians (2,232 m^3) and Thai (2,223 m^3).
  - The differences between countries depend on a range of factors. The four main ones[7] are: consumption volume and model, climate and agricultural methods. In addition, commercial trade between countries causes a transfer of virtual water flows (*Virtual Water Trade*) since raw materials, goods and services all have a given virtual water content. The *Water Footprint* can be broken down into two parts: internal Water Footprint, or, in other words, domestic consumption of water resources, and external Water Footprint, which is the external consumption of water resources coming from other countries.

- Globalization of water use seems to entail both risks and opportunities.
  - The greatest risk is represented by the fact that importation of products with high virtual water content implies externalization of the indirect effects of exploitation of this resource by the importing country to the exporting one. In addition, for each country, an excessive dependence on the water resources of other countries could occur.
  - One of the main opportunities is that virtual water import could become an alternative water source, making possible to protect local resources. In addition, on a global level, there could be savings in the volume of water consumed when a product is sold by a country with high productivity of water resources (for a given product) to a country with low productivity.

- Water is "*a scarce economic good*"[8]. Correctly determining its economic value[9] makes it possible to: efficiently allocate available water resources among the various competing uses; define in a clear and commonly recognized way the value of the resource; make investment into water services and infrastructure sustainable over the long-term; and make international and national policy decisions regarding water resources allocation, infrastructure investments and waste reduction efficient and efficacious.
  - The economic value of water not only takes into consideration the price (how much people pay for water in relation to consumption and tax burden) and cost (overall costs required to supply water to consumers), but also the social-cultural significance and the overall direct and indirect benefits generated by the availability and use of the resource[10].

- *The "right to water" lies in recognizing that each individual, without any discrimination whatsoever, has the – physical and economic – right to an adequate and safe quantity of water*. Currently, about 1 billion people do not have access to sufficient and adequate water resources, while 2.5 billion people still lack access to improved sanitation facilities. The availability of uncontaminated water is a critical factor in the prevention of water-related diseases such as dysentery and typhus, the cause of approximately 1.5 million death each year, 90% of which in children under five[11].

- Actions aimed at improving the water supply and sanitation facilities of a community must not be adopted in an isolated

5 World Water Council, 2008
6 This indicator was conceived of in 2002 by Prof. Arien Y. Hoekstra of the University of Twente (The Netherlands) within the context of UNESCO-promoted activities. Hoekstra is co-founder and president of the Scientific Committee of the Water Footprint Network formed in 2008
7 *"Water footprints of nations: Water use by people as a function of their consumption pattern"*, Hoekstra, A.Y. e Chapagain, A.K., Water Resources Management, 2007
8 "*Water has an economic value in all its competing uses and should be recognized as an economic good*" - Principle No. 4 Dublin Statement, International Conference on Water and the Environment in Dublin, 1992. *"Water is no different from any other economic good. It is no more a necessity than food, clothing, or housing, all of which obey the normal laws"* - Baumann and Boland, 1998
9 UNESCO, *"Water in a Changing World"*, The 3rd UN World Water Development Report, 2009
10 The 2nd UN World Water Development Report: *"Water, a shared responsibility"*, United Nations, 2006
11 WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP), *"Progress on Drinking Water and Sanitation"*, 2008

manner, but must be part of a coordinated intersectorial development strategy that includes infrastructure, instruction and governance capabilities. No country or entity can think to resolve such a wide-ranging problem as access to water on its own. Global action that involves governments, agencies and organizations is required.

RECOMMENDATIONS

In our view, there are seven priority areas for action:

1. *Models and instruments for integrated water resource management.* Define policies, models and integrated management tools to effectively tackle problems tied to water resources.
2. *Innovation and technology to increase water productivity.* Break the existing correlation, between economic growth, demographic growth and a resulting increase in the levels of water consumption.
3. *Lifestyles and consumption with a lower virtual water content.* Orient the behavior of individuals and consumption models towards more responsible lifestyles i.e. that imply a more aware utilization of water.
4. *Wide-scale commitment and responsibility to guarantee access to water.* Foster access to drinking water and sanitation facilities for populations that, currently, find themselves disadvantaged from this standpoint, by promoting necessary investment and removing technical and political constraints.
5. *Efficient localization of cultivation and virtual water trade for global savings of the water resources consumed.* Re-think, on a global scale, the localization of the production of goods that have the greatest impact on water consumption from an efficiency standpoint.
6. *Water neutrality to bring about a reduction in the consumption of water and compensation of external factors due to exploitation.* Further develop the concept of water neutrality as a way of efficiently taking on the totality of issues tied to limiting consumption of water resources and as a tangible instrument in promoting more efficient use of this resource.
7. *Correct economic exploitation of water resources for effective management and more efficient use.* Rethink the functioning of the markets on which water is traded through definition of economic mechanisms and models characterized by enhanced efficacy and efficiency, and which are capable of precisely defining the economic value associated with water use.

Introduction

"... we can contain it, divert it, collect it, purify it, package it, transport it and transform it, the only thing we can't do is manufacture water which makes managing it an imperative"

World Bank, "*Water Program*", 2008

Over recent years, the issue of water and issues coming from its management have become central within debate worldwide, at all levels: economic, institutional, political and social.

The central nature of the "water question" worldwide can be traced to a multiplicity of reasons, but one in particular represents, with direct efficacy, the reason for which the study of problems linked to water and potential policy approaches for solving them have become so fundamental today and, even more so, for the future: **although renewable, water is a scarce resource**. As the World Bank has noted, we can contain it, divert it, collect it, purify it, package it, transport it and transform it, but we cannot "manufacture it". This simple observation leads to a complex truth: handling and managing water as a resource, as well as its use, represents one of the greatest challenges that society faces today on a **global scale**.

The issue of water management calls into question many different players, areas of application and problems connected to it both directly and indirectly. Water is one of the most relevant resources from an economic, sanitary, social and political point-of-view.

In order to effectively take on such a significant issue requires some **basic assumptions** that facilitate comprehension.

These points, which will be developed and examined in the course of this paper, are represented by the concepts of **virtual water** and **Water Footprint**, the question of **accessibility to water** and **economic evaluation of water** as a scarce resource.

From analysis of this phenomenon conducted on the basis of the theoretical approach cited above, a number of points, considerations and proposals have emerged which provide a number of potential **guidelines** for the future for managing water resources and solving the problems connected with it. The outlining of these "areas for action" will comprise the concluding part of this paper.

Part A: Scenario

1. THE REFERENCE SCENARIO

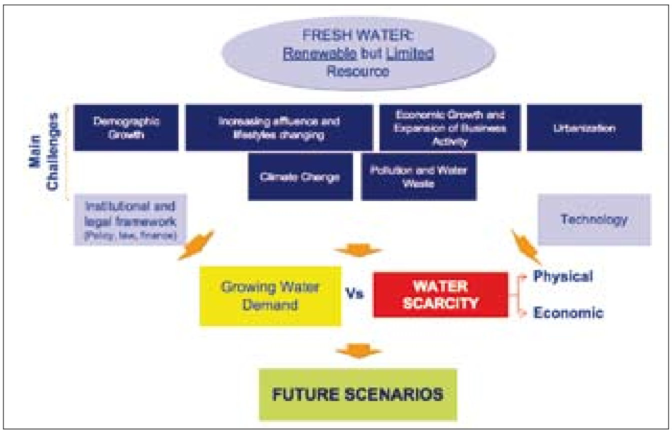
1.1 The framework

The contextual framework of the phenomenon, water, has been broken down into **four essential aspects**:

- **availability** and uses of the water;
- identification of the major **global trends that** significantly affect (today and even more so tomorrow) the growth in the demand for water resources;
- concept of water **scarcity**;
- possible **future scenarios**.

The figure below illustrates the approach used in the interpretation of the water resources reference scenario.

Figure 1. Logical-interpretative description of the reference scenario



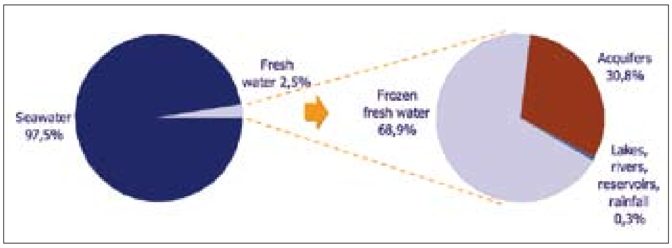
Source: The European House-Ambrosetti elaboration, 2009

1.2 Water availability and use

Water, an essential element for life and for the ecosystem, has always been relatively abundant, so much that man has always tended to take its perennial availability for granted: at a global level, in fact, water sources are still abundant, but at a regional level requirements do not always match effective **availability**.

Overall, our planet has available approximately 1.4 billion km^3 of water (this is a fixed volume); but only roughly 2.5% of this is freshwater and most of this resides in the glaciers and in the Polar ice caps or can be found deep under the sub-surface. The difficulties linked to the use of such resources are obvious: a little less than 45 thousand km^3 of water (equal to 0.003% of the total) is theoretically usable (these are so-called "freshwater resources"). It is estimated, however, that only 9-14 thousand km^3 of water, equal to approximately 0.001% of the total), is actually available for use by man, in terms of meeting suitable quality criteria and being accessible at acceptable costs.

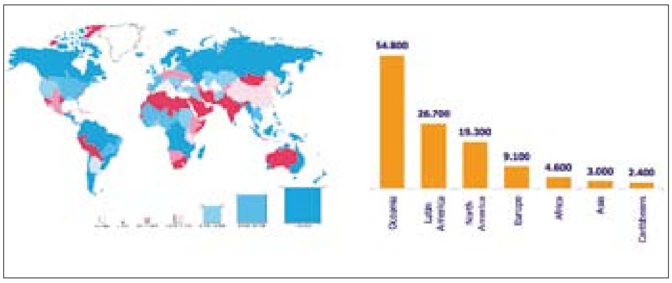
Figure 2. Allocation of the world's water resources



Source: The European-House Ambrosetti re-elaboration from "Water at a glance", FAO Water, 2006

Analyzing the world's water distribution and availability, it may be seen how the freshwater resources are distributed unevenly among the regions of our planet: nine countries alone (Brazil, Russia, China, Canada, Indonesia, the United States, India, Colombia and the Democratic Republic of the Congo) possess 60% of the total resources.

Figure 3. Freshwater availability (m^3 per capita per annum)

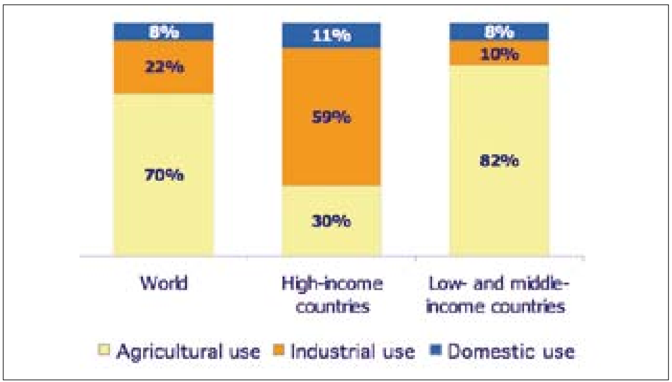


Source: "Facts and Trends – Water", World Business Council for Sustainable Development (WBCSD), 2006

In order to analyze the efficiency with which water resources are allocated, it is also important to consider the sectoral allocation of the same.

In this sense, the data clearly show an extremely uneven allocation in favor of the agricultural sector: **agriculture-related use accounts for approx. 70% of global water consumption**. This value is even higher in Countries with a medium-to-low income (in some developing countries it reaches as much as 95%), while in developed countries industry tends to weigh predominantly on total consumption. The burden of industry appears particularly evident in Europe and in the United States, where it accounts – in terms of water consumption – for 52.4% and 48.0% respectively[12].

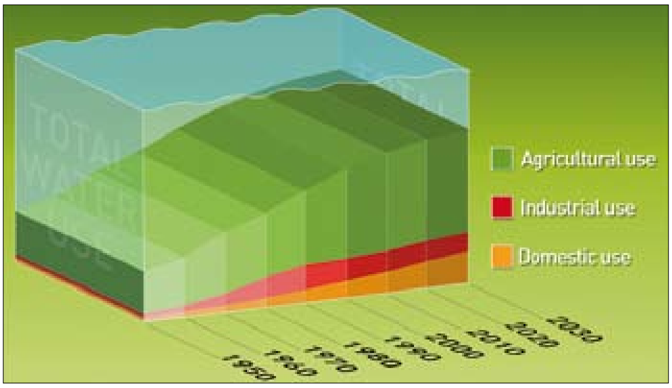
Figure 4. Use of water resources per sector type: the current state



Source: "Facts and Trends – Water", World Business Council for Sustainable Development (WBCSD), 2006

If this is the current picture, future forecasts do not envisage substantial change: it is estimated that in 2030, agriculture will still be the sector responsible for the greatest consumption of world water resources[13], while the burden of industry will remain stable or, at the very most, drop slightly, chiefly thanks to increased efficiency of production processes. The use of water for domestic purposes (in relation to health and hygiene requirements) will, on the other hand, rapidly increase, overtaking the industrial sector.

Figure 5. Water use per sector: future prospects



Source: "Facts and Trends – Water", World Business Council for Sustainable Development (WBCSD), 2006

In the agricultural sector, the contribution of rainwater guarantees sufficient resources to cover 80% of the tilled land worldwide, while the remaining 20% is covered by irrigation. Higher yields can, however, be obtained thanks to irrigation techniques, which account for the generation of 40% of total agricultural production. In particular, irrigation appears a key element to enable developing countries (in many cases characterized by a limited rainfall) to nourish their populations.

However, due to demographic growth, the persistence of inefficient irrigation methods and growing competition for the use of water resources, it is estimated that between 15% and 35% of current water withdrawals for irrigation will not be sustainable in the future[14]. So it is clear that deep thought has to be given to developing an effectively sustainable growth model, that can guarantee access to food for a growing world population, in the face of increasingly diminishing water resources.

Industry is the second in line after agriculture for the consumption of water resources. Additionally, the quantities of water used vary enormously from one production sector to another. The huge amounts of water used by industry should not surprise us: just think of how many types of production are based on the use of water, both directly (as an ingredient in products for human consumption such as in the food, drinks and pharmaceutical sectors for example) and indirectly (within production cycles).

As regards domestic use, FAO[15] data show that consumption worldwide differs considerably from country to country, with a particularly wide gap between developed and developing countries, ranging, for example, from 4 m^3/per annum per capita in Mali to 106 m^3/per annum in France, to 215 m^3/per annum in the United States.

The consequences of a similar inequality appear significant not only from the economic efficiency standpoint but also, and especially, from the humanitarian and health perspective. The UN fixes the minimum daily per capita requirement of water for primary needs connected with food and hygiene at 20-50 litres per day. More than one person out of six in the world does not reach this standard.

Figure 6. Population with access to drinking water

Source: The European-House Ambrosetti re-elaboration on AQUASTAT database data, FAO, 2006

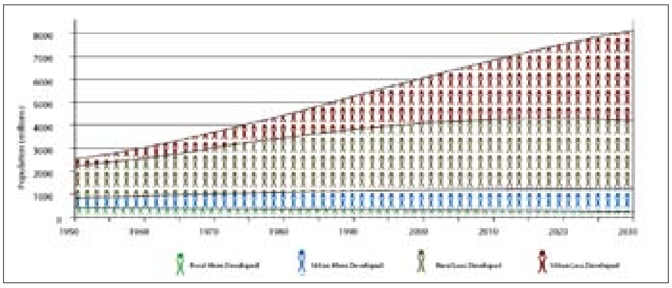
12 "*Water at a glance*", FAO Water, 2006
13 According to even longer term forecasts, in 2050 agriculture will account for 90% of consumption of global water resources. Source: World Water Assessment Programme, The United Nations World Water Development Report 3, "*Water in a Changing World*", UNESCO, March 2009
14 *"Facts and Trends – Water"*, World Business Council for Sustainable Development (WBCSD), 2006
15 AQUASTAT database, FAO, 2006

1.3 Factors affecting the growth in the demand for water resources

In relation to the current availability and allocation of water resources, it might be useful to provide a brief outline of the factors which, within the reference context, are likely to affect the world demand for water in the future.

Among these, a particularly significant role is played by **demographic dynamics** and **increasing urbanization**. Demographic growth estimates calculate that the world's population will increase to over 8 billion people by 2030, reaching 9 billion by 2050.

Figure 7. Demographic growth and urbanization

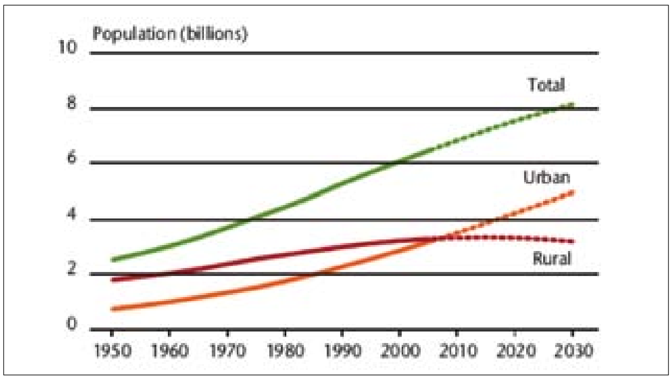


Source: UNDESA, World Urbanization Prospects

The world population already uses **54% of the freshwater resources** contained in rivers, lakes and accessible acquifers: as the population grows it is estimated that within 2025 the water withdrawals required to meet the needs of the population will increase by 50% in developing countries and 18% in developed countries. In particular, the world food requirement in 2025 will have increased by 55% compared to 1998, leading to an increase of at least 14% in the water requirement for irrigation. At the same time, the demand for water will increase in order to respond to primary hygienic-sanitary necessities, to energy production requirements and to industrial development. Within an undeniably complex context, a note of optimism is, however, provided by the UNESCO estimates[16], according to which the increase in the volume of water resources required for irrigation (+14%) could be lower compared to the increase in the land surfaces irrigated (+34%), thanks to the adoption of more efficient irrigation techniques.

In parallel with this, a marked acceleration in the urbanization process is recorded (as it may also be observed in Figure 7, which clearly highlights how the element that has registered – and will continue to register in the future – the greatest growth rates is that of the urban population in the less developed countries). In 2007, for the first time in history, the urban population exceeded the rural one, with direct consequences in terms of infrastructures for access to water[17] (Figure 8). In fact the investments required to guarantee the distribution of water to a steadily increasing number of citizens – as well as for the related treatment and purification of the water deriving from domestic and industrial uses – appear colossal.

Figure 8. An increasingly more urbanized population



Source: UNDESA, World Urbanization Prospects

The increase of the world population, economic growth and the greater wealth of the population of the developing countries is further accompanied by a **change in dietary habits** and by an increase in the calories consumed (suffice it to say that over the last 20 years meat consumption in China has more than doubled and that by 2030 it will double again). This determines an increase in the water resources used, in the light of the fact that the production of meat, milk, sugar, vegetable oils requires, on average, the use of a larger quantity of water compared to the production of cereals.

In general, the improvement of the economic and living conditions of the populations of the so-called emerging countries, together with the **expansion of economic activities** – ranging from industrial activities through to services and tourism – place increasing pressure on the water resources available and on the natural ecosystem.

The economic growth together with the arrival on the markets of large portions of population previously excluded from mass consumption generate very serious problems also from the **waste management** perspective. The dramatic dimensions of the problem can be illustrated with a few numbers[18]. It is estimated that each day 2 million tons of general waste generated by human activities are thrown into the rivers. The contribution of the food sector to the production of organic substances that are contaminating water resources is 40% in developed countries and 54% in developing countries. In developing countries, 70% of industrial waste is discharged into rivers without undergoing any kind of purification treatment, thereby polluting part of the freshwater resources available.

Last but not least, another factor that will affect the availability and management of water resources is that of *climate change*. There is by now a large consensus of opinion regarding the effects on water and its availability of certain environ-

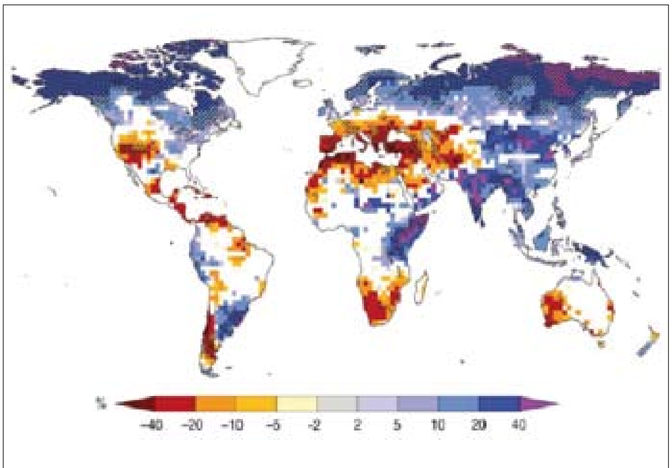
16 UNESCO, World Water Assessment Program
17 UNDESA, World Urbanization Prospects

mental macro-changes to which the planet is going to be subjected in the decades to come, due to the rising temperatures and disruption caused by *climate change*[19]:

- a strong contraction of the ice-covered surface of the land and sea (according to some forecasts, a considerable part of the polar ice caps may have disappeared definitively by the end of the 21st century);
- a significant increase in the frequency of "extreme" phenomena, such as heat waves and heavy precipitation;
- a gradual shift towards the poles of non tropical storms, heavily influencing winds, precipitation and temperatures.

There is likely to be an **increase in the flow rate of rivers** and in the **overall availability of water** in the Northern hemisphere, while tropical and semi-arid areas (mainly the Mediterranean basin, the Eastern United States, South Africa and the North-East of Brazil) will have to deal with a **significant decline** in water resources.

Figure 9. Difference between the annual levels of rain forecast for the period 2090-2099 and the values recorded in the period 1980-1999



Source: Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.

Due to the profound changes induced by climate change, certain terrestrial and marine ecosystems (among which the Mediterranean basin) will suffer serious consequences, first and foremost due to the considerable reduction in the rainfall.

The impact of climate change on the Mediterranean ecosystem (on all of southern Europe in general) will manifest itself mainly through a significant reduction in water availability and crop productivity: agriculture in general and certain specific crops (mainly cereals) will be badly struck by rising temperatures and decreasing precipitation, while the negative effect on the soil will be mainly linked to marked erosion phenomena.

Generally speaking, on a worldwide scale, **two *macro-trends*** likely to have a powerful impact on the terrestrial and marine ecosystems alike may be identified:

- the strong **increase in the atmospheric concentration of CO_2**, which is generating a progressive increase in the acidification of the oceans and water bodies, with negative consequences both on the very existence of the marine ecosystems, and on the availability (and connected costs) of the water resources usable for human purposes;
- the gradual **slowing down that is expected to take place in the southern current of the Atlantic ocean** (MOC = *Meridional Overturning Circulation*) in the course of the 21st century: although difficult to estimate, the effects of the structural changes of this current are expected to impact enormously on the marine ecosystems, on the concentration of CO_2 and of oxygen and on terrestrial vegetation in general.

The IPCC envisages[20] the possibility of a substantial reduction in the quality of the water both at surface and sub-surface levels, with significant implications on health. Moreover, one of the most critical effects of *climate change* and of the phenomena linked to it is that of a considerable increase in pressure upon urban and rural infrastructures connected with scarce-water resources, which could generate not only allocation- and distribution-related problems, but also a high level of conflict between nations, especially in cases regarding access to trans-boundary waters.

1.4 The role of technology in water management

Given the sheer vastness of the topic, this document is not the right context in which to examine precisely and exhaustively the various aspects regarding the role of technology in the management of water resources. A few remarks regarding the areas likely to impact significantly on water resources in the near future are, however, called for.

In particular, the United Nations identified, in a recent report entitled "*Water in a Changing World*[21]", to which the reader is referred for further details on this aspect, a number of main areas of technological development relevant for the future management of water resources, among which:

- environmental research and development;
- renewable energy sources and bioenergy;
- nanotechnologies;
- ICT *(Information and Communication Technology)*.

The first point is of a general nature and is transversal to the various environmental topics, including that of water management. In numerous developed countries in recent years there has been an increase in **environmental research and development costs**, with a view to promoting innovative technologies

18 UNESCO, World Water Assessment Program
19 "*Climate Change 2007: Synthesis Report. Summary for Policymakers*", Intergovernmental Panel on Climate Change
20 "*Climate Change 2007: Synthesis Report. Summary for Policymakers*", Intergovernmental Panel on Climate Change
21 World Water Assessment Programme, The United Nations World Water Development Report 3, *"Water in a Changing World"*, UNESCO, marzo 2009

that could help improve the quality of the environment. This trend is not, however, observable – at least not at the same rate – in developing countries. For this reason, there tends to be a technological transfer from developed to developing countries. This transition appears particularly important in a future perspective, as an essential factor for guaranteeing "sustainable" growth to these countries, also from an environmental standpoint.

Research connected with renewable energy sources has recently benefitted from a clear-cut political orientation towards the reduction of emissions that are harmful to the atmosphere. Thanks to these efforts during this phase, important technological innovations focusing on the increasing use of renewable energy sources are being developed, for example in the field of solar energy, tidal energy, new generation geothermal systems and those based on the integration of various bioenergetic sources. Nevertheless, in the near future only a part of the energy demand will be realized using renewable sources, while traditional sources (fossil fuels and nuclear energy) will still be the predominant sources. But these sources generate a considerable impact as regards water consumption. For example, the generation of one megawatt/hour of electricity requires 2 m^3 of water using coal, 2,5 m^3 using nuclear energy and 4 m^3 using oil.

A rapidly growing trend, recently also at the centre of a scientific and economic debate, is that of research and applications connected with bioenergy. If, on the one hand these energy sources appear to have a lower impact on pollution, causing fewer harmful emissions for the atmosphere, on the other hand they involve a greater use of water resources, requiring a substantial use of water for their exploitation (see paragraph 2.2).

Nanotechnologies appear to have great potential in relation to techniques such as desalination and the purification of wastewaters in order to remove polluting metals, so that quantities of water may be recovered, at limited costs, for domestic, health and hygiene-related purposes as well as for irrigation. The only critical issue resides in the high initial costs for the studying and application of these technologies: it is not clear, therefore, what kind of time frame might be necessary for the large scale application of such innovations.

Last but not least, transversal to all the current and prospective technological improvements is the innovation and dissemination of information and communication technologies (ICT). This appears to be of major importance for spreading knowledge of phenomena and of potential applications, as it can provide a fundamental contribution in terms of monitoring the state of exploitation and pollution of the world's water resources.

1.5 The institutional and legal framework

1.5.1 The regulatory and governance system in the field of water management

The legal framework and the type, quality and legitimation of the *policies* covering the management of water resources appear essential elements with a view to defining and applying efficacious and efficient rules (and consequent controls) with the power to effectively promote the correct "governance" of the water resources available. The regulatory framework can, however, either be an important lever for change or a significant barrier to it; and this can occur both on an international scale and on a national and local one.
It appears useful, therefore, to endeavor to provide answers to the following questions: why is the regulatory framework so important for the effective governance of the water resources? Why is it possible to state – as UNESCO did in its most recent *World Water Development Report*[22] – that significant critical issues exist in this regard? What general guidelines can be developed to overcome such critical issues?

The regulatory framework is important for three basic reasons:

- it defines directly and indirectly the guidelines and the possibilities for concrete intervention on the subject of the governance of the world's water resources;
- it has a direct impact on the possibility to unify and coordinate the action (regulatory and implementational) of a wide variety of players involved directly and indirectly in water management;
- it has a fundamental effect on the management and resolution of the conflicts that can arise in relation to water governance, with reference both to its possible alternative uses and to the cases of resources shared between several nations (this function of the regulatory framework seems particularly important, especially in a future perspective: if the scenarios on the availability of water are confirmed, the controversies concerning a good the strategic importance of which is destined to increase exponentially will be one of the elements in the spotlight worldwide).

The major critical issues identified at a regulatory and policy level concern two main areas: the "institutional" and the "regulatory" areas. In actual fact:

- from the "institutional" standpoint, it appears clear that the objectives and the guidelines identified at an international level actually outline a common policy framework which, in order to be implemented at a practical level, requires supranational institutions equipped with adequate powers, national institutional frameworks defined in such a way as to be able to adopt/implement such indications and codified forms of participation and sharing between citizens, through the specific institutional mechanisms that allow it;
- from the "regulatory" standpoint, the stratification gener-

22 World Water Assessment Programme, The United Nations World Water Development Report 3, *"Water in a Changing World"*, UNESCO, marzo 2009

ated by the simultaneous presence of numerous institutional and regulatory levels exerting a direct or indirect effect on water resource management requires: a clear framework within which areas of competence and responsibility can be assigned; a clear definition of the levels of autonomy within which national and local legislation (which is in fact the regulatory level most widely applied and hence crucial for the correct governance of water resources) can adopt/interpret/amend the international guidelines; harmonization – as far as is possible – of the different sector regulations that indirectly involve water resources.

Both the overall regulatory framework and the consequent possibility for effective governance of the resource, water, involve a significant critical issue represented by the existence of a vast system of non-codified regulations regarding water (especially in developing countries) that interact, often in an uncoordinated manner, with the codified regulatory framework.

In particular, the coordination between national regulatory frameworks is – in the case of water – absolutely vital, as it is a resource that necessitates a global approach.

Policy legislation and guidelines drawn up at a supranational level appear – particularly in the light of the future perspective of an ever increasing integration of the management of the water problem – particularly important for an effective understanding of the critical issues that exist and of the potential areas of intervention. Among these, the regulations and guidelines drawn up at a European level, and specified in the paragraph below, are extremely interesting.

1.5.2 Priorities and objectives set by the European Union in the field of *water management*

The European Union stated its position on the issue of *water management* in the 2000 Framework Directive for Community action in the field of water policy[23]. The Directive establishes a legal framework in order to guarantee that throughout Europe there will be "*sufficient quantities of good quality water available*".

The Directive opens with a "policy statement" that is as clear as it is challenging: "*Water is not a commercial product like any other but rather a heritage which must be protected, defended and treated as such*". With a similar declaration and with the precise breakdown that logically follows on from the same, it places at the centre of European policy the theme of the sustainability of the use of a resource which:

- is acknowledged to be a heritage, i.e. a good with an extremely high value (not only economic) for the whole of Europe;
- to be protected and defended: underscoring the theme of the protection of the water, as a good that is both scarce and vital;
- it is not comparable to a commercial product: its use cannot be determined on the basis of mere market logic.

The Directive assumes quality of the water to be one of the macro objectives on which Member States should, in the medium term, place the emphasis (it refers to the "good status" of all the water resources within 2015) and in order to do this it numbers among the concrete objectives to be realized that of extending the effective protection provided by the Community, national and local authorities to all types of water (both surface and groundwater).

Within this framework, the problem of the pollution of surface water is acknowledged to be urgent and of central importance (establishing the need to define correct emission limit values for given groups or families of pollutants), and placed among the priority objectives is the commitment to guarantee the existence of a water pricing policy that would provide an adequate incentive for users to use water resources efficiently (the attribution of the correct economic value of the good, water, is therefore pinpointed, extremely clearly, as an absolute priority for Europe). In particular, as the National Institute of Agricultural Economics also indicates[24], individual Member States are expressly asked, in the implementation of their own policies, to take into account the principle of sustainable cost recovery for water services, including environmental and resource-related costs, according to the Polluter Pays principle (pollution tax).

In concrete terms, the area to which the Member States will be required to "apply" the declared concepts of efficiency, sustainability and quality is that of the river basins[25], identified as a reference unit on a Community scale: Management plans for these river basins will have to be developed by all Member States, and this applies to both exclusively national river basins and to those that are common to several States. The need for cooperation between Member States has therefore been ascertained and is further confirmed by the fixing, among other things, of the objective to rationalize and harmonize Community and national policies on water resources.

Last but not least, one of the main novelties of the Directive is the fact that citizens are recognized as being parties to involve actively with a view to successfully achieving the objectives set, and the needs, expectations and suggestions of the final users are fixed as priorities.

23 Communication of the Commission to the European Parliament and Council "Towards sustainable water management in the European Union - First stage in the implementation of the Water Framework Directive", 2007

24 INEA, Irrigation Report, "*Water Framework Directive 2000/60: analysis of the impact on the irrigation sector and on fishing*", 2007, commissioned by *the Ministry of Agricultural, Food and Forestry Policies*

25 The term "river basin" refers to the territory in which all the surface waters flow through streams, rivers and possibly lakes emptying into the sea in a single estuary

Although the guidelines laid down by the Framework Directive appear to be moving in the right direction, it is nonetheless important to acknowledge that very little has been done by Member States to follow up these policies which appear to be perfectly in line with all the indications provided by international institutions, which continually call attention to the absolute necessity to take action in order to preserve the planet's water resources.

In fact, in its 2007 Communication, the European Commission[26] highlights the **failure to fully implement** the Water Framework Directive: according to the Commission, inefficacious pricing policies (that fail to reflect the level of importance of water resources at a local level) continue to exist. Uneven allocation of water resources persists among the various economic sectors (creating imbalances between the need for water and the water resources effectively existing). Great potential for water savings can be identified but remain unexploited (also due to the lack of proper evaluation and monitoring programs) and a real and efficient integration of the water issues in the various sectoral policies has not yet been observed (with negative repercussions on efforts to protect the available water resources).

In the light of a European regulatory and implementational scenario that is a far cry from the objectives set in the Framework Directive in 2000, the European Commission has drawn up a set of **guidelines for the future**, that are built on a basic assumption: an integrated approach to water-related problems based on a combination of options, appears to be more efficacious and efficient than solutions based solely on water supplying schemes or economic tools. The main strategic orientations identified are:

- to set up a **water pricing policy** that is based on a **consistent economic assessment of water uses and water value**;
- to introduce **compulsory water metering programs** in all sectors that use water;
- to develop a **more efficient allocation of water** and water-related funding;
- to improve **land-use planning**;
- to finance **water efficiency** (e.g. by guaranteeing an appropriate use of European and national funds in order to improve the management of the water demand and/or by developing fiscal incentives);
- to develop **drought risk management plans** (by devising methods for fixing drought risk thresholds and mapping the areas affected by the phenomenon);
- to evaluate the possibility of creating **further water supply infrastructures**;
- **to promote the technologies and practices that enable an efficient use of water** (e.g. through the drawing up of a new Directive on water efficiency in the building sector, similar to that on energy efficiency;
- to develop **voluntary agreements with all the economic sectors** that use water for product planning, buildings, networks and practices that allow a more efficient and rational use of water resources;
- to foster the emergence of a **water-saving culture in Europe** (to this end the priority intervention sectors are information, training and education);
- to encourage the integration of rules on water management in existing and future **quality assurance and certification schemes**;
- to assess the possibility of expanding the **current Community labeling systems** to promote more efficient appliances and products demonstrating greater respect for water;
- to improve **information, knowledge and data collection** (e.g. by disseminating the results of research carried out on water scarcity and drought more widely in order to facilitate access to them and use of them);
- to explore, potentiate and encourage **technological and research activities** in this sphere, also through networking activities.

It may be observed, that the critical issues identified and the guidelines laid down by the European Community trace a very clear path, that of the efficient management of the scarce water resources available, realizable through a set of coordinated and integrated concrete measures that recognize the invaluable features of the good, water, and the need to recognize its real worth, both in terms of quantity and quality.

1.6 Water scarcity

The world water supply issue must be viewed in conjunction with the great *trends* outlined above, all of which concur in defining a **demand** for water that is **generally on the increase**.

From the theoretical standpoint, a situation of "**water scarcity**" emerges when the demand for water resources by man and by the ecosystem exceeds the resources available. A distinction may be made between **environmental** and **economic scarcity**.

Environmental scarcity exists when **more than 75% of rainwater and groundwater** is withdrawn and used for agricultural, industrial and domestic purposes: in this case, the exploitation of the water resources has either reached or already exceeded the sustainability limit. Environmental water scarcity is said to be incipient when **more than 60% of rainwater** is withdrawn, risking a future lack of water resources, from an environmental point of view.

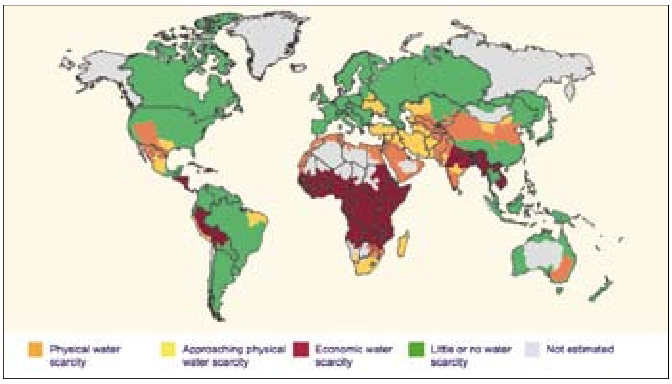
In technical terms, economic scarcity, on the other hand, arises when the obstacles linked to human, institutional and financial capital prevent access to water, even although the water resources are available at a local level and could satisfy

26 Communication of the Commission to the European Parliament and Council: "*Addressing the challenge of water scarcity and droughts in the European Union*", 2007

human requirements. In particular, economic scarcity exists when water resources are plentiful but less than 25% of the rainwater can be used to satisfy human requirements.

On the basis of this environmental criterion, on a worldwide scale, the areas characterized by water scarcity are mainly represented by North Africa, some internal areas of southern Asia, part of Australia and the south-eastern area of the United States. If, on the other hand, we analyze water scarcity from the economic standpoint, it may be observed how the areas most hard-hit by this problem are those of central Africa and a portion of the Indian peninsula.

Figure 10. Areas with environmental and economic water scarcity



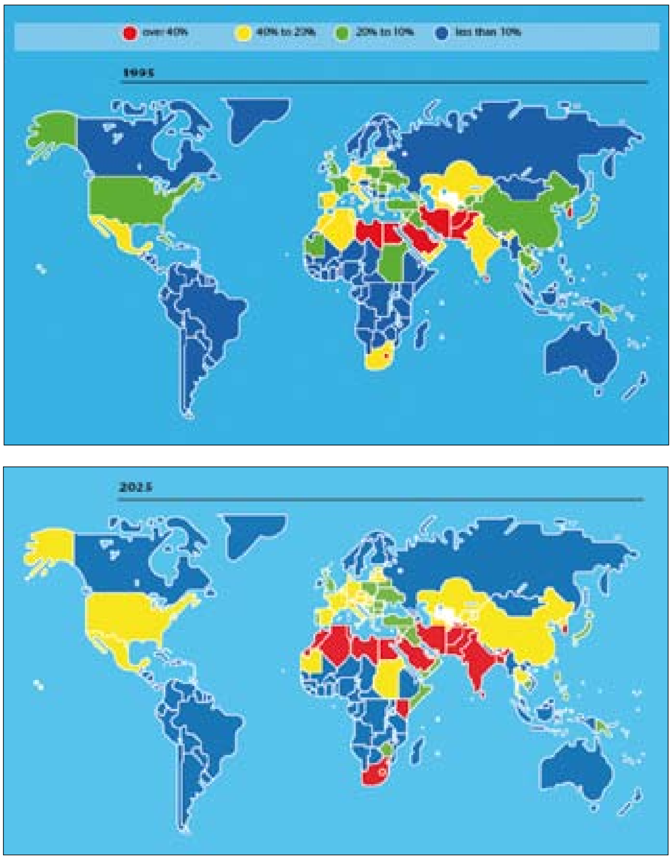
Source: Comprehensive Assessment of Water Management in Agriculture, 2007

1.7 Future scenarios

The degree of scarcity of water resources, especially down the line, can be identified in a particularly efficacious manner through an analysis of the amount of water used in the various geographical areas compared to the resources available.

In 1995, the areas characterized by a high rate of withdrawal of the available resources (greater than 20%) were located in the south of the United States, North Africa, some areas of Western Europe, the Arabian Peninsula and certain areas of South-East Asia. In the future scenario in 2025 (Figure 11), the situation appears dramatically worse in terms of the ratio between resources used and resources available. It is, in fact, estimated that the area of the world subjected to a rate of withdrawal exceeding 20% will increase substantially compared to 1995, extending to cover the entire territory of the United States and a sizeable part of mainland Europe and the south of Asia, with wide areas located in Africa and in the Indian peninsula[27] registering rates of over 40%.

Figure 11. Amount of water used compared to resources available – comparison of two scenarios, 1995 and 2025



Source: "Business in the world of water. WCCSD Water Scenarios to 2025", WBCSD, 2006

The situation does not appear any different if we consider directly the prospective availability of water per capita in the various areas of the world: Africa will drop from approx. 16,000 m^3 per capita in 1960 to less than 4,000 m^3 in 2025. Asia will drop from an availability per capita of approx. 6,000 m^3 to approx. 2,000 m^3. The Middle East and North Africa will drop from approx. 4,000 m^3 per capita in 1960 to less than 2,000 m^3 in 2025.

So a particularly difficult scenario is in store for the future and wise and courageous choices with the power to positively affect the trends in course need to be made here and now.

27 *"Business in the world of water. WCCSD Water Scenarios to 2025"*, WBCSD, 2006

BOX 1

World Water Day 2009 *Transboundary Waters: Shared Waters, Shared Opportunities*

The organization of an international day to celebrate water was proposed[28] in 1992 at the United Nations Conference on Environment and Development (UNCED) and was subsequently adopted by the United Nations General Assembly which, on 22 March 1993, organized the first World Water Day.

The aim of the initiative is to draw attention to the importance of freshwater resources and incentivize sustainability in the management of water resources. Each year the World Water Day concentrates on a particular aspect of the theme of water. This year it has chosen to focus on the theme *Shared Water – Shared Opportunities*. Special attention will be given to **transboundary waters**, with the intention of promoting the development of cooperation initiatives between the various nations which, also at a territorial level, share this resource. The event will also promote **peace**, **security** and the **growth of economic sustainability**.

Growing needs, uneven distribution over the territory, situations of scarcity and limited accessibility are all elements that intensify the competition for access to water resources by the various withdrawal and usage systems. This is a patently obvious aspect, especially for the river basins which cross various physical and political boundaries. In fact, all governments are committed to ensuring that their citizens have access to a quantity of water sufficient to meet their needs and attempts to seize, control, manage or preserve the resources available have been, and still are, the cause of conflict and civil war.

The areas at greater risk, from this point of view, are located in the Middle East and North Africa. In the Middle Eastern countries, in fact, strong tension connected with the control of water resources have arisen in the past: one example of this is the Arab-Israeli conflict, which is closely connected with the control of the River Jordan. The River Nile represents another sensitive river basin, as its waters flow through 10 African countries: Ethiopia, Sudan, Egypt, Uganda, Kenya, Tanzania, Burundi, Ruanda, The Democratic Republic of the Congo and Eritrea[29]. Another two rivers of immense historical import, the Tigris and the Euphrates which have been watering the agricultural crops of Turkey, Syria and Iraq for thousands of years, caused serious clashes between the 3 countries.

These are only a few examples of transboundary river basins. In the world there are 263 basins that cross 145 countries, covering almost half of the earth's surface. Additionally, more than 270 fresh water supplies flow in the underground aquifers, passing over national boundaries.

Figure 12. Main transboundary river basins, 2009

Source: "Shared Water, Shared Opportunities" – World Water Day 2009

The need to promote integrated solutions, in a spirit of **cooperation**, is particularly urgent in the areas affected by

28 United Nations Department of Economic and Social Affairs – Division for Sustainable Development "*Agenda 21: Chapter 18, Protection of the Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and use of Water Resources*", 1992

29 The reader's attention is drawn to the fact that in 1999, in Tanzania, a meeting of the Council of Ministers of Water Affairs of the Nile Basin was held during which the ten countries signed a strategic agreement that aims to resolve the conflict by devising a plan aiming to "*achieve sustainable socio-economic development through equitable utilization of water resources, recognizing the right of all the countries through which the river flows to use the resources of the Nile to promote development within its boundaries*"

BOX 1

these shared river basins, with a view to promoting peace and security as well as sustainable economic development.

History has taught us on numerous occasions that water, being a vital element, can exert a strong impetus towards cooperation; it can compel the parties involved to resolve their differences, not allowing conflicting interests to jeopardize the supply of water resources to the populations depending on it. In fact, over the last sixty years around 300 international agreements have been signed on this subject against only 37 recorded cases of conflict and violence [30].

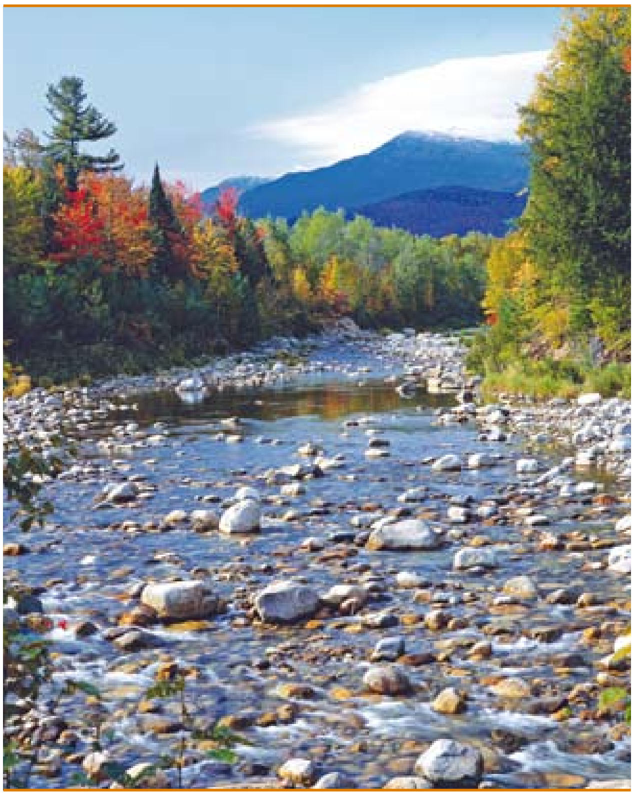
The main intention of the international organizations is to promote the peaceful use of transboundary rivers, dealing with any conflicts arising and encouraging cooperation between the nations and the parties involved. For this reason, facilitating the integrated management of shared water resources and reinforcing the commitment to cooperation of the parties involved is a priority for the conclusion of agreements inspired by the principle of equitable use of resources.

Over recent years numerous agreements and declarations have been made concerning the management of these particular river basins; some countries have even set up institutions specifically for the purpose of dealing with this aspect. Notwithstanding the undoubted progress achieved, numerous vulnerable situations nonetheless persist because joint management tools have not been developed for many of the international river basins and certain fundamental aspects of management are clearly lacking. Of the 263 existing transboundary river basins, 158 have not yet been the object of a joint management agreement.

So many gaps still exist and the implementation and creation of international agreements is a priority of the utmost urgency.

The promotion of cooperation in the management of transboundary river basins can contribute to uniting populations in the pursuit of the common goal of guaranteeing sufficient water resources to each and everyone. This involves an important change in values and perceptions: water must no longer be considered as a good to be exploited but as a fragile common resource to be used for the benefit of one and all and a potential aid to the development of greater cooperation and trust between nations.

"Whether we live upstream or downstream, we are all in the same boat. We all share the responsibility for managing the world's transboundary waters for current and future generations".



30 World Water Day 2009 (www.worldwaterday.org). Wolf A. T., The Transboundary Freshwater Dispute Database, http://www.transboundarywaters.orst.edu/database/

Part B: Interpretation Keys

2. VIRTUAL WATER AND WATER FOOTPRINT

The **virtual water**[31] content of a product (commodity, good or service) is the volume of freshwater used to produce it. It refers to the sum of the water used in the various steps of the production chain. The term "virtual" refers to the fact that the vast majority of water utilized to create the product is not physically contained in the product itself, but was consumed during the phases of its production.

2.1 The three colors of virtual water

More specifically, the virtual water content of a product may be constituted of **three components**:

- *Green virtual water* which is the volume of rain water evaporated during the production process. This is a component that is especially relevant for agricultural cultivation and refers to the total amount of rain water evaporated from the soil during the growth period of the crop (it includes plant transpiration and other forms of evaporation);
- *Blue virtual water* which is the volume of surface or ground water evaporated during the production process. For agricultural cultivation, it is the sum of irrigation water evaporated from the soil and that evaporated from irrigation ditches and man-made reservoirs. For industrial products and domestic use, it is the quantity of evaporated water taken from the ground water or water basins and which is not recycled into the water system from which it comes;
- *Grey virtual water* which is the volume of water polluted during the production process. This component may be quantified by calculating the volume of water required to dilute polluting agents introduced into the water system during the production process.

The use of each of these three components of virtual water **has a different impact on the hydrogeological cycle**. For example, consumption of Green water has an invasive impact on environmental equilibriums compared with Blue water.

2.2 Virtual water content of a number of products and variation in virtual content in some diets

First of all, it is interesting to apply the concept of virtual water to **agricultural products** (products derived from the cultivation of plants and animal husbandry), since agriculture – as was stated in section 1.2 – absorbs approximately 70% of the water resources utilized by man on a global level. From the table below, which summarizes the virtual water content (expressed in cubic meters per ton) of some agricultural products in a number of countries around the world, **significant differences** are seen, both comparing the various products among themselves and taking into consideration where they were produced.

Figure 13. Average virtual water content of a number of agricultural products (m^3/ton), in some countries

	World average	USA	China	India	Russia	Brazil	Italy
Rice	3.419	1.903	1.972	4.254	3.584	4.600	2.506
Wheat	1.334	849	690	1.654	2.375	1.616	2.421
Maize	909	489	801	1.937	1.397	1.180	530
Soybeans	1.789	1.869	2.617	4.124	3.933	1.076	1.506
Beef	15.497	13.193	12.560	16.482	21.028	16.961	21.157
Pork	4.856	3.946	2.211	4.397	6.947	4.818	6.377
Goat meat	4.043	3.082	3.994	5.187	5.290	4.175	4.180
Chicken meat	3.918	2.389	3.652	7.736	5.763	3.913	2.198
Eggs	3.340	1.510	3.550	7.531	4.919	3.337	1.389
Milk	990	695	1.000	1.369	1.345	1.001	861
Cheese	4.914	3.457	4.963	6.793	6.671	4.969	4.278

Source: The European House-Ambrosetti re-elaboration based on Hoekstra A.Y., Chapagain A.K., Water footprints of nations: Water use by people as a function of their consumption pattern", 2007

In particular, **animal husbandry products** (meat, eggs, milk and derivatives) **have a much higher virtual water content than cultivated products** given the fact that before being transformed into food products, animals which are raised consume for a number of years a tremendous amount of products cultivated as feed (in addition to direct consumption of water for drinking and other operations).

In addition, the **content of virtual water in the same product can vary significantly from place to place**, depending on factors such as climate, agricultural techniques employed, crop yield, etc.

To have a better understanding of the differences between various products and awareness of the volume of virtual water they contain, Figure 14 provides virtual water data for a number of products used daily by consumers (e.g., a kg of rice

31 The concept of virtual water was created in 1993 by professor John Anthony Allan of King's College, London and School of Oriental and African Studies, for which he was awarded the Stockholm Water Prize in March 2008

or beef) and manufactured goods (e.g., an A4 sheet of paper, a T-shirt and a pair of leather shoes).

Figure 14. Average virtual water content of some products

Product (1 Kg)	litres
Wheat	1.300
Sugar cane	1.500
Rice	3.400
Pork	4.800
Cheese	5.000
Beef	15.500

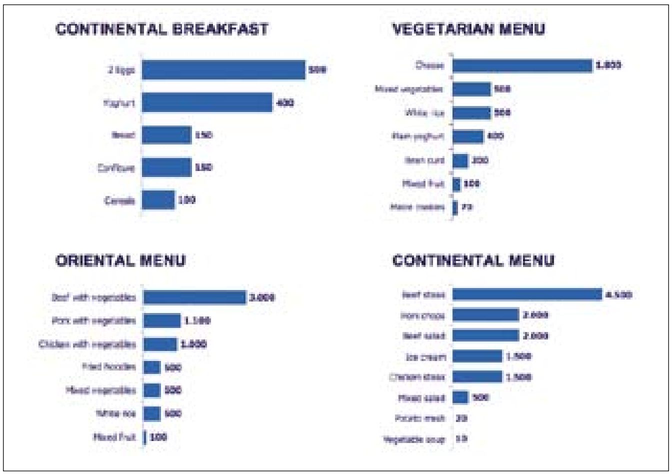
Product (unit of product)	litres
1 sheet of A4-paper (80g/m^2)	10
1 tomato(70g)	13
1 potato (100g)	25
1 microchip (2g)	32
1 cup of tea (250ml)	35
1 slice of bread (30g)	40
1 orange (100g)	50
1 apple (100g)	70
1 glass of beer (250ml)	75
1 glass of wine (125ml)	120
1 egg (40g)	135
1 cup of coffee (125ml)	140
1 bag of potato crisps (200g)	185
1 glass of milk (200ml)	200
1 cotton T-shirt (250g)	2.000
1 hamburger (150g)	2.400
1 pair of shoes (bovine leather)	8.000

Sources: The European House-Ambrosetti re-elaboration based on Water Footprint Network, www.waterfootprint.org; Hoekstra A.Y., Chapagain A.K., Water footprints of nations: Water use by people as a function of their consumption pattern", 2007

From the examples provided in the figures above, it is clear that different eating habits imply a greater or lesser consumption of water resources depending on whether the foods consumed have a greater or lesser virtual water content. In fact, an individual utilizes on average 2 to 5 liters of water per day for drinking, while the daily consumption of virtual water for eating purposes is approximately 1,500-2,600 liters for a vegetarian diet and approximately 4,000-5,400 liters for a meat-rich diet[32].

The figure below provides the virtual water content for a number of dishes in a hypothetical international menu.

Figure 15. Virtual water content of a number of dishes in a hypothetical international menu

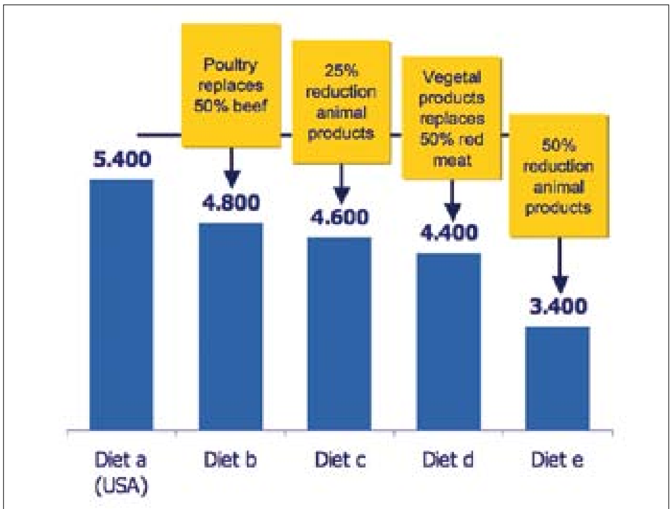


Source: World Water Council, 3rd World Water Forum, 2003

Unquestionably, the evolution of individual eating habits will have a significant impact on the availability of water resources. In this regard, it has been estimated that if all the inhabitants of our planet were to adopt the meat-rich diet of western countries, it would require an increment of 75% of the water used currently to produce food[33].

The figure below illustrates the impact of some diet choices–modifications made in the typical American diet (rich in red meats)–on the volume of water required to produce foods in the diet.

Figure 16. Impact of changes in eating habits on the virtual content of the average American diet (liters per person per day)



Source: The European House-Ambrosetti re-elaboration based on Renault D., Wallender W.W., "Nutritional Water Productivity and Diets: From 'Crop per drop' towards 'Nutrition per drop'", Agricultural Water Management, 2000

32 World Water Council, 2008
33 Zimmer D., Renault D., "*Virtual water in food production and global trade: Review of methodological issues and preliminary results*", 2003
34 It is estimated that global energy demand will grow by 55% by the year 2030. Source: IEA, 2008

Finally, the growing global demand for energy[34] also exerts strong pressure on the accompanying demand for water resources. In particular, the **production of biofuels** has increased exponentially in recent years[35] (ethanol production has tripled from the year 2000 to the present with 77 billion liters produced in 2008 and it is estimated that it could reach 127 billion liters by 2017[36]), primarily due to the instability of petroleum prices and support from international and national environmental policies. Although biofuels represent a valid means for reducing dependence on fossil fuels, they do create some **pressure on the equilibrium of the water system and biodiversity of some countries** because of the large amount of water (and fertilizers) required in the cultivation of corn, sugar cane and other crops used to manufacture biofuels. In fact, to produce a liter of biofuel requires an average of approximately **2,500 liters of water**[37] (with variations that can even be significant between various geographical areas because of the variation in the level of irrigation of fields) that is equivalent to the volume of water required to produce an amount of food sufficient to the daily caloric requirements of a person.

2.3 The Water Footprint

The concept of virtual water has recently been re-worked with the definition of "Water Footprint" which presents a new **indicator of water use**[38]. In fact, the Water Footprint measures water use in terms of volume (expressed in m^3) of evaporated and/or polluted water and may be calculated not only for each product or activity, but also for each well-defined group of consumers (an individual, family, inhabitants of a town or an entire nation) or producers (private companies, public entities, economic sectors). Specifically:

- the Water Footprint of a **product** (tangible good or service) consists of the total volume of freshwater consumed to produce it, taking into consideration the various phases in the production chain (coincides with the concept of virtual water described above);
- the Water Footprint of an **individual, community or nation** consists of the total volume of freshwater consumed either directly or indirectly by the individual, community or nation (water consumed to produce goods and services utilized);
- the Water Footprint of a **company** consists of the volume of freshwater consumed during the course of its activity, added to that consumed in its supply chain.

The Water Footprint does not simply indicate the volume of water consumed, but also refers to the **quality** (in addition to the quantity) of the water and *where and when* it is consumed. In particular, the space/time aspect of this indicator makes it a candidate – as will be seen below – to be a tool to better comprehend the **global character of the issue of freshwater availability** and to quantify the effects on consumption of this scarce resource that are generated by the production and consumption of goods and services and **international trade**.

2.4 The Water Footprint of a country

"The problems tied to water are often closely connected to the world economic structure. Many countries have externalized their Water Footprint in a massive way, importing from other places those goods that require a tremendous amount of water to be produced. This places under pressure the water resources of the exporting countries where, too often, mechanisms aimed at wise management and conservation of resources are lacking. Not only governments, but also consumers, business and each community can make the difference in improving water resource management"[39].

In addition, commercial trade between countries not only causes a transfer of goods from one place to another, but also **virtual water flows** (*Virtual Water Trade*) since, as stated above, raw materials, goods and services all have a given virtual water content.

For this reason, to measure the utilization level of global water resources by a country, it is not sufficient to count the use of water resources present within its own boundaries; the water used to produce imported and exported goods and services must also be taken into consideration.

Therefore, the Water Footprint of a country is defined as the total volume of freshwater consumed to produce goods and services utilized by its inhabitants and, since not all goods and services utilized in a country are produced internally, the Water Footprint is divided into two parts:

- **internal Water Footprint,** the consumption of domestic water resources;
- **external Water Footprint,** the consumption of external water resources, i.e., those from other countries.

To evaluate the Water Footprint of a country, the total consumption of internal resources must be calculated, minus the virtual water flows that leave the country through exportation, and plus the virtual water flows that enter the country through importation.

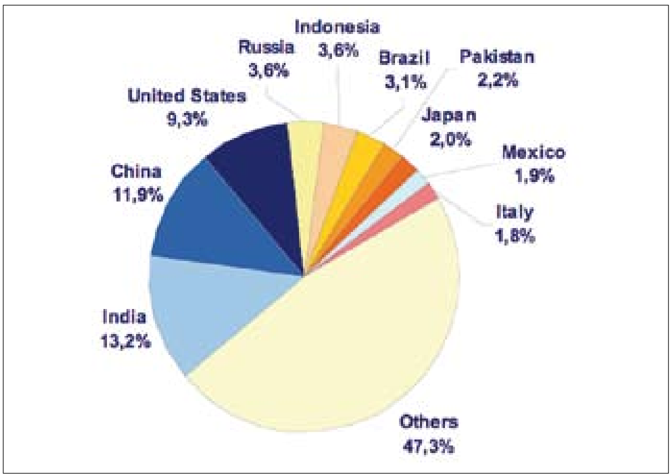
The global Water Footprint amounts to 7,452 billion m^3 of freshwater per year, equal to 1,243 m^3 per year per capita.

Taking into consideration the Water Footprint as an absolute value, the country which consumes the greatest volume is **India** (987 billion m^3), followed by **China** (883 billion m^3) and the **United States** (696 billion m^3). The top ten countries comprise

35 Despite the fact that it currently represents a modest level (approx. 2%) of the global market for fuels utilized for transport
36 IEA, 2008
37 World Water Assessment Programme, The United Nations World Water Development Report 3, "*Water in a Changing World*", UNESCO, March 2009
38 This indicator was conceived of in 2002 by Prof. Arien Y. Hoekstra of the University of Twente (The Netherlands) within the context of UNESCO-promoted activities. Hoekstra is co-founder and president of the Scientific Committee of the Water Footprint Network formed in 2008
39 Arjen Y. Hoekstra

52.7% of the global Water Footprint (Figure 17).

Figure 17. Division of the global Water Footprint by country



Source: The European House-Ambrosetti re-elaboration based on Hoekstra A.Y., Chapagain A.K., Water Neutral: reducing and offsetting the impacts of water footprints", Value of Water, Research Report Series No. March 28, 2008

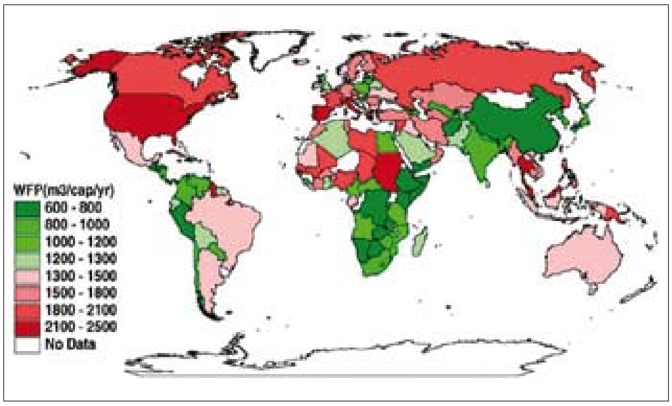
If per capita values are taken into consideration, on the other hand, citizens of the United States have an average Water Footprint of 2,483 m^3 per year, followed by Italians and Thai. As can be seen from the figures below, citizens of countries such as China, Bangladesh, South Africa and India have significantly lower rates than those of more developed countries.

Figure 18. *Per capita Water Footprint by country (m^3/year)*

Source: The European House-Ambrosetti re-elaboration based on Hoekstra A.Y., Chapagain A.K., Water Neutral: reducing and offsetting the impacts of water footprints", Value of Water, Research Report Series No. March 28, 2008

In the figure below, which indicates in green those countries with a per capita Water Footprint less than the worldwide average, and in red those with a per capita Water Footprint above the average, there is a marked difference between countries in consumption of worldwide water resources.

Figure 19. *Per capita Water Footprint by country (m^3/year)*



Source: Hoekstra A.Y., Chapagain A.K., "Water Neutral: reducing and offsetting the impacts of water footprints", Value of Water, Research Report Series No. March 28, 2008

These differences are the result of a number of factors which, taken together, determine the level of a country's Water Footprint. Specifically, these can be identified in the following four major factors[40]:

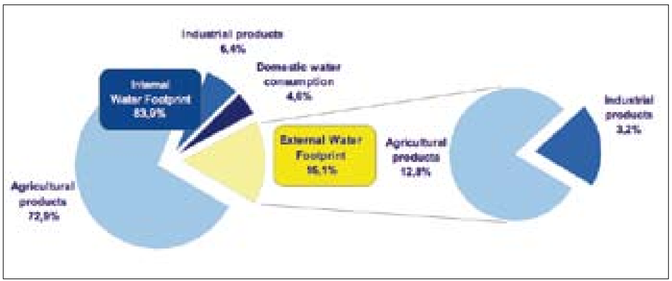
1. Volume of consumption, generally connected to the gross domestic product (wealth) of a country;
2. Consumption model, above all in terms of eating habits, which can be more or less oriented towards meat consumption (for example, average meat consumption per capita in the US is 120 kg per year, three times that of the average worldwide) and use of manufactured goods. The consumption model is generally also connected to the wealth of the country;
3. Climate, which affects, above all, precipitation, plant transpiration and amount of water required for crop growth;
4. Agricultural methods, especially in terms of the efficiency of water use. For example, in Thailand, the yield of the rice crop is around 2.5 tons per hectare, compared with a worldwide average of 3.9.

The global Water Footprint is largely determined by the production of agricultural products and food, followed by the production of manufactured goods and domestic use of water. In addition to the sector responsible for water consumption, Figure 20 also provides the percentage of water consumed ascribable to exports. Sixteen percent of the global Water Footprint derives from the creation of products for export.

The breakdown of the Water Footprint varies significantly from country-to-country, especially in terms of the external Water Footprint level. For example, Italy imports 51% of the virtual water consumed, while India only 1.5%.

40 *"Water footprints of nations: Water use by people as a function of their consumption pattern"*, Hoekstra, A.Y. e Chapagain, A.K., Water Resources Management, 2007

Figure 20. Breakdown of the global Water Footprint by consumption category and differentiation between internal and external Footprint



Source: The European House-Ambrosetti re-elaboration based on Hoekstra A.Y., Chapagain A.K., Water Neutral: reducing and offsetting the impacts of water footprints", Value of Water, Research Report Series No. March 28, 2008

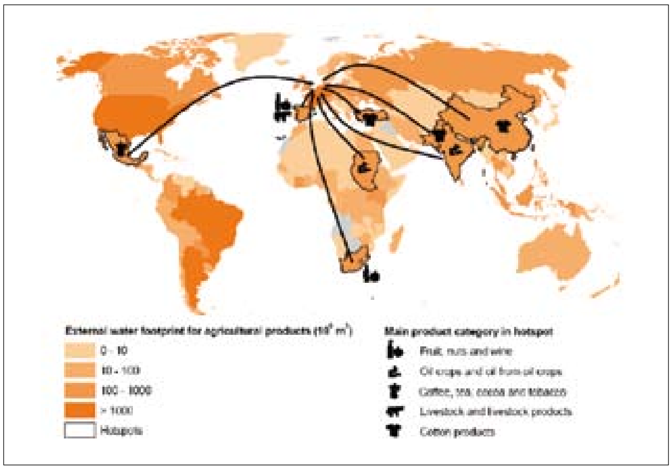
2.5 Virtual water flows (Virtual Water Trade): risk or opportunity?

The level of **interdependence between countries in the virtual exchange of water resources**, already considerable today, is destined to grow even more in the future, given the on-going process of liberalization in international trade.

Globalization of water use seems to entail both **risks** and **opportunities**.

The greatest risk is represented by the fact that importation of products with high virtual water content implies **externalization of the indirect effects of exploitation of this resource by the importing country to the exporting one**. Because in many countries water utilized in agriculture has a much lower price than its real value (please refer to Chapter 4), the costs associated with water consumption by exporting countries are generally not fully reflected in the price of the products consumed by importing countries. This factor can generate an imbalance from the standpoint of efficiency and equity in international trade, and, more concretely, imbalances within the water system of exporting countries. For example, the figure below provides a map of the impact of the external Water Footprint for the Netherlands: the various shades of orange indicate water consumption in the various countries of the world connected to the consumption of agricultural products by Dutch citizens and highlighted are the countries in which the external Water Footprint of the Netherlands (and the products associated with its) generates relatively high social and environmental effects.

Figure 21. Map of the impact of the external Water Footprint of the Netherlands



Source: Hoekstra A.Y., Chapagain A.K., "Water Neutral: reducing and offsetting the impacts of water footprints", Value of Water, Research Report Series No. March 28, 2008

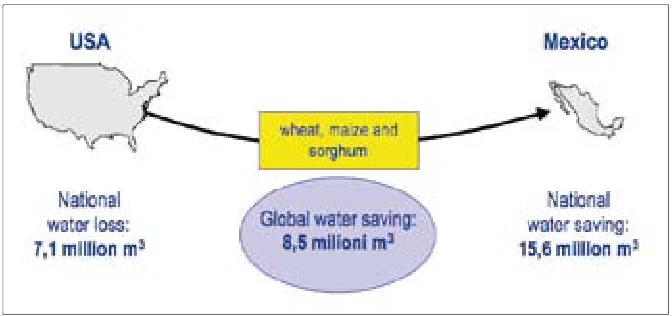
What can be deduced from this is that the consumption of some agricultural products by the Netherlands represents a threat to the equilibrium of the water system of other countries (Mexico, South Africa, the Sudan, Spain, Turkey, India, China, etc.) from which the Netherlands imports these products, due to the conditions of stress and scarcity of water in these areas.

A second element of risk, for some countries which import products with a high level of virtual water, is represented by an **excessive dependence on the water resources of other countries**. For example, Jordan already imports a volume of virtual water 5 times greater than its own internal renewable water resources. While, on the one hand, this imbalance makes it possible for Jordan to preserve its own water resources and limit the risk of them being exploited in an unsustainable manner, on the other it exposes the country to excessive dependence on foreign countries. Other countries in the region (such as Kuwait, Qatar, Bahrain, Oman and Israel), just as some European nations (the United Kingdom, Belgium, the Netherlands, Germany, Switzerland, Denmark, Italy and Malta), currently find themselves in the position of importing a higher volume of virtual water than that which they take from their own internal resources.

A derivative opportunity from the growing liberalization of international trade is the fact that **virtual water can be considered an alternative source of water**. As a result, it represents an actual tool for managing water resources available to each country. In fact, in our economy that is increasingly open to trade, countries which suffer from a scarcity of water resources within their own boundaries can reduce pressure by importing products with high virtual water content from countries in which this resource is more plentiful, and exporting products with a lower virtual water content.

Finally, international trade of virtual water could mean **a savings in the volume of water consumed** when a product is sold by a country with high **productivity of water resources** (for a given product) to a country with low productivity. For example, in the import-export relationship between the United States and Mexico (Figure 22), it can be seen that there is a type of optimization of water use in the production and sale of wheat, corn and sorghum, thanks to the greater water productivity for these crops in the US as compared to Mexico. In fact, foods produced in the US and exported to Mexico have a markedly lower virtual water content (7.1 million cubic meters) compared with what Mexico would consume cultivating these products directly within their own boundaries (15.6 million cubic meters). From the standpoint of global water resources, the net savings total 8.5 million cubic meters.

Figure 22. Global saving of virtual water in the trade of wheat, corn and sorghum between the US and Mexico



Source: Ashok K. Chapagain, Arjen Y. Hoekstra, "The global component of freshwater demand and supply: an assessment of virtual water flows between nations as a result of trade in agricultural and industrial products", 2006

3. ACCESSIBILITY

"Access to safe water is a fundamental human need and, therefore, a basic human right. It is an urgent matter of human development and human dignity. Together we can provide safe clean water to all the world's people. The world's water resources are our life line for survival and for sustainable development in the twenty-first century."

Kofi Annan, United Nations Secretary-General

3.1 Water: a universal right

These are the words of the then-Secretary General of the United Nations in his opening address to the "*Water for Life Decade 2005-2015*", an initiative born of the need to awaken and channel the efforts of the international community towards the goal of accessibility and fruition of water, a resource that is indispensible for the well-being and dignity of people, as well as the economic and social development of nations and communities.

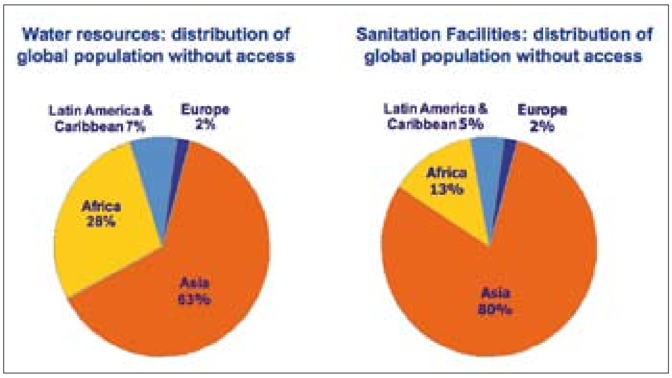
Already in 2002, the United Nations Committee for Economic, Social and Cultural Rights[41] officially recognized[42] water as a "***limited natural resource and a public good*** *and, above all, a* ***human right***". The "***right to water***" lies in recognizing that each individual, without any discrimination whatsoever, has the – **physical** and **economic** – right to an **adequate and safe** quantity of water.

Making **drinking water** accessible in sufficient quantity and quality to satisfy the basic needs of a person (drinking, cooking and washing) is, therefore, a priority shared on a worldwide level, as well as one of the targets (no. 10) of the Millennium Development Goals (MDG) that 147 heads of state and governments set through the Millennium Declaration signed in September 2000.

The *target* to be reached is that of "halving",[43] by 2015, the percentage of the population without sustainable access to drinking water and basic hygiene-sanitation facilities.[44]

To have an idea of the magnitude of this challenge, it should be remembered that currently, over 1.1 billion people do not have access to sufficient and adequate water resources, while 2.5 billion people do not enjoy an adequate hygiene-sanitation system.

Figure 23. Distribution of the world's population without access to water resources and sanitation facilities



Source: The European House-Ambrosetti re-elaboration on WHO/UNICEF data, 2004

The availability of uncontaminated water is a critical factor in the prevention of water-related diseases such as dysentery and typhus, the cause of approximately 1.5 million deaths each year, 90% of which in children under five years of age[45].

41 The United Nations Committee for Economic, Social and Cultural Rights is the body assigned to monitoring implementation by ratifying states of the International Agreement on Economic, Social and Cultural Rights and, as part of this, respect for the principles included in the Universal Declaration of Human Rights

42 UN ESCR, "General Comment No. 15", 2002 (the General Comment is a document which lists a series of guidelines for member states of the United Nations regarding interpretation of specific aspects of the treaty on human rights in terms of the specific competence of the issuing body)

43 The base reference year for this goal is 1990

44 United Nations, "*United Nations Millennium Declaration*", New York, September 2000

45 WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP), "*Progress on Drinking Water and Sanitation*", 2008

According to WHO/UNICEF, in those areas most severely hit by these problems, improved possibility of access to drinking water and treatment and hygiene services would involve:

- a reduction in death rates due to these factors; it is estimated that approx. 1.6 million people could be saved each year;
- a reduction in work hours lost by adults due to illness and therefore greater involvement by them in economic and productive activity;
- a reduction in school absences, i.e., greater participation by children in scholastic activities and education, the primary driving force in future economic development.

According to a cost-benefit analysis conducted by WHO[46] regarding the actual possibility of accomplishing target no. 10 of the Development Goals and related action plans by the year 2015, it was estimated that each US dollar invested to improve access to water and sanitation facilities would generate an economic return of between 3 and 34 US dollars[47]. Naturally, the extent of the economic return varies on the basis of the starting conditions of the area involved and the technologies utilized.

Specifically, pursuing this objective will involve[48]:

- an annual reduction in public health costs of 7.3 billion dollars and, contemporaneously, 340 million dollars in private health costs;
- an annual gain of approx. 1.5 billion healthy days for children under the age of 5, 272 million school days and 320 million work days (for the population between 15 and 59 years of age), for a total of approx. 9.9 billion dollars;
- time savings created by easier access to water, valued at approx. 63 billion dollars per year.

For these benefits, it is estimated that the total outlay required to reach the target in developing countries would be:

- approx. 42 billion US dollars for the part of the goal involving the creation of infrastructure for safe access to water;
- approx. 142 billion dollars for the part of the goal involving meeting hygiene-sanitation needs.

This translates into a per capita outlay of 8 dollars for the first partial goal and 28 dollars for the second[49]. The **total estimated annual investment**, starting in 2005 and up to 2015, would thus be around **18 billion**[50] dollars (4 billion for water and 14 billion for the hygiene-sanitation component) compared with approx. **84 billion** dollars annually in **total benefits**.

3.2 The current water accessibility scenario

The United Nations has established specific criteria for meeting the "right to water". Water must be:

- **available on a continuous basis** and in **sufficient quantity;**
- **safe;**
- **physically and economically accessible.**

The first of these criteria, availability of a **sufficient quantity**, is strongly influenced by the distance between the "water source" and habitation. The minimum accessibility level is that required to meet basic physiological needs. It corresponds to approx. 20 liters per person per day, which generally requires a water source located within a kilometer (or travel time of no more than 30 minutes).

Figure 24. Accessibility level and quantity of water collected

Service level	Distance/ Time	Likely volumes of water collected	Needs met	Intervention priority and actions
No Access	More than 1 kilometre/ More than 30 minutes round trip	Very low (often below 5 litres per capita per day)	Consumption can not be assured Hygiene practice compromised Basic consumption may be compromised	**Very high** – Provision of basic level service
Basic Access	Within 1 kilometre/ Within 30 minutes round trip	Average unlikely to exceed approximately 20 litres per capita per day	Consumption should be assured Hygiene may be compromised Laundry may occur off-plot i.e. away from home	**High** – Hygiene education – Provision of intermediate level of service
Intermediate Access	Water provided on-plot through at least one tap (yard level)	Average approximately 50 litres per capita per day	Consumption assured Hygiene should not be compromised Laundry likely to occur on-plot i.e. within the confines of the household	**Low** – Hygiene promotion still yields health gains – Encourage optimal access
Optimal Access	Supply of water through multiple taps within the house	Average of 100 - 200 litres per capita per day	Consumption assured Hygiene should not be compromised Laundry will occur on-plot	**Very low** – Hygiene promotion still yields health gains

Source: Howard G., Bartram J., "Domestic water quantity, service level and health", WHO, 2003

Improved access to drinking water would make it possible to satisfy physiological, alimentary and sanitation needs of individuals and encourage enhanced attention to personal hygiene.

It is believed that where water is supplied through a single tap, within the confines of the household's living area ("on-plot"), the water used is typically about 50 litres per person per day. This means access to an intermediate level of service and, at this level, it is much easier to ensure good hygiene. For example, it is estimated that households may use 30 times more water for child hygiene compared with those who have to collect water from a external sources.

46 WHO, "*Safer Water, Better Health: Cost, Benefits and Sustainability of interventions to protect and promote health*", 2008. WHO - Guy Hutton, Bartram Jamie, "*Evaluation of the costs and benefits of water and sanitation improvements at the global level*", 2008

47 According to a study conducted by the United Nations, the economic return - measured once again in terms of reducing health costs while increasing profitability and time saved - on each dollar invested in meeting the goal is US$8. UNDP, "*Human Development Report 2006*", 2006

48 Estimates on a global level

49 Hutton G., Bartram J., "*Regional and Global Costs of Attaining the Water Supply and Sanitation Target (Target 10) of the Millennium Development Goals*", 2008

50 According to the authors, these figures are in-line with estimates published in previous studies, the most recent of which, made in 2004, called for a global annual outlay of US$11.3 billion. The most recent estimates stress the need not to focus analysis solely on new structures, but to also take into consideration pre-existing ones and, as a result, the maintenance costs for these associated ones. In fact, they estimate that the maintenance costs required to maintain existing structures in optimum status is approx. US$54 billion per year

51 WHO, "*Guidelines for Drinking-water Quality*", Third Edition, 2008

The second criteria involves the quality of water for human consumption. Water must not contain pathogenic agents or chemical substances that could be a risk to human health. In addition, it must be acceptable in terms of color, odor and taste so that people do not prefer to utilize unsuitable sources.

Parameters for water safety and quality are normally established by local or national regulations. The WHO has drawn up guidelines that may be utilized as a reference for the development of national standards, and which, if properly implemented, assure safe drinking water[51].

As previously stated, the criteria of accessibility states that each individual must be guaranteed safe and convenient access to water resources and infrastructure. It is also specified that accessibility must be assured "near each home, school and workplace".

In addition to being physically accessible, water must also be economically accessible. Assuring accessibility also implies that the cost of the resource conforms to the economic means of individuals.

3.2.1 Access to drinking water

In order to quantify and evaluate the availability and quality of access to water resources on a global level, international organizations utilize what is known as the "drinking water ladder". This methodology differentiates the population on the basis of the type of water system (distribution facility) to which it has access. Drinking water supply is therefore be broken down into three categories:

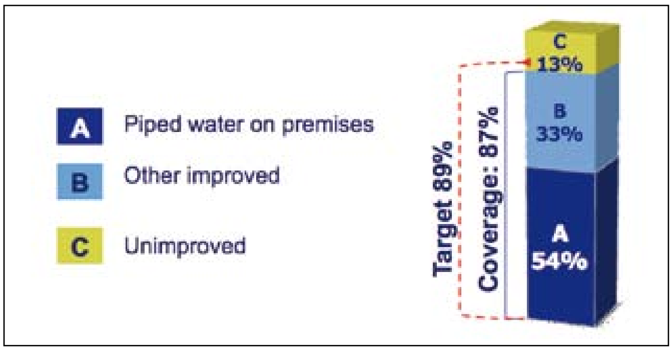
A. piped water on premises: piped household water connection located inside the user's dwelling, plot or yard;
B. improved drinking water sources other than piped water: public taps or standpipes, tube wells or boreholes, protected dug wells;
C. unimproved drinking water sources: access through facilities inadequate to protecting the resource from potential contaminating agents and/or through inadequate means of collection[52].

Currently[53], 87% of the world's population has access to drinking water through plumbing (54%) and/or shared facilities, such as wells and public taps (33%). These facilities are considered suitable to guarantee safe access to this resource.

Compared with 1990, approx. 1.6 billion people, to date, have obtained access to these types of facilities.

In order to meet target No. 7 of the Millennium Development Goals by 2015, an additional 2% of the world population must have these facilities available to them.

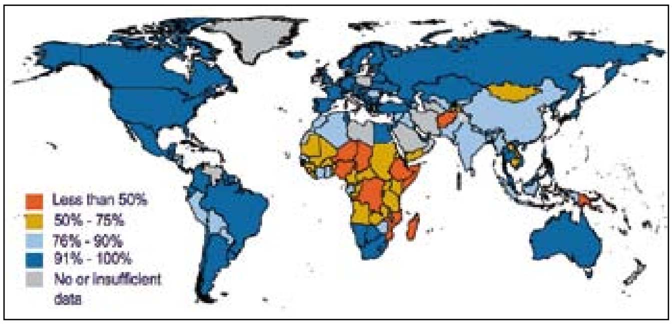
Figure 25. Proportion of the world's population by type of available water facilities



Source: The European House-Ambrosetti re-elaboration of WHO/UNICEF data, 2006

Analyzing this aspect from a geographical standpoint, what emerges is that the countries of Sub-Saharan Africa are those which face the greatest challenges for having access to drinking water. Approximately 1/3 of the people who do not benefit from safe, constant water supply live in these areas. In Europe, it is estimated that approximately 41 million people live in these conditions.

Figure 26. Drinking water coverage, 2006

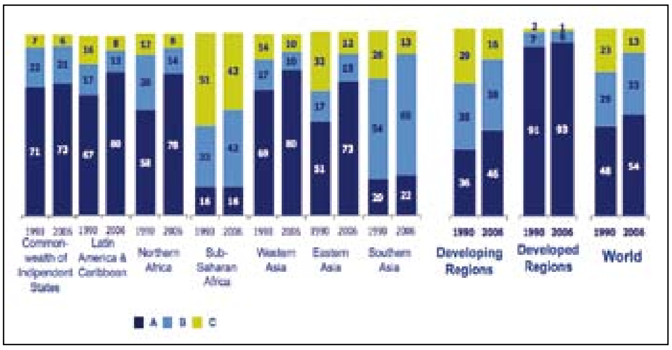


Source: WHO/UNICEF, "Progress on Drinking Water and Sanitation", 2008

In the countries of Sub-Saharan Africa, the availability of suitable facilities (types A and B) is decidedly less than in other countries. Nonetheless, looking at the progress made since the 1990s, it can be seen that the percentage of people benefiting from direct or indirect water access has increased from 49% in 1990 to 58% in 2006 (+9%). This means that an additional 209 million Africans have had access to safe water resources.

52 WHO/UNICEF, "*Progress on Drinking Water and Sanitation*", 2008
53 These figures refer to the most recent data available, for the year 2006

Figure 27. Percentage of the population with access to drinking water, by type of facility (percentage of the total population), 1990-2006

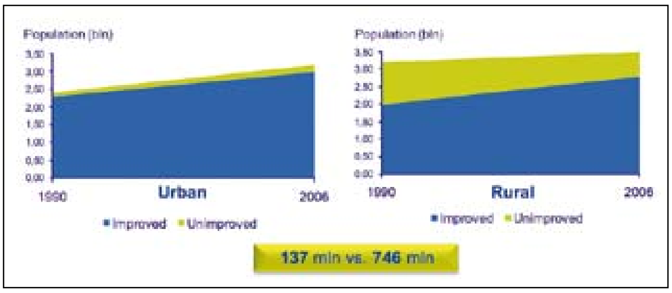


Source: The European House-Ambrosetti re-elaboration of WHO/UNICEF data, 2008

Analysis of the situation, also from the point of view of the type of human settlement, is important for highlighting the most critical areas for action. In fact, one of the greatest disparities in the field of water and sanitation facilities is that between urban and rural areas. This is the case, not only because in rural areas income tends to be on average lower, but also because it is more difficult and often more costly (on a per capita basis) to supply these services to a scattered rural population, as opposed to a more-concentrated urban population.

As can be seen in Figure 28, there continues to be a marked disparity between urban and rural areas. A full 746 million people living in rural areas do not have access to safe water sources, against 137 million people in urban areas. Eighty-four percent of the world population that gets their supplies from non-secure water sources lives in rural areas.

Figure 28. Access to water resources, urban vs. rural areas, 1990-2006

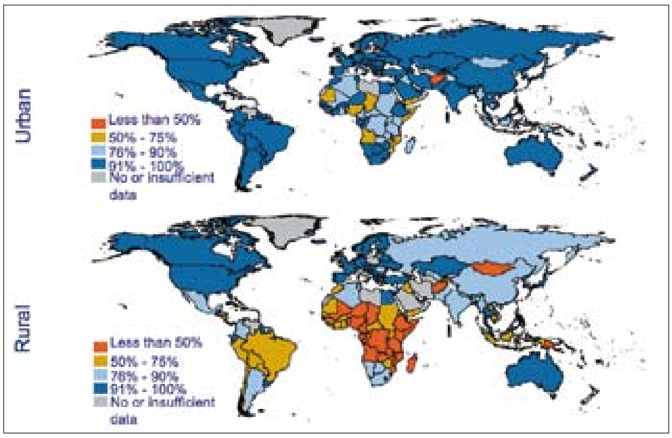


Source: The European House-Ambrosetti re-elaboration based on "Progress on Drinking Water and Sanitation", WHO/UNICEF, 2008

In addition, compared with 1990, the urban population has grown by approximately 956 million people, 926 million of which have obtained access to suitable facilities. As a result, the part of the urban population without suitable access has grown from 107 to 137 million. The challenge of being able to meet the growing needs of urban areas is also one not to be underestimated.

The disparity of access between urban and rural areas is more accentuated in Latin America (91%-100% vs. 50-75%) and in the regions of Sub-Saharan Africa, especially in Mauritania, Liberia, Nigeria, Niger, Angola, Mozambique, Somalia and Eritrea, where the availability of safe water resources is between 50% and 75% for those living in urban areas, compared with levels under 50% in rural areas.

Figure 29. Coverage of improved drinking water sources, urban areas vs. rural areas, 2006



Fonte: WHO/UNICEF, "Progress on Drinking Water and Sanitation", 2008

From the analysis performed by the WHO/UNICEF, it emerged that **the current situation is in-line with the goal set by the United Nations. If current trends are maintained, by 2015 the percentage of the population with direct access to water in their own homes will be greater than 90%.**

3.2.2 Access to sanitation facilities

The Millennium Development Goal (target No. 10) does not refer merely to water supply, it also makes explicit reference to access to basic hygiene-sanitation facilities (sanitation facilities in habitations, sewers, promotion of better hygiene practices, etc.).

The need for sanitation facilities and sewers is directly connected to the protection of the quality of water resources from contamination from human and animal waste.

In order to measure current availability as well as the progress attained in this area, international organizations utilize what is known as the "sanitation ladder", a method of analysis that divides the population on the basis of the type of sanitation facility they have available. This method differentiates between:

A. Improved (suitable) sanitation facilities (62% of the world population);
B. Shared sanitation facilities[54] (8% of the world population): sanitation facilities of an acceptable type shared between two or more households;

54 Facilities which prevent contact between man and his own excrement. These include: flush toilets, accompanying sewer system, septic tanks, etc.
55 The category D is defined "open defecation" - WHO/UNICEF, "*Progress on Drinking Water and Sanitation*", 2008

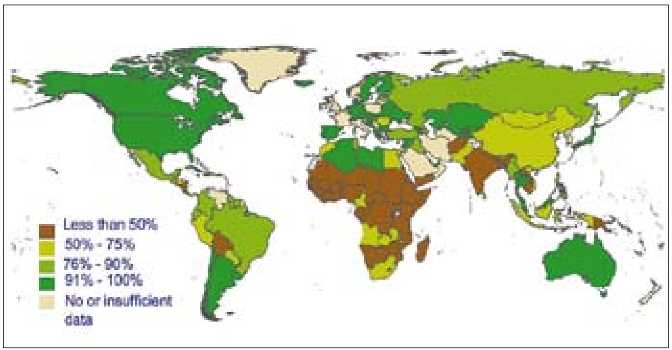
C. Unimproved (unsuitable) sanitation facilities (12% of the world population): facilities that do not ensure hygienic separation of human excreta from human contact;
D. Facilities not available (18% of the world population)[55].

Figure 30. Percentage of the global population by type of available sanitation facilities, 2006

Source: The European House-Ambrosetti re-elaboration of WHO/UNICEF data, 2008

Currently, 2.5 billion people do not have suitable sanitation facilities available to them. Seventy-six percent of these people (1.9 billion individuals) live in **Asia** and 12.5% in **Africa** (313 million people), while in **Europe** it is estimated that the level is 3.4% (approx. 85 million people).

Figure 31. Percentage of the population by availability of improved sanitation facilities, 2006

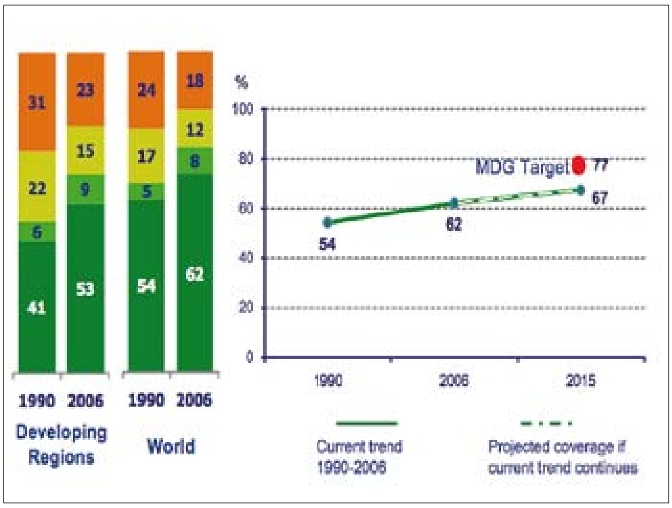


Source: WHO/UNICEF, "Progress on Drinking Water and Sanitation", 2008

From 1990 to 2006, approx. 1.12 billion more people (+8%) on a global scale, benefited from suitable sanitation facilities. This means that the percentage of the world population currently[56] satisfied is approx. 62% of the total.

The majority of the countries not in-line with meeting this Millennium Development Goal are in Sub-Saharan Africa and South Asia. Unfortunately, for this aspect, it will not be possible to meet the goal if current trends are maintained.

Figure 32. Percentage of the population by type of available sanitation facilities, 1990-2006 and trend, 1990-2015



Source: The European House-Ambrosetti re-elaboration of WHO/UNICEF data, 2008

Recognizing the importance of sanitation facilities for health, the environment, reduction in poverty and economic and social development, and given the inadequacy of the results attained, the United Nations proclaimed 2008 the "International Year of Sanitation", their purpose being to take on the problem through increased deployment of resources and financing which would contribute to reaching a situation of greater equilibrium.

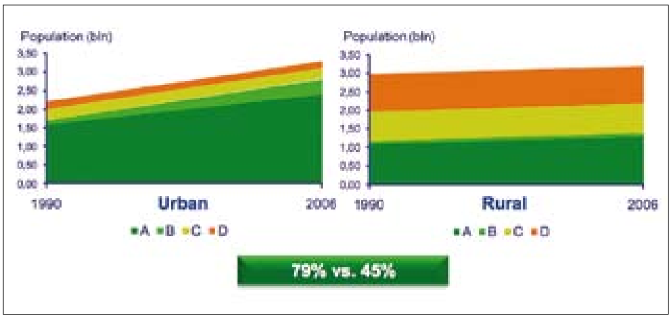
As already stated in reference to water supply, there is a marked **disparity** between **urban areas** and **rural areas.**

The percentage of individuals with access to suitable facilities in urban areas has reached approx. 79%, while in rural areas it is approx. 45%. This means that over 7 people out of 10 who are without sanitation facilities, live in rural areas.

The growing process of urbanization under way therefore represents a growing challenge. In fact, compared with 1990, even if 779 million people have gained access to suitable sanitation facilities (type A), a further 177 million have not benefited from them. The ability to offer this service has not been able to maintain the same rate of growth as that of the urban population (+956 million people).

56 These figures refer to the most recent data available (2006)

Figure 33. Trends in sanitation facilities coverage, urban vs. rural areas, 1990-2006



Source: The European House-Ambrosetti re-elaboration based on "Progress on Drinking Water and Sanitation", WHO/UNICEF, 2008

3.3 Summary remarks

Actions aimed at improving the water supply and the hygiene-sanitation facilities of a community must not be adopted in an isolated manner, but be part of a **coordinated intersectorial development strategy** that includes **infrastructure**, **instruction** and **governance capabilities**.

In fact, to have the facilities operate in an efficient and sustainable way over time requires **periodic maintenance** as well as **education** and creation of **professionals** appropriate to this purpose. In addition, the communication of **information** regarding collecting/preservation methods of water resources in habitations represents a critical factor in maintaining the organoleptic qualities of the water over time and preventing the creation of potential habitats for disease-carrying insects.

Meeting the goals set by the United Nations requires **joint involvement** of all players on both a **local** and **international** scale, whether **public** or **private** entities.

4. ECONOMIC EVALUATION OF WATER

"*Nowadays people know the price of everything and the value of nothing*"

Oscar Wilde

4.1 Equity and efficiency: towards new water resource management models

Water has always been considered a "public" resource and as such entrusted to the management of national governments and local public entities. This is because of its fundamental role as an "essential good" for subsistence in the lives of people.

Only recently has there entered into the debate on an international level the need to verify the adequacy of the set of goals that water delivery systems pursue given the changes in the reference context.

In fact, **a system of fixed rules** to answer primarily the legitimate and fair criteria of **social equity** (access to water for all) finds itself currently in difficulty faced with the emergence of a second, equally important goal: efficient use of the resource[57]. It is clear that, at least in part, these two goals are contradictory.

The risk lies in the fact that focusing attention solely on equity could give rise to the impossibility of meeting it in the medium-to-long term due to the partial unavailability of the resource itself. For this reason, a long, hard look must be given the thinking behind how water supply facilities operate so that equilibrium can be found within the facilities between the objectives themselves, starting–in particular–from the two cited above.

The systems of rules that govern water management and distribution–in particular the ways of assessing the value of the good–are a central aspect of each line of reasoning regarding water management. While regulatory structures depend on the specific conditions of each country (and each geographical and administrative region within the country itself) and therefore must be analyzed in a much more specific manner, the theme of evaluation of water can be approached from a fairly general standpoint. For this, the introduction of **economic models that can correctly price water resources** constitutes an important turning point in defining regulatory structures capable of giving proper scope to the need for enhanced protection of water resources[58].

Given the near impossibility of making use of efficient market mechanisms[59] (only natural given the public nature of this good) that automatically promote the search for a point of convergence between value and price, the water pricing models currently in use are often contradictory and even arbitrary. They reflect the uncertain assessment of the value of the underlying good to which to attach a coherent price level.

4.2 Why an economic evaluation of water?

Water is a "*scarce economic good*",[60] whose preservation is increasingly important.

57 "*Supply Water - For a Price*" - International Decade for Action, Water for Life 2005-2015, United Nations, 2004
58 "*Sustainable water pricing*" - J.A. Beecher, P.E. Shanaghan
59 http://www.nwc.gov.au/www/html/491-water-market-information.asp
60 "*Water has an economic value in all its competing uses and should be recognized as an economic good*" - Principle No. 4 Dublin Statement, International Conference on Water and the Environment in Dublin, 1992. "*Water is no different from any other economic good. It is no more a necessity than food, clothing, or housing, all of which obey the normal laws*" - Baumann and Boland, 1998
61 UNESCO, "*Water in a Changing World*", The 3rd UN World Water Development Report, 2009

Specifically, there are four main reasons (which even leading international institutions make reference to) in favor of a correct economic evaluation of water[61].

- to render efficient the allocation of available water resources between alternative uses through identification of a "correct price" for the various uses (agricultural, industrial and domestic);
- to make clear, shared and recognized the value of a resource which, because of its scarcity, must not be wasted (the issue of water waste) and, because of its importance in the life of man, must be made available to broad-scale layers of the world's population which are currently denied access to this resource (equity of access);
- to render sustainable over the long-term investments in infrastructure and water services, including also to solicit future private initiatives to work alongside public ones (Public-Private Partnerships - PPP);
- to render increasingly efficient and efficacious international and national political decisions on allocation (geographic and use) of this resource, infrastructural investment and reduction of waste.

4.3 Factors required for a full economic evaluation of water

First of all, a distinction should be made: in terms of economic evaluation of water, price, cost and value of the water are spoken of.

Price refers to how much people pay for water in relation to consumption and tax burden. Cost is determined by the overall costs required to supply water to consumers, i.e., the overall operational costs related to infrastructure and maintenance and to cover investment. Finally, the economic value of water is referred to when not only price and cost are taken into consideration, but also the social-cultural significance and overall direct and indirect benefits generated by the availability and use of the resource[62].

In fact, there are many factors that impact upon the value each individual and the entire community attribute to water. Among these, for example, are the economic resources of the user and country (available income, buying power, etc.), how the water will be utilized (agriculture, industry, domestic, etc.), ease of supply (availability of the resource, infrastructural efficacy and efficiency, etc.), the system of social, cultural and environmental values (ethnic group, religion, traditions, lifestyle, urbanization, attitude towards water as a resource, etc.). Specifically, it is this last factor which, more than the others, impacts on value[63]. In the world, there are significant differences in attitude, sensitivity, attention and commitment of people and communities towards water use and conservation.

However, the value of a resource can also be determined by calculating all the cost items required to guarantee its availability in the medium-term. In this case, the overall cost of the resource and its value would equal out. This is what the *Sustainable Cost Recovery*[64] model is based upon, which equates the economic value of water to the sum of direct and indirect costs traceable to water and its use. Among the various examples of this model is that offered by the World Water Development Report of the United Nations.

Figure 34. The "Sustainable Cost Recovery" model

Source: "Water, a shared responsibility", UNESCO - The 2nd UN World Water Development Report, 2006

But in this case, what does it mean to take the reference context into consideration? Let's take a look at an example. In developed countries where wealth is more diffuse and water availability is higher, a higher price would constitute a way to make the population–generally less attentive to waste–aware of the importance and value of water as a resource. In developing countries, on the other hand, where water plays a vital, indispensible role in survival and where it is already considered, therefore, a scarce resource, including the reference context in determining its value guarantees a greater possibility of access to the entire population through resource management optimization.

A further example tied to water evaluation involves pollution reduction.

Among the costs tied to the economic, social and environmental context, those connected with the negative external effects connected to water use are especially critical. The absence of a price structured in a way to incorporate all the relevant cost components makes free riding economically advantageous. If no one is called upon to pay anything for pollution and waste of water, the best economic choice is thus that of not internalizing the negative external effects caused by one's own activity (pollution or waste of scarce water resources).

Issues that are partially similar were faced by the international community in terms of CO_2 emission pollution of the

62 The 2nd UN World Water Development Report: '*Water, a shared responsibility*', United Nations, 2006
63 Hanemann M., "*The Value of Water*", University of California, Berkeley, 2005
64 Rogers et al. 1998, Savenije, H.H.G. and Van der Zaag, P. 2001, and Matthews et al., 2001 in "*Valuing and charging for water*". The 2nd UN World Water Development Report: "*Water, a shared responsibility*", 2006. UNESCO, "Water in a Changing World", The 3rd UN World Water Development Report, 2009. *Directive 2000/60/EC of the European Parliament and Council, dated October 23, 2000, which creates a framework for EC action regarding water policy. "Strumenti innovativi nelle politiche dell'acqua: economia e partecipazione nella Water Framework Directive*", Alessandro De Carli, Università Bocconi

atmosphere. Naturally, water as a good has its own characteristics, but there does seem to be a parallel in terms of the problems and potential approaches to solving them. As in the case of atmospheric pollution, water is also a public good which generally is provided without having to pay a sum that fully incorporates all costs tied to its use (direct financial costs, infrastructural costs, opportunity costs, negative external effects, etc.). If there were a correct system for economically valuating water, those who could draw from the availability/use of the resource a high use value[65] would be willing to acquire the right to exploit it by paying more for it. Those who attribute a lower value to water would be willing to sell it for an amount not less than the value attributed to the resource.

A similar solution was developed by economist Ronald Coase who developed the theorem[66] which provided the basis for the solution found for the problem of harmful CO_2 emissions.

In the same way, if we take into account the concept of opportunity cost, a good pricing model should provide incentive for more efficient forms of use.

Irrespective of the method adopted[67], current analysis models are not yet fully utilizable. In fact, in addition to requiring high-level scientific skills, there are also a number of problems tied to external factors that are highly-variable and involve qualitative evaluation.

In addition, each country has its own special features that necessitate adjustments in method and analysis. In recent years, however, technological evolution and growing experience in this field have brought about significant improvement in the efficiency of analysis, reinforcing belief in the utility of these tools.

Briefly put, this issue is very complex and still in its early phases of development. What would seem certain, however, is that further reflection connected with water evaluation is a fundamental nexus in optimizing its use and conservation in the medium-to-long term.

65 It should be noted that use value does not simply measure economic return in a strict sense; it indicates the existence and intensity of a positive/negative value for the object at hand, which could also be ethical, social, moral, etc.

66 "*The Problem of Social Cost*", The Journal of Law and Economics (October, 1960). Coase's basic idea is that when the parties interested in external effects can negotiate between themselves without costs, efficiently implement their decisions and have them be respected, a socially-efficient result is always forthcoming, irrespective of how the law assigns property rights (and, with them, responsibility for damage). In these cases, the activities individuals reach agreement upon do not depend on the contractual power of the parties or the goods each possesses at the start of negotiations

67 In the literature, a number of other models for economic evaluation of water and its uses have been proposed, including: calculation of tariffs for water use, water pollution tax and pollution quotas

Part C: Recommendations

5. AREAS OF INTERVENTION

The broad-ranging nature and extreme complexity of this issue, together with its intrinsic interdisciplinary nature, make it very difficult to formulate a concluding statement capable of reflecting the entire spectrum of issues that must be taken on in the future, as well as provide detailed answers relating to them. The level of the recommendations can also vary considerably, depending on the degree of specificity and detail to be pursued.

In addition, the question of water is, to a large measure, specific to each individual country, territory and geographic area. Each situation is different in terms of the availability of this good, resources, competences, culture and regulatory approaches.

On the basis of the nature of this document – which has been designed to highlight the primary critical issues connected to water use with the objective of contributing to raising the level of attention and awareness throughout Italy and the rest of world – we will limit ourselves here to formulating what we believe must be the primary relevant guidelines, along with comments regarding some of the most important and urgent concrete actions.

It should be noted that, in this field, there are no individual measures or actions that could dictate lines of discontinuity. What is involved, on the other hand, is to activate coherent and incisive **overall medium/long term policies** that could provide orientation for economic and productive models over time. But even more than this, the individual and social styles of living and consumption towards enhanced attention and improved use of water resources with the awareness that they represent critical assets for the survival of man and his well-being. Only an overall more balanced use of available water resources can allow us to face the future with greater serenity, as well as promote a climate of peace and social justice in many areas of our planet.

A separate issue, related to each of the recommendations proposed, is that of technology. Each of the points covered implies the use of state-of-the-art technologies, at least in part. In fact, better technology makes it possible to pursue the improvement goals proposed more easily and faster. For this, **technological innovation aimed at water resource management must be promoted and facilitated** because it represents the basic precondition for preserving one of the most important resources on the planet.

In our opinion, there are seven priority areas for action, which are outlined below. Briefly, these are:

1. Prepare policies, **models and integrated management tools** to effectively take on problems tied to water resources. While researchers are increasingly convinced that without an integrated approach (integrated water resource management) that takes into account all possible sources of impact on the availability and quality of water resources no significant results can be made, policy makers are still struggling to create integrated regulatory systems and implement choices arising from them.
2. Break the existing correlation that is very strong today, between **economic growth, demographic growth and the consequent increase in the levels of water consumption**. Without actions aimed at reducing the relative use of water within the industrial and food production processes, the risk of environmental imbalance in the near future is extremely high with catastrophic consequences for the planet and its inhabitants.
3. Orient the behavior of individuals and consumption models towards **lifestyles that imply more responsible utilization of water**. In fact, currently in the western world, the level of awareness of the importance of a different, more respectful approach to water use is very low.
4. Foster **access to water** for populations which currently find themselves disadvantaged from this standpoint, by promoting necessary investment and removing technical and political constraints.
5. Re-think **on a global scale localization of production** of goods with greatest impact on water consumption from an efficiency standpoint. From this standpoint, agricultural products constitute the area of greatest attention.
6. Further develop the concept of ***water neutrality***[68], as a way of efficiently taking on the totality of issues tied to limiting consumption of water resources and as a tangible instrument in promoting more efficient use of this resource.

68 Hoekstra A. Y., "*Water Neutral: Reducing and Offsetting the Impacts of Water Footprints*", UNESCO-IHE, Research Report No. March 28, 2008

7. Rethink the functioning of the markets on which water is traded through definition of economic mechanisms and models characterized by enhanced efficacy and efficiency through the creation of economic models which are capable of precisely defining the economic value associated with water use.

Let us now take a more detailed look at each of these points.

1. 1. MODELS AND INSTRUMENTS FOR INTEGRATED WATER MANAGEMENT

Actions created outside the traditional boundaries assigned to water resource management are today capable of exercising tremendous impact on the way water is used and allocated. Even the recent UNESCO report, *Water in a Changing World*[69] incisively underscores how decisions taken by players outside the water sector have relatively greater weight on the goals of global water resource conservation than the choices and actions available to those directly involved in water management itself. This does not mean that the goals of incrementing the volume of water supplied, reducing loss and increasing overall the efficiency of water management systems that are the responsibility of the former, are less relevant. However it does broaden the area of the goals that must be undertaken, the sectors affected and the allocation processes involved.

For this, as a first step, national governments must be aware of the extent of the challenge and make use of increasingly efficient, integrated models of water management. For an issue of this complexity, understanding the connection between the phenomena in which to intervene is absolutely vital.

2. INNOVATION AND TECHNOLOGY TO INCREASE WATER PRODUCTIVITY

As mentioned in one of the sections above, water – a good that is renewable but cannot be produced – is by definition a scarce resource. Its capability to satisfy growing volumes of needs is subordinated to improved access and high productivity in its use. The ways for successfully taking on the first of the issues mentioned related to the impact on resources by demographic and economic growth processes, involve above all the use of technologies capable of boosting the productivity of water as a resource (thus obtaining quantitatively greater output for the same input, the so-called "more value per drop").

Industrial-related productive processes (which may be more easily standardized and controlled than agricultural ones) make it possible to more easily obtain even very high levels of productivity growth. The introduction of investment incentives into technologies that are already available, can, in fairly short periods of time, lead to significant savings in the volumes of water utilized in productive processes. As a whole, however, industrial-related advances have a lower potential for overall impact and, therefore, have relatively less weight than advances made in the agricultural sector. In fact, it should be borne in mind that agriculture-related use accounts for 70% of global water consumption.

This is, therefore, where the greatest maneuvering room for recovery of productivity can be found. An example is the adoption of advanced techniques for collecting rain water to be used for irrigation.

In addition, the spread of agricultural irrigation management tools and technologies aimed at maximizing efficiency do not always translate into enormous investment into technologies, but often, more simply, into the spread of knowledge and know-how.

3. LIFESTYLES AND CONSUMPTION WITH A LOWER VIRTUAL WATER CONTENT

Awareness-raising actions aimed at modifying lifestyles offer a potentially major possibility for impact. It does not merely involve calling for a more intelligent use of water in daily activity in terms of food preparation and hygiene, but also introducing a generally more attentive mentality to possibilities for water resource conservation. The introduction of diets with a moderate consumption of meat is a good example of a lifestyle that is not only healthier, but also more respectful of water.

More generally, consumption habits should be oriented towards the use of goods and services with a lower virtual water content:

- by increasing consumer awareness about the virtual water content in products, for example, providing on a special label the amount of water consumed in the production of that good or service (product Water Footprint);
- introducing, within each merchandise category, incentive systems for the purchase of products and services with lower water content, perhaps also correlating virtual content to price.

4. WIDE-SCALE COMMITMENT AND RESPONSIBILITY TO GUARANTEE ACCESS TO WATER

In terms of access to drinking water and proper sanitation facilities for the populations of poorer countries, much has been done in the last decade and the results obtained have been encouraging. What is required now is that, even faced with different types of priorities due to the global economic and financial crisis, commitments must be respected and attention to this issue remain very high. European countries, in particular, can play a very important role in this context by making investments, lending support to solve regional political crises and promoting political solutions.

Within this context, information sources also have an im-

69 World Water Assessment Programme, The United Nations World Water Development Report 3, "*Water in a Changing World*", UNESCO, March 2009

portant role. In our view, these sources must play a watch-dog function so that access to water can finally become a universally acknowledged right for all.

Specifically, in terms of accessibility to water resources sufficient to meet basic physiological and sanitary requirements, formulating guidelines and recommendations is fairly complex. There are many organizations and bodies already active in this sector through financing and concrete projects in those areas most hard-hit by this problem. Having defined a specific target within the Millennium Development Goals framework was a further step in this direction, with the promise to create greater awareness, orient the players involved in a single direction and to implement an *ad hoc* program of on-going monitoring.

Here we limit ourselves to noting the importance of backing the actions created by these organizations in a coherent and intersectorial strategy that includes infrastructure, instruction and suitable management capabilities.

5. EFFICIENT LOCALIZATION OF CULTIVATION AND VIRTUAL WATER TRADE FOR GLOBAL SAVINGS OF THE WATER RESOURCES CONSUMED

Correct location of production activities, specifically agricultural cultivation, is an issue which must be taken on with great care. Agriculture, by nature, is strongly rooted to its local context and this cannot and must not be called into discussion. By the same token, while not wanting to outline apocalyptic scenarios, it seems only correct to underscore that the consequences of climatic change (for example, changes in the location and intensity of precipitation) must be taken firmly into consideration in the medium term. What is suggested here is greater attention to the localization of cultivation, also incorporating water efficiency into the system of variables that lead to the choice of a location. In particular, choices involving production location could take advantage of the opportunities to maximize consumption of Green water, instead of Blue water.

In addition, as described in section 2.5, it is also possible to take advantage of the opportunities offered by the growing liberalization of international trade by orienting exchanges of goods with a high virtual water content from geographic areas with high water resource productivity to those areas with lower productivity (*Virtual Water Trade*).

6. WATER NEUTRALITY TO BRING ABOUT A REDUCTION IN THE CONSUMPTION OF WATER AND COMPENSATION OF EXTERNAL FACTORS DUE TO EXPLOITATION

In terms of the issue of reducing the Water Footprint, the concept of water neutrality has only recently been developed. Rendering an activity "water neutral" means reducing its Water Footprint (in other words, reducing the consumption and pollution of the water utilized) to the extent possible and economically compensating the negative external aspects of the remaining Water Footprint (investing in projects that promote fair and sustainable use of water in the environment and community involved).

Generally, this does not mean reducing water consumption to zero (since this is not possible, unlike the concept of carbon neutrality which calls for reducing CO_2 emissions to zero). The concept of water neutrality can be developed for a product, a company (in reference to reducing the Water Footprint and economic compensation of the Water Footprint remaining of the entire supply chain) or for an individual or group. Although its quantitative aspects still need to be developed and defined in more detail, the concept of water neutrality seems to represent a useful tool for guiding stakeholders in the definition of Water Footprint reduction targets and mechanisms for compensating its environmental and social impact.

7. CORRECT ECONOMIC EXPLOITATION OF WATER RESOURCES FOR EFFECTIVE MANAGEMENT AND MORE EFFICIENT USE

The functioning of the water market, whether public or private, is one of the basic issues for promoting greater water efficiency. Central to the debate is the identification of a proper mechanism for defining value. Defining the "proper value" (and, as a result, the right price) of water makes it possible to reduce waste and increase the efficacy of environmental conservation policies.

Determining the price represents the search for a difficult point of equilibrium: it must reflect criteria for equitable distribution – since water is a public good and its access must be protected – and, at the same time, discourage an excessive or improper use. In addition, setting a value is possible, but is difficult to apply since it is conditioned by individuals and the economic, social and environmental reference context. As a result, finding general solutions is difficult.

Despite this, as for all scarce resources, identification of correct systems of distribution rules is of fundamental importance.

The key represented by price also makes it possible to take on, in a tangible way, specific issues of tremendous relevance for what is being discussed here, specifically the issue of industrial pollution. It is clear that, in this case, differentiating the price of water to foster adoption of better water management models for production processes and treatment of waste water, could provide significant incentive for companies for environmental protection.

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