THE ROLE OF TECHNOLOGY IN IMPROVING WATER MANAGEMENT
THE *AQUASTRES*S EXPERIENCE

1 – WHAT IS THE DEMAND FOR TECHNOLOGY IN THE MANAGEMENT OF WATER RESOURCES?

The demand for technology to improve the management of water resources has developed over time in three phases. The first phase, which lasted many centuries, involved the collection of good quality water and its transportation, even over large distances, to the point of use, as well as the disposal of waste water. The technology deployed was mainly of the civil engineering type. This phase, which dates back to antiquity and of which archaeological evidence still exists, lasted until the Industrial Revolution in the 19th century, when chemical and biological technologies became available and it became more economical to draw supplies from closer and lesser quality sources.
In the second phase, these technologies, based mainly on the use of coagulant and oxidizing chemical products to clarify and disinfect the water, as well as various forms of microbiological beds to metabolize organic substances, have made considerable progress in recent decades. However, they have reached their peak technological and economic efficiency in the third phase, in which we are living, which is characterized by a radical change in demand, now characterized by greater complexity and in some cases by outright crisis. The causes of this change must be sought above all in the rapid population growth and in the process of globalization, which lead to rapid variations in the distribution and intensity of the demand as a result of the great migratory flows, large urban concentrations, industrial development and increasing food needs.
Situations of crisis are also caused by climate variations which are increasingly producing unpredictable and widespread scarcity of natural resources for long periods of time, even in geographic areas where sufficient resources are normally available. Extreme events of this kind are often, in some parts of the world, the cause of a worsening situation of hunger and poverty culminating in great migratory flows and sometimes war among populations.
The response to this new type of demand, which sometimes takes on dramatic overtones, cannot be reduced, as we shall see below, to the mere provision of technology, however necessary, but also

requires more sophisticated solutions in which technical action is accompanied by action of a social, economic and institutional nature and, when necessary, by international agreements. This approach corresponds to the need to provide systemic solutions which supersede the previous approach based on sectorial action.

2 – TECHNOLOGICAL INNOVATION

Technological innovation is necessary to ensure the future well-being of society and its sustainable development by making available the necessary tools to cope with the prospects of increasing water stress whenever this is due to scarcity, qualitative deterioration, or waste of available resources. The need and opportunity for technological innovation have led to a wide-ranging debate recently being carried out in the public and private sectors by the European Commission and involving institutional, scientific and industrial subjects as well as consumers. The results of this debate are contained in a series of interesting reports and grouped into the following types of priority solutions:[1]

- Integrated Water Resources Management (IWRM)
- Better management of demand and supply
- Improvement of water quality and security
- Development of novel approaches to the design, construction and operation of water infrastructure assets
- Establishment of an enabling framework

Evidently, these are indications for systemic solutions into which technology must be integrated in the various applications. It is therefore important to note that technological innovation must take these needs of integrability into account.

[1] European Water Supply and Sanitation Technology Platform (http://www.wsstp.org)

The most widespread and significant technology implications refer to drinking water supply and the industrial sector, especially as far as water treatment is concerned. However, also agriculture needs technology, in particular for wastewater re-use in irrigation.

The technologies with the greatest potential for development in the various sectors of use are

- For drinking water supply:
    - methods and tools for reducing domestic consumption
    - the treatment of non conventional resources (recycled water, desalinated water, rain water)
    - improvement of quality and security of distributed water
    - reduction of environmental impact of the treatment of supplied and discharged water
    - improved maintenance of water treatment and distribution plants
    - containment of production costs
    - simple economic devices for supply and treatment of discharges in scattered and remote settlements
    - diffuse and remote control of quality and consumption
- For industrial supply:
    - process modifications to reduce water consumption
    - reduction of environmental impacts by means of process modifications, elimination of harmful chemicals from industrial processes, more sophisticated discharge treatment technologies which may include selective techniques
    - optimization of energy cycles and energy recovery resulting in the production of desalinated water
    - more advanced monitoring and control systems
- For agricultural supply:

- simple and economic use of non conventional resources (wastewater, cascade systems, brackish water, other marginal water resources)
- intelligent irrigation systems (leakage detection systems, real time monitoring of water quality and quantity)
- introduction of crops resistant to salinity and drought
- reduction of environmental impacts by reducing emissions (improved animal diets, replacement of minerals fertilizers by more sustainable alternatives, such as manure, bio-solids, wastewater
- optimization and control of agrochemicals use.

3 –BARRIERS TO THE INTRODUCTION OF TECHNOLOGY AND INNOVATION

The introduction of new technologies in the three sectors examined has generally taken place slowly. The culture of drinking water supply systems is highly conservative and resistant to new technologies when these require change or adaptation of existing infrastructural systems whose construction entailed significant financial investments. This is true even though drinking water supply systems are generally old and quite likely in need of improvement.

A transversal culture prevails in which problems are solved at a central level which is comparatively unfavourable to local solutions. The instinctive suspicion that a reduction in the quantities of water supplied lengthens the time required to amortize the huge infrastructural investments and thus increases amortization costs also has a negative effect on measures aimed at reducing water consumption

Industrial systems tend to prefer to use tried and tested technologies and are not inclined to implement changes which cannot guarantee the continuity of industrial processes

As far as the agricultural sector is concerned, change is typically much slower than in the other two sectors and so the resistance to the introduction of new technologies is greater, also because in this sector the return on new investments is generally more difficult.

In identifying the principal critical factors determining this state of affairs it must be said from the outset that in the water sector the timing and mode of change are determined mainly by the existing system of rules as well as by the behaviour of public management systems, which exert a strong influence on that of private systems.

The regulatory tool exerting the strongest influence is clearly that of standards. When the EU, a State or a Region adopts a more rigorous standard that the one against which the systems in use are measured, the adoption of a new technology may become a necessity. The same may be said, in the opposite sense, of the absence of standards to guarantee the users of new technologies, such as in the case of recycled wastewater for which the system of rules is inadequate in practically the whole of Europe.

In addition to these barriers of a psychological – cultural and regulatory nature there are also barriers of an economic nature linked to the high cost of new technologies during their early stages, that is, before market development allows these costs to be reduced. This sets up a vicious circle that only targeted action by public authorities can break.

Other barriers are:

- the length of time and high cost necessary for new technologies to progress from the laboratory to their full-scale implementation, requiring efforts that many companies are unable to sustain on their own

- the considerable weight of public investments, whose procurement procedures entail offering prices based on the design by a consultant, who normally hedges hisor her risks by adopting conventional technical solutions
- the inadequacy of the management and technical skills of both public and private subjects who decide on the investments, which actually leads them even to forego the opportunities and advantages offered by comparatively new yet well proven technologies, as in the case of IT tools for controlling the wastewater collection and treatment process or for preventive rehabilitation of drinking water networks.

4- EMBEDDING TECHNOLOGY IN AN IWRM SYSTEM

From the previous discussion, it has clearly emerged that it is essential to use increasingly enhanced technologies to solve water supply problems which change over time and tend to become more complicated. However, it also emerges the fact that that technology alone is not enough to solve these problems satisfactorily. The acceptance of the use of new technologies requires the existence of a set of favourable conditions of a non technical nature that respect the social, economic, cultural and legal aspects typical of the context in which the new technology is implemented.

This is the basis upon which the new concept of Integrated Water Resources Management (IWRM) is founded. This concept not only includes the conventional aspects of protecting the quantity and quality of the resources, of water treatment and distribution, but also includes careful consideration of consumer expectations, their requirements, and their acceptance of the consequences of the choices made.

The availability of fresh drinking water is considered one of the unalienable rights of man and must therefore be guaranteed by governments. The awareness of this right inevitably gives rise to suspicion surrounding the growing tendency to entrust water services to private companies. This

conflict has given rise to a still unresolved debate that was echoed strongly at the last World Water Forum in Mexico.

On the other hand, the production of water is an expensive business and the apparently simplest way to cover the costs is to sell the water on the market as a commodity, which is something private companies are accustomed to doing. Two different ways of organizing the water sectors thus exist, a public one and a private one. Experience has shown that the first is unlikely to guarantee the necessary technological progress and the second runs the risk of being unduly speculative, thus making the cost to the consumer unduly high. This leads to the difficult task of setting a correct balance between the consumers' right to have the water they need and the companies' right to earn a just profit from their investments.

None of the organization schemes adopted by the various governments to solve this problem has so far succeeded in settling the controversy. Obviously no choice can neglect that a primary regulatory function of governments to safeguard the interest of the two parties, with special attention being paid to the weaker sectors of society.

The continuing debate on such delicate ethical and legislative issues must be backed up by an important information and communication effort which should uniform the level of knowledge of the problems possessed by the subjects concerned in the institutional, scientific, entrepreneurial and community world, and lead each part to appreciate the perception of the problems and expectations of the other, thus promoting a climate of mutual confidence that encourages widespread participation in the decision-making processes.

The importance of this principle can be demonstrated using several examples. Suffice it to think how the attainment of a sufficient level of public awareness canl ensure a greater readiness of

consumers to acknowledge the correct cost of water and adopt the proper behaviour to reduce consumption and resolve conflicts among users.

This must all be provided for in the body of the legislation, which has to set out the fundamental principles governing rights and opportunities, safeguarding both, provide correct responses to the previously discussed demand for change, and establish an enabling framework for the definition and application of systemic solutions for water supply which respect local conditions.

5-THE EU INTEGRATED PROJECT *AQUASTRESS*

The problems described above constitute the background of a research proposal which was funded by the European Commission, within the 6th Framework research program, as an Integrated Project named *AquaStress*, aiming at mitigating water stress through new approaches to integrating management, technical, economic and institutional instruments.

The *AquaStress* rationale is based on the following principles:

- water stress is a global problem with far reaching economic and social implications
- the mitigation at regional scale has traditionally relied on technology- intensive solutions rather than on the control of demand accompanied by policy and regulatory measures
- a cultural change in the European approaches to water stress and water management is needed, from centralist infrastructure dependency towards a bottom-up adaptive system approach
- research should improve the understanding of water stress and promote adequate responses from an integrated multi-sectorial perspective (institutional, socio-economic, environmental, technical)
- operational approaches should be tailored to local needs and developed through a participatory process involving citizens and user communities.

AquaStress generates scientific innovations to improve the understanding of water stress from an integrated multi-sectorial perspective to support:

- diagnosis and characterisation of sources and causes of water stress;
- assessment of the effectiveness of water stress management measures and development of new tailored options;
- development of supporting methods and tools to evaluate different mitigation options and their potential interactions;
- development and dissemination of guidelines, protocols, and policies;
- development of a participatory process to implement solutions tailored to environmental, cultural, economic and institutional settings;
- identification of barriers to policy mechanism implementation;
- continuous involvement of citizens and institution within a social learning process that promotes new forms of water culture and nurtures long-term change and social adaptivity.

The main aim is to develop stakeholder-driven; European- scale, comprehensive integrated approaches to the diagnosis, prognosis and mitigation of water stress through:

- new insights into pressures and drivers of water stress in different regions
- assessment of divers policies, institutions and cultural factors as causes and remedies of water stress
- integration of multi-sectorial expertise for vulnerability assessment, solutions evaluation and adaptive planning
- understanding and empowerment of stakeholder-driven participatory decision-making in water management
- development of social learning processes promoting new forms of water culture.

The project addresses the greatest challenges facing water managers, that is how best to continue existing and new analysis and mitigation options to deliver integrated sustainable solutions, through the following expected outcomes:

- a radically innovative water stress mitigation framework
- comprehensive guidelines to implement mitigation options on different scales.
- IT knowledge management tools to support the new integrated stakeholder-driven approach
- enhanced methodologies to evaluate effectiveness of measures and to develop tailored mitigation options
- impact assessment of new technologies
- tools for embedding culture change in society through training and education.

Research is continuing to make incremental improvements to the very large number of diverse technologies, management systems, social measures and economic and policy instruments that are being used to mitigate water stress However, research, development and demonstration of even one new technology require a huge investment over a long period of time, and this is therefore beyond the scope of this IP. One of the greatest challenges in respect to global water stress is to make better use of the tools which already exist. *AquaStress* makes a major contribution towards this objective. To do this, it explores new interfaces between technologies and social approaches, disciplines and sectors, and develops a radically innovative water stress mitigation conceptual framework and guidelines to implement integrated options.

In order to facilitate the change from a culture dominated by “infrastructure” solutions to more integrated approached, attuned to local needs and supported by the citizens, *AquaStress* has the following characteristics:

- it is grounded on a *Case Study approach.* The IP works intensely in eight different Test Sites which are representative of water stress problems across Europe and North Africa.

- it is truly stakeholder driven. Local Stakeholder Fora have been established in the eight Test Site areas, while one other high level Stakeholder Forum provides a European scale overview.
- it emphasizes the integration of multi-disciplinary expertise to address complex social and physical problems. A high level of flexibility has been included within the project plan to facilitate the "Call Down" of a wide range of expertise to inform and advise the local Stakeholder Fora involved in the Case Studies. In particular experts develop advice on the many inter-sectorial linkages and feed-backs in the Case Study areas.
- these three aspects of *AquaStress* are supported by a IT knowledgebase system which facilitates the integration of research activities, the workings of the stakeholder fora, dissemination of research progress and communications, and provides operational guidelines and tools for stakeholder driven integrated water stress mitigation solutions.
- an extensive and intensive training and education programme embeds *AquaStress* within the Test Sites, informs and extends the involvement of the wider community in the project, and communicates research results widely across Europe and internationally

The *AquaStress* dimensions are illustrated in Fig. 1, while Fig.2 indicates the locations of the Test Sites.

6- CONCLUSIONS

In conclusion, while the development and application of technologies has a role in the improvement of water management practices across Europe, this alone cannot provide the solution to water scarcity problems that we are facing to an increasing degree.

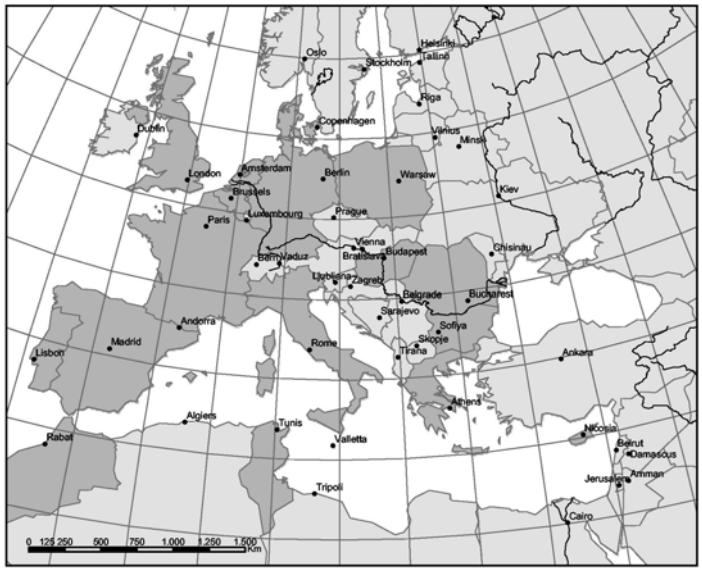
The introduction of new technologies for water management in the three main sectors, civil, industrial and agricultural, is slow and subject to barriers of a technical, economic, regulatory,

institutional and cultural nature. New systems of Integrated Water Resources Management recognize this and provide a framework for integrating new technologies into a broader picture which involves changes at a societal and behavioural level.

The EU, and specifically the Directorate for Research, has embraced these concepts and through the funding of the IP *AquaStress* and other research projects, is providing support for research aimed at developing new approaches for integrating technical, economic and institutional instruments for the mitigation of water stress. The results of the research should support the development of a broader water management picture, and the implementation of new behavioural models and regulation for addressing water stress at a European level.

Figure 1 - *AquaStress* dimension

Aquastress Dimension



- Consortium

35 Partners
17 Countries (Europe and North Africa)

- Project life

4 years

- Budget

Project cost 14.087 K€
EC grant 10.300 K€

- Research units & effort

7 Work Blocks
31 Work Packages & 174 Tasks
1449 PM of RTD

4

Figure 2 – *AquaStress* Test sites